THE EFFECT OF CHANGING AREAS AND LEVELS OF TECHNOLOGY OF CORN AND COTTON PRODUCTION ON THE NET FOREIGN EXCHANGE IN THAILAND

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ABSTRACT

THE EFFECT OF CHANGING AREAS AND LEVELS OF TECHNOLOGY OF CORN AND COTTON PRODUCTION ON THE NET FOREIGN EXCHANGE IN THAILAND

By

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The primary objective of this study was to evaluate the net foreign exchange position of the country with major emphasis on shifting production patterns and technology levels of crop production in Thailand. Five alternative strategies involving shifts in production patterns and technology levels for corn and cotton were evaluated.

To evaluate the alternatives, costs, returns and net returns per rai were calculated based on survey data and related information, then foreign exchange components of inputs were disaggregated to calculate the foreign exchange costs and returns per rai of rice, corn and cotton, then these results were aggregated for a major production zone as a basis for evaluating the alternative strategies.

The results of the analysis showed that shifting cotton area to traditional corn production with a rapid increase in modern corn production would improve farmers' income and net foreign exchange and would be feasible with regard to

current labor supplies in the region. On the other hand, rapid expansion of modern cotton production relative to modern corn production would result in the highest net return for the alternative considered but would not be feasible with current labor supplies. Considering the alternative of rapid expansion of modern corn production leaving cotton areas and technology unchanged, the results indicated the highest net foreign exchange but this alternative also would result in labor shortage. Finally, a compromise alternative with a slow increase of modern corn and cotton production would result in a small increase in total net return and net foreign exchange as well as leaving some labor surplus.

In evaluating these alternatives the approach was to measure the effects on farm earnings and net foreign exchange from strategies which would consider different rates of technological growth and shifts in the production pattern for the major crops under study. The methodology did not include a search for the optimum solution. The "best" solution depends on the weighting of alternative national goals, the time period within which national goals should be fulfilled, and the extent of the national commitment to fulfill these goals.

To the extent that both improved net foreign exchange earnings and improved net earnings for farmers in a production

area suitable for both corn and cotton production are goals of high priority this study is offered to provide tentative guidelines for policy making and for specifying further research.

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By

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To my parents.

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CHAPTER I

INTRODUCTION

Thailand is an agricultural country. She has long been food self-sufficient and a leading rice export country in South-East Asia. Although other sectors of the economy are rapidly gaining in importance, roughly 86 percent of the population live in rural areas and mostly as farm households. Agriculture employs at least 76 percent of the labor force and provides some 73 percent of total export earnings. The rate of growth of Thai agriculture is high, even on a per capita basis. From 1961-62 to 1969-70, the annual increase in total farm output averaged 4.9 percent, or 1.5 percent per capita.[1]

Thai agriculture consists primarily of crop production. Rice is the most important crop not only for domestic consumption but also for export. Rice has long been the traditional export of Thailand (since 1855) and still remains preeminent, but corn, rubber, cassava, kenaf, oilseeds and cotton have gained importance in the past 10-15 years. The main factors

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[1]Omero Sabatini. The Agricultural Economy of Thailand. ERS-Foreign 321, Washington, D.C.: U.S. Department of Agriculture, Economic Research Service, 1972, p. 2.

stimulating increased production of these crops have been the government efforts to develop an agricultural infrastructure, training, research and extension activities coupled with increased foreign demand for these crops.

The success of Thai agriculture in expanding and diversifying its production has contributed to the remarkable economic development of the country over the past decade. Not only did agriculture provide a steady and sometimes expanding flow of foreign exchange resources, but it also was able to absorb many of the new entrants into the labor force productively and thereby expand the internal demand for the products of the urban sector.

The relative increase in agricultural production was brought about by increases in the area cultivated. The increase in yields has not been significant for the last two decades. There were obstacles in the methods of production, availability of inputs, knowledge among the farmers and fluctuation of output prices. Historically, the production increase was largely due to opening up new land. As the population and demand increased, more land was brought under cultivation. At the present time, the virgin lands are almost completely exploited except for an area under forest reserve law. The opportunity to open up new lands no longer exists. Thus further increases in overall production must rely heavily on yield increases through new technology such as using new seed varieties, fertilizers, insecticides, herbicides and production practices.

The Problem

Thailand, like other developing countries undergoing the process of economic development, needs foreign exchange to import capital inputs as well as certain raw materials needed to facilitate economic growth. For several years before 1969, Thailand was able to offset a large trade deficit and maintain a favorable balance of payments through capital transfers resulting largely from foreign aid, U.S. government expenditures in Thailand (mostly military), tourist revenues, and foreign investments.

The surplus in the balance of payments allowed Thailand to keep its imports essentially free of any restriction. However, the trade deficit widened rapidly in the late 1960s, primarily because of a rapid increase in the importation of consumer goods both durable and nondurable; they were increased more than 48 million dollars in 1972.[2] In 1969, the balance of payments showed its first deficit (some $48 million) in about a decade. In 1970, the deficit was considerably higher, amount to $137 million, it declined to $86 million in 1971 but was a surplus in 1972 amounting to $98 million.[3] The trade deficit was reduced in 1972 over 1971 by $34 million due to increased value of exports.

Prospects for a stable surplus position in the balance

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[2]Department of Customs.

[3]Bank of Thailand, Monthly Report, May 1973, p. 68-9.

of payments are not favorable for several reasons. The world demand for a number of Thai export commodities are weak and rely heavily on the performance of other countries; nonfarm commodity imports are likely to continue at high levels; and imports of capital inputs for agriculture and industry will continue to rise as Thailand sustains its process of economic development.

The government has begun taking action aimed at improving the balance of payments. One attempt is to intensify its export promotion activities, as well as the effort to increase foreign sales through negotiated international agreements. The major exports from Thailand are mainly agriculture products, although the relative importance in total trade has declined from 86 percent in 1961 to 73 percent in 1969.[4] The domestic demand increase due to population increases overrode the slower growth in productivity. The government's strategies are to increase research to encourage farmers to use modern inputs, modern practices and to diversify agricultural production. These strategies are aimed not only at increased productivity for domestic and export use but also to improve income of the farmers.

At present, increased yields for existing crops are essential whether additional land is brought under cultivation or not. This is necessary to maintain or gain competitive position amongst competing exporters, as well as to meet

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[4]Sabatini, op. cit., p. 67.

the demand of Thai farm families for increased incomes and level of well being.

The response of various crops to fertilizer has been studied, and it seems clear that increased yields justify the use of large amounts of fertilizers. However, certain crops like cotton can be grown successfully without fertilizer, requiring instead careful and efficient insect control. The ratio between the price of fertilizer price and crop price varies by crops from quite high for rice and corn to quite low for cotton (see Table 1.1). In 1972, it required 7.48 kg. of rice to obtain 1 kg. of fertilizer and 8.01 kg. of corn to obtain 1 kg. of fertilizer. Thus, the utilization of fertilizer as well as other modern inputs in producing these crops need to be evaluated in terms of foreign exchange cost and foreign exchange earnings or savings.

Agriculture production in Thailand is expected to continue increasing in view of the government's growing involvement in agricultural planning, anticipated technological advance, improvements in the infrastructure and increased commercialization. However, the alternative crops which should be emphasized is a problem facing government policy makers. Moreover, it is likely that changes in emphasis will be necessary from time to time as shifts in world supply and demand occur. New methods of production will provide an opportunity to expand production and exports but will require additional imported inputs. It appears that for cotton, import substitution may not expand fast enough

to meet domestic demand. Rice and corn expansion could, under some circumstances, require foreign exchange expenditures which use up a significant fraction of the exchange which the increased exports earn. Thus, as Thailand responds to the need to maintain her foreign exchange situation, it appears that it needs to evaluate among commodities, the net contribution to exchange earnings.

Table 1.1. Kilograms of Commodities Needed to Purchase 1 Kilogram of Amophos (Analysis 16-20-0), 1967-1972.

Commodities	1967	1968	1969	1970	1971	1972
Rice	5.97	5.92	6.58	8.68	10.40	7.48
Corn	9.88	9.38	7.98	8.15	8.32	8.01
Cotton	2.03	1.60	1.62	1.76	1.62	1.66

Source: Agricultural Economics Division,"Problems of Fertilizers to Increase Agriculture Productivity," Bangkok: Ministry of Agriculture, 1973 (unpublished report in Thai).

Objectives of the Study

The broad objective of this study is to organize empirical evidence on the selected crops, significant to Thailand's international trade, so as to evaluate more effectively the effect of changes in production upon farm earnings and net foreign exchange earnings. This will require the accumulation of farm production cost data for the selected crops under two alternative levels of technology and foreign exchange cost as well as the returns in producing these crops. Then an attempt will be made to convert these

unit calculations to a regional basis in order to compare the net farm earnings and net foreign exchange among crops, under certain alternative sets of assumptions regarding changes in production areas and expansion rate of adopting modern practices.

The specific objectives of the study are as follows:

1. To determine the cost and return per rai on the production of rice, corn and cotton under two levels of technology.
2. To calculate farm returns over variable costs and farm labor and foreign exchange earning per rai for the three commodities included.
3. To compare the farm returns and net foreign exchange earning on a regional basis under alternative sets of assumptions.
4. Analyze the conclusions for their policy implications.

Plan of this Study

Chapter II will focus on the methodology selected for analysis and sources of data. The selection of commodities, location of production for selected crops and other background information pertaining to these crops will also be discussed.

Chapter III will focus on the assembling of physical units of inputs required in producing one rai of the selected crops under two levels of technology. With the going market price of inputs and outputs, the cost and returns per rai and farm earnings per rai can be determined.

Chapter IV will focus on the disaggregation of foreign exchange component on import inputs required in the production The c.i.f. and f.o.b. price of imports and exports will be used to determine the foreign exchange revenue per rai. Then the production areas will be aggregated to the dominant production region for the selected crops. Considering alternative sets of assumptions, several solutions regarding possible crop production patterns will be analyzed. The total net returns and net foreign exchange will be compared among the several assumption sets.

Chapter V will summarize the findings and offer policy recommendation which follow from the analysis.

CHAPTER II

METHODOLOGY AND DATA SOURCES

Recent technological advances have led to sweeping changes in the agricultural situation in Asia, particularly where recent food grain deficits have been transformed into actual or potential surpluses. Thailand, utilizing a majority of its cultivated land holding in rice production, has long been a rice exporting nation. However, in the long run, if rice production cannot be accelerated, many problems will arise. Rice surplus for export will decline as domestic demand increases due to increased population. This with other factors held constant, will decrease foreign exchange earnings. As a result, one of the major policy problems currently facing Thailand is to evaluate the merits of promoting alternative crops for the purpose of earning foreign exchange through increased exports or by saving foreign exchange through import substitution. The increased corn production of Thailand has been an amazing development to all interested in agricultural growth. From a "zero" level in the early 1950s, corn production expanded very rapidly, increasing from 3.6 million rai in 1965 to 6.2 million rai in 1972. Today, Thailand ranks as the world's third or fourth largest corn exporter. In 1972 alone, Thailand sold

corn valued at 1.9 million baht on the world market. The only other crops which are more important in terms of export are rubber, kenaf, cassava and soybeans. Cotton production is insufficient for domestic requirements. Thailand must import cotton every year as a result of rapid expansion in textile industries. In 1971, approximately 150 tons of cotton were imported with a value of more than 500 million baht.[1] The government, realizing the need to increase foreign exchange spending on cotton imports, launched a program of study to identify problems and bottlenecks with regard to increased cotton production.[2]

The overriding problem facing the cotton industry in Thailand is to reverse the setbacks in cotton production and, in the years ahead to produce enough of the crop to meet the needs of a growing demand from the textile industries.

Overview of Analytical Procedures

For reasons which will be explained later, this study focuses attention on the production of rice, corn and cotton in the upper portion of Central region. To fulfill the research objective information on cost of production and return per rai for each crop will be assembled. The average physical units of inputs required on each stage of farm

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[1]Suthat Supinachareon, "Economics of Cotton Production in Sukhothai and Loei Provinces," Agricultural Economics Division, Ministry of Agriculture Bangkok, Thailand, June 1972, p. 2. (Mimeograph in Thai).

[2]R. J. Grimble, The Economics of Cotton Production. London: Overseas Development Administration, 1971, p. 8.

operation namely, land preparation, planting, weeding and cultivation, fertilizing, spraying harvesting and packing, also the power requirements during farm operation will be gathered at two levels of technology. Using information on going market price of inputs and outputs in 1972, the costs and returns per rai as well as farm returns can be determined.

Disaggregation of foreign exchange components on required import inputs in production will be undertaken. Assumptions on life expectancy and import parts of farm machinery will be made. Also, the total number of hours needed for field work will be determined in order to calculate the cost of foreign exchange per hour of work expended. For other imported inputs such as fertilizers, insecticides and fuel, the average c.i.f. price of those inputs in 1972 will be used. Thus the foreign exchange cost and revenue per rai can be determined. At this point, the performance of each crop can be examined on the basis of net return and foreign exchange earning per rai. Rice does not compete with corn and cotton for land utilization due to different growing seasons and rice is a lowland crop while corn and cotton are upland crop (assuming no irrigation).

The production zone, which is characterized as a predominately corn-cotton producing area will be aggregated. Thus, the net farm returns and net foreign exchange can be calculated based on alternative assumptions regarding land and labor utilization, rate of expansion, adoption rate of

modern practice, etc. Results from the analyses of these alternatives will provide certain guidelines for policy recommendations.

Measurement Units

Units of measurement used throughout the thesis are those common in Thailand. Rai is a measurement of land area equivalent to 1,600 square meters or approximately 0.4 acre. Baht is a unit of currency which is approximately equivalent to 5 U.S. cents. Kilogram is a unit of weight approximately equivalent to 2.2 pounds (abbreviated as Kg.). Ton is a unit of weight equivalent to 1,000 kilograms or 2,200 pounds. Changwat is the largest territorial subdivision class corresponding to the states in the U.S. or provinces in Canada.

Sources of Data

It was hoped when the study was initiated to obtain all farm-level data from a 1972 survey conducted by the Agricultural Economics Division of the Ministry of Agriculture. This survey encompassed the entire country and included about 8,000 farms whereby head-of-households were interviewed for recall and current information. For the 10 changwats selected for this study there were about 1,000 farms included in the survey. Unfortunately, permission to use all 1,000 farms was not possible. Instead a random sub-sample of 20 records per changwat for 10 changwats was drawn for a total of 200. The

number of rice, corn and cotton farms found in this sub-sample is summarized in Table 2.1.

Table 2.1. Number of Rice, Corn and Cotton Farms Found in Random Sub-Sampling of 1972 Survey.

Changwat	Rice	Corn	Cotton	Other	Total
Saraburi	10	10	0	0	20
Phetchabun	4	12	4	0	20
Phitchit	10	0	0	10	20
Phitsanulok	9	6	0	5	20
Uttaradit	9	9	0	2	20
Chainat	10	1	0	9	20
Sukhothai	10	8	0	2	20
Nakhonrajsima	6	0	0	14	20
Lopburi	2	8	0	10	20
Loei	0	0	0	20	20
Total	70	54	4	72	200

Since to be counted as a rice, corn or cotton farmer it was necessary that a crop be harvested, it is possible that crop failures caused understatement of actual farms growing the crops. This is especially probable for cotton where 200 farms drawn randomly from a predominantly cotton producing area show only 4 farms (in a single changwat) with a successful harvest.

The survey data were used for computing input-output relationships for rice and corn but were not used for cotton because of the lack of cotton farms with harvested area. The survey was used for physical inputs on rice and corn but

to compute the cost of inputs on all crops required supplemental information obtained from reports prepared by the Department of Economics and Business Administration, Kasetsart University, The Ministry of Commerce and from personal interviews in shops in Bangkok.

The lack of cotton farms in the survey required considering alternative ways of analyzing the economics of cotton production.

1. To expand the initial sub-sample of 200 farms to a number large enough to include an adequate number of cotton farms. Unfortunately, the initial 200 was all that could be made available. Therefore, it became necessary to seek other sources for information on cotton production.
2. To use national average yield of cotton. This information was available but the cost of production data on farms used in this average were not available.
3. To use another study involving cotton farms. Fortunately, the same division in the Ministry of Agriculture which conducted the above survey also conducted in 1972 a one-time special farm accounting survey on cotton farms in the region under study. The method was to interview periodically for an entire production season compared with the single interview used in the survey above. Whether there would be a crop failure or not was not known in

advance. However, when the summary was prepared only harvested area was included. No farms had complete failure, thus the results show total production costs per unit of crop harvested.

All records in this 128 farm accounting study have not been summarized. Those available for analysis included 78 cotton farms in two changwats, Sukhothai (28) and Loei (50). Cotton yield on these 78 farms was computed to be about 40 percent higher than the national average. However, the yields and physical inputs were measured so carefully it appeared to be the best possible source of cotton production information for the immediate study.

Modern methods of production as defined for this study were not found in either of the above surveys. For coefficients pertaining to rice and corn production, results from experiments conducted by the Department of Agriculture, under farm conditions were used. In the case of cotton modern method coefficients were obtained from research under controlled experimental conditions also conducted by the Department of Agriculture in the Ministry of Agriculture.

The foreign exchange costs were taken from the Department of Customs, Ministry of Finance. The disaggregation of foreign exchange inputswere based on various sources of information and necessary assumptions. The disaggregation of foreign exchange for farm machineries, machine fuel and

oil etc. were supplemented with other studies. The total production area for changwats was taken from the reports of Agricultural Extension Department.

Further personal interviews were made of agriculturalists and agricultural economists in Thailand to get further insight and for arriving at realistic assumptions needed in the analysis.

Selection of Crops

The production of economic crops such as rice, corn, cotton, kenaf, cassava, sugar cane and soybean have long been concentrated in certain locations. Even though the southern portion of the Central region is particularly suitable for rice cultivation and has become known as the "rice bowl" of Thailand, rice is grown generally throughout the Kingdom because Thai farmers desire to be self-sufficient in their staple food, rice, thus farmers will utilize all suitable land for rice production, even though there may be a higher potential average monetary return to resources from other crops.

Corn production was stimulated all along the way served by Friendship Highway which came into service in the 1960s. The production of corn has increased since 1960 due to an increase in foreign demand. New land was brought into cultivation and the Upper Central Plain became as it is known today the "corn belt" area of Thailand. Almost 60 percent of all cotton in Thailand is grown in changwats

Sukhothai and Loei. Changwats Lopburi, Saraburi and Phetchabun account for about 25 percent of total cotton production[3]

Rice and corn are major exports of the country. Thailand earned $221.7 million on rice exports and $98.85 million on corn exports in 1972. Cotton imports have increased in response to the expansion of the textile industry in Thailand. Cotton imports in 1972 amounted to $36.45 million.[4]

Given the goal of this study to determine the effect on farm earnings and net foreign exchange resulting from changes in production systems, the selection of rice, corn and cotton was appropriate because these crops play a major role in foreign exchange earnings and savings within the agriculture sector of the country.

Selection of Areas

The total land area in Thailand is 321.25 million rai. Out of the total area 95.15 million rai is in farm holdings constituting about 29.62 percent of total land. The paddy land amounts to 68.18 percent of farm holdings. The field crops area amounts to 11.82 million rais which is about 12.42 percent of total agriculture land.[5]

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[3]Grimble, Ibid., p. 1.

[4]Bank of Thailand, Monthly Report, May 1973, p. 50-1.

[5]Ministry of Agriculture, Agricultural Economics Division, Land Utilization of Thailand 1971, Agricultural Statistic Bulletin No. 24, Bangkok, Thailand, 1972, p. 11.

The majority of the corn and cotton producing area is to be found in the upper portion of Central Region. Within these areas rice is scattered all over the lowland areas which cannot be utilized by other field crops. These areas are of most importance in making comparisons on cost and returns in the production of rice, corn and cotton.

Background of Selected Crops

Rice

Rice is still the basic subsistence crop of Thailand, and a very high proportion of the farmers grow some rice. The area under rice is still more than twice as great as the area under all other crops taken together. Rice is of great importance as a source of foreign exchange revenue to the country. Most of the farmers try to avoid having to buy rice. They will grow a surplus of rice partly as an insurance against poor weather and only partly for cash income. Not every province grows a surplus of rice, though most do. The main deficit areas are Bangkok and some provinces to its southeast and southwest, and also the extreme south of Thailand. The flow of rice is thus mainly southward. Bangkok's main rice supply is from the Central Plain.[6]

The area under rice cultivation expanded rapidly from 9.3 million rais in 1907 to 41.6 million rais in 1962 and 47 million rais in 1972 (see Appendix A.1). This rapid increase

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[6]T. H. Silcock, Thailand Agriculture Development in Asia. Edited by R. T. Shand, Canberra: Australia National University Press, 1969, p. 116.

in acreage is due to the rapid growth of population, limited opportunity for employment in the city, and the fact that rice is the main staple food of the people. To the Thais, rice represents breakfast, lunch and dinner.

Average rice yield exhibited a steadily declining trend until 1967 when it averaged 220 kg. per rai. Then the average yield jumped to 270 kg. per rai in 1967 and to 300 kg. in 1970 (see Appendix A.1). There are two reasons to explain this rise in yield. One is varietal improvement and the diffusion of the varieties by the government agencies to farmers. Another is the expansion of area under irrigation. The utilization of modern inputs namely fertilizers and insecticides is still insignificant at the present time.

Government has invested in rice research for a considerable period of time. A breeding program was started in the early 1950s. The principle technique was to select and collect a large number of samples from farmers' fields, test them under low fertility conditions (resembling farmers' condition), and then release the best material back into the local area from which they came. Many local varieties of traditional type are present in Thailand. Thai people are over discriminating in their taste for rice, and Thailand has long had a reputation in export markets for high quality rice. Hence the emphasis in the breeding program was logically on both grain quality and high yielding varieties.

Irrigation has received heavy emphasis by the Thai government for a long time. Some of the structures in the

Chao Phya Delta date back to 1924. The biggest push started in 1950. The main policy has been to construct large multi-purpose dams and reservoirs and main canals with laterals. The farmer has been responsible for constructing farm ditches. In general, the farmer has not done so, and consequently very little of the area under the command of major dams has good water control. This is mainly due to incomplete and poorly designed systems, rather than lack of interest on the part of the farmers. Part of the difficulty also lies in the multiple purposes for which the dams were built. Electric power generation, navigation, and prevention of salt water intrusion seem to have higher priorities than irrigation. In some cases where there is water in the canal during the dry season, but not enough to permit gravity irrigation, farmers have purchased small pumps and pumped the water from the canal onto the fields. There has recently been a major shift in government policy, away from massive investment in large projects to investment in better utilization of water from the projects already constructed.

The farmers pay considerably more than the world price for such fertilizers as ammonium sulfate and urea. The reason is that an investment has been made in an obsolete lignite conversion based fertilizer factory. Because the process is inefficient, cost of production is from 1.5 to 2.0 times the cost in the most efficient modern plant.[7]

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[7]Author inquired with the people in the Ministry of Industry.

There is concurrently an embargo on importation of ammonium sulfate and urea. When free imports were permitted, the plant could not sell its production. Because it was financed by a foreign loan, the government has been hesitant to write the plant off as a bad investment. However, the recommendation of Extension Department to use amophos (16-20 analysis) instead of pure nitrogen fertilizer because it is cheaper and there are no import restrictions.

With the high world price of rice relative to the domestic price and with government wanting to keep the domestic price low, the private exporters have been required to pay a premium for the privilege. The rate of that premium was roughly set at the difference between world market price and Thai domestic price. It is uncertain what the net effect of the abolition of the rice premium would be. The higher prices of rice would probably lead to more effective labor input in rice production, an increase in the use of other factors such as land and fertilizers input might also increase. The extended lands, however, are likely to be marginal and thus would be inferior in quality. But the higher price of rice would make the use of fertilizers profitable,[8] and the increased use of fertilizers would counteract the depressing effect of land scarcity. Thus, the productivity of rice would be improved.

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[8]See Sura Sanittanont, Thailand's Rice Export Tax. Table 40-41.

Corn (Maize)

Corn is one of the important crops of the world since it can be used for human consumption as well as for animal feed and it can be used as a raw material in industries such as soap, margarine, alcohol, etc. Corn is relatively cheaper in terms of feed value than barley or oats. It can be easily grown requiring only 90-120 days for maturity and can resist dry weather very well. So the crop can be expanded very rapidly and can provide a very good source of income to producing countries.

Corn production in Thailand expanded rapidly during the last 10 years, partially because of the increase in world demand for animal feed. Corn improved farmers income, so many farmers made a shift from other field crops to corn in recent years. Corn production between 1937-1946 did not change very much with the total production area remaining about 67,000 rai with a total output per year of approximately 8,000 tons. In 1957 the area devoted to corn increased to 606,000 rai with a corresponding production of 135,800 tons. Ten years later the area had increased to 5,183,000 rai with total production of 1,950,000 tons (see Appendix A.2).

Between 85 and 90 percent of total corn production areas are concentrated in 9 changwats which border the "rice bowl" on the north and east. There were only 5 changwats which have had extensive corn growing namely, Lopburi, Nakorn Sawan, Nakhonrajsima,Phetchabun and Saraburi. The other

four changwats have a minor proportion of the total corn area.[9]

The average yield of corn in Thailand has increased dramatically until very recently. The average yield in 1949 amounted to 127 kg. per rai and it jumped to 306 kg. in 1960 and increasing to 402 in 1970. However, by 1972 the yield had declined to 211 kg. per rai. There are three reasons to explain this phenomenon: (1) the breeding program which started in late 1950s developed several varieties which proved to be successful under field conditions and were released to farmers contributing to the early increase, (2) new land was brought under cultivation and initially corn yield was high. But with consecutive plantings on the virgin soil without replacement of lost nutrients, corn yields began to decline. Also, there was no irrigation in corn producing areas. During the drought year, a lot of damage to the crop will bring the average yield down, and (3) in addition, the price of fertilizer has been high relative to corn price, so the farmers did not use fertilizers.

Further expansion of land for corn production will be rather difficult because, for one thing, there is not much virgin land left for development. If corn needs to be expanded further, and recognizing the need to replenish lost nutrients, special government action may be required.

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[9]Pradit Rangsaritkul, and Natteethip Krasin, Production and Marketing of Corn, Bangkok: Ministry of Commerce, Thailand 1972, p. 14-17.

Modern corn storage facilities in the provinces and in Bangkok are minimal. Construction of corn storage facilities is now progressing in several locations in Thailand. But during the 1966-70 period, storage facilities were small relative to the production and market flow of corn. Consequently, most corn flows rapidly out of the producing areas at harvest time, moves by truck and barge to Bangkok, and is rather quickly exported.

Cotton

The textile industry in Thailand has expanded rapidly. The production of cotton fabric increased from 109 million square yards in 1962 to 344 million square yards in 1969. The importation of cotton lint increased from 7.7 million kg. to 17.2 million kg. during the same period.[10] The government realizing the large amount of foreign exchange required for cotton imports, launched a program of study to find out the problems and bottlenecks of increased cotton production.

Cotton is an upland crop which has been grown extensively in two changwats, Sukhothai and Loei which accounted for about 54 percent of the total areas. The other area which accounts for about 25 percent of total cotton production includes Lopburi, Saraburi and Phetchabun. The major cotton production is in these changwats.[11]

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[10] Grimble, op. cit., p. 54-5.

[11] R. J. Grimble, The Economic of Cotton Production. London: Overseas Development Administration, 1971, p. 1.

Since the mid 1950s and more so in the last decade, considerable effort has been made towards breeding and selecting improved varieties of cotton which will produce both higher yields and better quality. Upland types were introduced from Africa and the U.S.A. and were crossed with Cambodian strains. However, it is the imported upland types such as Reba B 50, Deltapine Smooth Leaf and Albar 200 that showed greater promise in the way of higher yield potential and better lint quality. At first Reba and recently Deltapine have been released by the Department of Agriculture and widely grown by cotton farmers.[12] The advent of improved types initially encouraged cotton growing so that production rose from an average of 23,000 tons of seed cotton between 1950 and 1955 to an estimated peak of 117,100 tons in 1968. Unfortunately this high output has been followed by a dramatic drop in production since then (see Appendix A.3). Over the same period, the average area under cotton increased from 205,000 rais to 832,000 rais. It is clear that the expansion in cotton production up to 1968 was largely extensive rather than intensive. In other words, the increase was more the result of an expansion in area planted than an increase in yield.

Average yield was 105 kgs. per rai in the period 1950-1955 and about 141 kgs. per rai from 1964-67, an increase of

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[12]Grimble, ibid., p. 2.

34 percent. Cotton in all regions of Thailand is produced entirely under rainfed conditions.[13]

The essential problem facing the cotton industry in Thailand is how to reverse the setback in cotton production and, in the years ahead to produce enough of the crop to meet the needs of the country's growing textile industry. The recovery of cotton production and achievement of the production objective, set by the Third Development Plan of 201,000 tons by 1976, will be no easy task. The problem is that, to the majority of growers, the difficulties of insect control are such that they will lose money (or make very little) from growing cotton. More cotton is not grown in Thailand because to the majority of farmers, the economics of growing the crop are not satisfactory; and when cotton is grown the technical and managerial problems of its production are normally too great for good yields to be obtained.

Grimble's study in Takfar has shown that, under present circumstances, farmers must expect to spend 350 baht on the purchase of insecticides for every rai of cotton they grow. This figure of 350 baht approximates the optimum i.e., the most profitable level of insecticide use under present farm conditions. Prospective growers should therefore be prepared to obtain, either by cash or credit, sufficient insecticide material for their total cotton area (i.e., 350 baht X area).

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[13]Grimble, ibid., p. 6.

Similarly, cotton farmers have experienced that over the course of the growing season, they will need to use a total of at least 200 man hours work for every rai of cotton they grow. Hence, available labor serves as an effective constraint. A further constraint to increasing cotton production is the capacity of spraying machinery available and the overall management capabilities of producers. The availability for spraying machinery also sets a limit to the maximum area of cotton that can be grown. A single power-operated knapsack sprayer, the type of machine most commonly found in the locality, can be used to look after a maximum of about 6-8 rai of cotton. These are the limiting factors which hinder the expansion of cotton production.

CHAPTER III

ESTIMATES OF PRODUCTION COSTS

The objective of this chapter is to assemble and analyze production costs for rice, corn and cotton in the designated area. Data sources for this work were explained in the previous chapter. The plan of the chapter is to define and discuss the components of production costs for traditional rice, modern rice, traditional corn, modern corn, traditional cotton and modern cotton in that order. This is followed by a tabulation of total production costs (excluding land charges) per rai for each crop. Then gross and net revenue per rai for each crop is computed. Finally, marketing margins and marketing cost for each crop is computed in order to figure net foreign exchange in Chapter IV.

In keeping with the objectives of the study it was necessary to distinguish between "traditional" and "modern" production practices. Even though the surveys of Thai agriculture indicate negligible modern production in 1972, it seems most appropriate to project future developments including components of more scientific production rather than to assume traditional methods will remain in a static fashion. Traditional production methods are defined as the

the predominant current practices as reflected in farm surveys. Modern production methods are defined as those based on recommended practices by the Department of Agriculture.

Labor Requirement and Production Costs of Traditional Rice

Usually, for the area studied, rice production starts in June or July and is harvested in January or February. Farmers start plowing their lands after the first rain comes. Most of the first plowing is done by tractors, except some farmers still use animal power. Tractor services are available for custom services in the locality when needed. Most of the second plowing and harrowing are done by animal power.

The physical units of labor, power, seeds, and fertilizers were taken from the 70 sample farms identified earlier. Labor and power requirement at each stage of farm operations was calculated as a weighted average with weights based on planted area within changwat then a simple average over changwats. This also holds for quantities and values of seeds, fertilizers, insecticides, and herbicides. However for average yield, weights were based on harvested area.

The survey reported number of rais plowed by tractors and harrowed by buffaloes. In other words, some farms completed first plowing by tractors and second plowing as well as harrowing by buffaloes. Other farms do all plowing and harrowing by buffaloes. The average time required for a 65 horsepower tractor to finish either first or second

plowing is .33 hours per rai or 20 minutes. The average time required for buffaloes to complete either first or second plowing as well as harrowing is 3.30 hours or 3 hours and 18 minutes (see Appendix C.1). These figures were used as a multiplier for the weighted average rais plowed by tractors and buffaloes. Then a simple average requirement for tractors and buffaloes was computed over the number of changwats.

The physical inputs requirements for producing one rai of rice is tabulated in Tables 3.1 and 3.2. Harvesting averaging 34.7 hours per rai on the average is higher than either land preparation or planting which in each case averages about 19 hours per rai. Buffaloes remain important sources of power relative to tractors. The average animal power use is 6.77 hours while the tractor is only .18 hours which is equivalent to a half rai of work by a 65 horsepower tractor.

The average seeds used is 11.15 kg. per rai. In general, farmers keep their own seeds for next year'splanting. However, the cost of seeds was figured using the 1972 market price of 8.97 baht. Usually, farmers apply fertilizers and insecticides in the nursery beds before transplanting to help insure uniform growth of the seedlings. The weighted average fertilizers for this purpose was only 1.3 kg. per rai. However, there were three farms in Saraburi reporting an application of about9 kg. per rai of fertilizers. They received the highest yield with an average of 500 kg. per rai.

Table 3.1. Hours of Labor and Power Sources Required to Produce One Rai of Traditional Rice, 1972.

Changwat	Land Preparation	Planting	Weeding and Cultivation	Fertilization	Spraying	Harvesting	Packing	Tractor[1]	Buffalo
Saraburi	10.92	22.47	3.90	.75	.83	33.19	.73	.43	4.98
Phetchabun	22.10	27.53	--	--	--	56.14	.81	.16	7.49
Phitchit	34.93	27.59	--	--	.21	30.28	--	.07	9.14
Phitsanulok	20.42	20.40	3.93	.44	.27	44.67	--	.10	8.12
Uttaradit	10.76	5.63	2.52	--	.39	19.15	--	.18	4.95
Chainat	7.85	6.0	.94	.18	1.33	28.67	2.6	.32	4.72
Sukhothai	9.12	15.56	1.35	--	.4	48.59	.19	.38	2.97
Nakhonrajsima	26.18	15.67	--	.36	--	29.89	1.07	--	9.54
Lopburi	32.58	37.09	--	.33	.54	21.58	.58	--	9.01
Average	19.43	19.77	1.4	.23	.44	34.68	.66	.18	6.77

[1]The time required for 65 hp. tractor in plowing one rai is 0.33 hours. This figure was used as a multiplier for an average tractor plowing in each changwat. (See Appendix C.1).

Total labor hour is 76.61 or 76 hours 37 minutes, approximately 9.5 days.

Source: Taken from a Survey Data.

Table 3.2. Average Variable Costs of Traditional Rice Production Per Rai in Selected Changwats, 1972.

Changwat	Yield Kg/rai	Seeds		Fertilizers		Insecticides		Herbicides	
		Quantity Kg	Cost (Baht)	Quantity Liter	Cost (Baht)	Quantity Liter	Cost (Baht)	Quantity Liter	Cost (Baht)
Saraburi	365.08	11.30	10.26	5.90	12.59	-	.12	-	1.10
Phetchabun	414.74	4.24	2.86	--	--	-	--	-	--
Phitchit	383.76	6.95	5.04	--	--	-	.21	-	--
Phitsanulok	410.41	11.90	8.82	1.05	1.53	-	.53	-	.53
Uttaradit	325.21	8.99	7.73	--	--	-	.13	-	.78
Chainat	314.88	28.01	23.64	1.10	2.20	-	.69	-	1.08
Sukhothai	293.19	11.66	8.96	--	--	-	--	-	1.04
Nakhonrajsima	271.26	7.16	5.34	--	--	-	--	-	--
Lopburi	303.30	10.14	8.11	3.64	6.36	-	.65	-	--
Average	342.42	11.15	8.97	1.3	2.52	-	.26	-	.5

Source: Taken from Survey Data.

The other five farms in the same province applied fertilizers at a lower rate of about 4 kg. per rai, receiving less than 400 kg. of rice per rai. There was insignificant use of insecticides and herbicides reported in all changwats.

Critical Inputs and Additional Labor Required Under Modern Method of Rice Production

The modern method of rice production requires critical inputs such as fertilizers and insecticides. Yield response is associated with these factors. The yield increase requires more time during harvesting and packing, also increased time during fertilization and spraying. The survey sample taken did not show any farm using modern methods. To suit our purpose, the yield response to modern inputs is based on the experiment conducted by Agronomic Management Section, Technical Division, Ministry of Agriculture.

The Agronomic Management Section conducts experiments every year under farm conditions all over the country. The purpose of this is to give recommendation to other departments responsible for agriculture as well as to interested farmers. The recommended fertilizer is Amophos (analysis 16-20-0) at a rate of 15 kg. per rai.[1]

The yield responses were taken from experiments conducted on 27 farms in Central Region and 15 farms in Northern Region.

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[1]Author inquired with agriculturalists in the section on the recommended rate of fertilizers.

The average yield for the two regions was 556 kg. per rai.[2]

Other input practices include the application of a 6 kg. per rai of B.H.C. to control rice stem borers and the spraying one time of either Sevin 85 or Folidol to control insects and diseases.

The information obtained shows that rice yields under "modern" technology average 213.58 kg. higher per rai than for traditional input levels. The time required for harvesting and packing also are higher. It is assumed that the labor and power required for farm operation under traditional methods will be the same as for modern practices except for fertilization, spraying, harvesting, and packing time which would be higher in the case of modern.

The Amophos fertilization is done before transplanting at a rate of 15 kg. per rai. The time required for fertilization is approximately 1 hour per rai. After 15 days after transplanting,B.H.C. is applied at 2 kg. per rai requiring 1 hour per rai. In the fifth week weeding and cultivation will be done with another 2 kg., application of B.H.C. per rai requiring approximately 8 hours per rai. In the eighth week the third 2 kg. application of B.H.C. will be made which requires 1 hour per rai. On the average for further insect

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[2]Department of Agriculture, Agronomic Management Division,"Experimental Results of Fertilizer Trial on Field Condition." January 1973. (Unpublished mimeograph in Thai.)

and disease protection, spraying will be done one time which requires approximately 1 hour and 30 minutes per rai. The total time required for weeding, cultivation, fertilization, and spraying more than by traditional method is 10 hours and 26 minutes.[3]

Increased time required during harvesting and packing as a result of higher yield will be calculated on the same percentage basis as traditional operation information on Table 3.1.

Increased time required for harvesting:

$$\frac{34.68}{342.42} \times 213.58 = 21.63 \text{ hours}$$

Increased time required for packing:

$$\frac{.66}{342.42} \times 213.58 = .41 \text{ hours}$$

The total labor hours increased under modern methods over traditional methods is 32 hours and 30 minutes or approximately four (4) days.

Labor Requirement and Production Costs of Traditional Corn

The corn season usually begins with land preparation and planting in May or June and ends with harvesting in August or September (depending on weather conditions). Land preparation is mostly done by tractors and buffaloes and

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[3]Twelve hours and 30 minutes - 2 hours and 4 minutes = 10 hours and 26 minutes.

requires less labor than is needed for rice. Planting corn is done completely by hand labor. At least once or twice weeding and cultivation is needed during the growing season. Corn producers in Thailand seldom apply fertilizers and insecticides. One reason is that new land brought under cultivation has sufficient soil nutrients for corn plants. But as pointed out earlier after 3 to 5 seasons soil fertility is exploited by the plant. This condition has caused the decline in average yield of corn. Corn yield fluctuations also are caused by flood or drought conditions in the region.

The physical units of inputs required in corn production per rai were taken from the 54 sample farms in 7 changwats namely, Lopburi, Sukhothai, Saraburi, Uttaradit, Phitsanulok, Phetchabun, and Chainat. The weighted average of labor used in production were derived from the total areas in each changwat and total hours required during farm operation.[4] The information on power used was based on reported numbers of rais plowed by tractors or buffaloes. The average time required for 65 horsepower tractors and buffaloes in plowing one rai is .39 hours and 3.13 hours, respectively. These figures used as multiplier on number of rais plowed by tractors and buffaloes for each changwat. The weighted average of variable costs including seeds, fertilizers, and

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[4]See detail on deriving weighted average from rice production in previous sections.

insecticides was obtained under the same procedure as for rice. There is insignificant use of fertilizers and insecticides on corn except for one farm in changwat, Saraburi which reported an application of 20 kg. of fertilizers per rai having an average yield of 503 kg. per rai. The physical units of labor and other inputs used in the production are tabulated in Tables 3.3 and 3.4.

Critical Inputs and Additional Labor Required Under Modern Methods of Corn Production

None of the corn farmers in the sample survey used fertilizers. Of the 54 farm questionnaires analyzed, only one farmer applied fertilizers and the yield response was not appreciably higher than that reported on the other farms without fertilizers. The two main reasons which may be offered to explain this phenomena have already been identified. The corn areas have been expanded rapidly during the last 15 years on virgin soils. The new land brought under cultivation has sufficient soil nutrients to produce high yield without commercial fertilizer. After successive cultivation, yields per rai have declined since farmers did not use fertilizers to replace the lost nutrients. Farmers received good return during these early years of corn production without the risk associated with applying fertilizers. The second reason is that the price of fertilizers has been quite high relative to the corn price, so farmers did not want to take the necessary risk in making the investment.

Table 3.3. Hours of Labor Required to Produce One Rai of Traditional Corn, 1972.

Changwat	Land Preparation	Planting	Weeding and Cultivation	Fertilization	Spraying	Harvesting	Packing	Tractor[1]	Buffalo
Lopburi	3.31	4.92	10.40	--	.08	9.63	--	.65	1.0
Sukhothai	.23	7.41	29.28	--	--	28.91	.63	.92	--
Saraburi	1.07	7.93	25.18	.14	--	25.47	.27	.66	.78
Uttaradit	2.86	9.27	22.16	--	3.69	19.97	0.76	.41	.88
Phitsanulok	2.72	14.0	23.81	--	--	28.75	1.51	.59	1.22
Phetchabun	1.74	11.64	18.05	--	--	29.23	.56	.48	--
Chainat	--	5.85	6.71	--	--	14.95	--	.39	--
Average	1.7	8.72	19.37	.02	.54	22.41	.53	.58	.55

[1]The time required for a 65 hp. tractor in plowing one rai is about 0.39 hours. This figure was used as a multiplier for an average tractor plowing in each changwat. (See Appendix C.1).

Total time required in farm operation is 53.29 hours or approximately 6.75 days.

Source: Taken from a Survey Data.

Table 3.4. Average Variable Costs of Traditional Corn Production Per Rai in Selected Changwats, 1972.

Changwat	Yield Kg/rai	Seeds		Fertilizers		Insecticides		Herbicides	
		Quantity Kg	Cost (Baht)	Quantity Kg	Cost (Baht)	Quantity Liter	Cost (Baht)	Quantity Liter	Cost (Baht)
Lopburi	430.87	3.81	4.65	--	--	--	1.25	--	--
Sukhothai	294.37	7.13	6.58	--	--	--	--	--	--
Saraburi	489.37	3.82	3.98	2.03	3.69	--	.04	--	--
Uttaradit	213.39	5.26	8.42	--	--	--	2.78	--	--
Phitsanulok	510.23	5.86	4.12	--	--	--	--	--	--
Phetchabun	467.18	5.43	6.83	--	--	--	--	--	--
Chainat	438.0	3.23	7.54	--	--	--	--	--	--
Average	406.2	5.77	6.02	.29	.53	--	.58	--	--

Source: Taken from a Survey Data.

The yield response to modern inputs was taken from the experiments of Field Crop Division, Ministry of Agriculture, conducted at two locations. One experiment was conducted at Farm Suwan using 50 kg. of fertilizers (14-14-14) per rai. The average yield taken from dry season and wet season is 751 kg. per rai. The other experiment conducted in farmers' fields in Saraburi province applied the same rate of fertilizer having the average yield of 672 kg. per rai.[5] Since yield potential of corn under modern method of production can go up to 751 kg. per rai with 50 kg. of fertilizers, this yield will be used to represent modern methods of corn production.

The yield difference between traditional and modern method was estimated to be approximately 345 kg. per rai. The increased yield requires more labor during harvesting and packing as well as fertilizing and spraying. The increased time required was calculated on the same percentage basis.

The increased time for harvesting:

$$\frac{22.41}{406.2} \times 344.8 = 19.02 \text{ hours}$$

The increased time for packing:

$$\frac{.53}{406.2} \times 344.8 = .45$$

The additional total time required for harvesting and packing is 19.47 hours.

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[5]Ministry of Agriculture, Field Crop Division, "Experimental Report on Fertilizer Trial," 1972 (Mimeograph in Thai).

Corn varieties adopted by farmers are not susceptible to disease. The only enemy is grasshoppers which destroy tremendous areas in some years but such an occurance is not common. During such an outbreak, it is impossible for individual farmers to control the problem by themselves. The agriculture department may send a special team to do the job. The recommendation is to spray only once for protection. The insecticides used can be either Endrin, Sevin or Folidol at the rate of 300 gm. per rai. The approximate time required for spraying per rai is two hours. The fertilizer application was done before planting at 50 kg. per rai. The time required for fertilization is approximately 1 hour and 30 minutes. The additional labor hours required under modern methods is 22.41 hours (19.47 + 3.50 - .56), approximately 2.75 days.

Labor Requirement and Production Costs of Traditional Cotton

Cotton production is labor intensive relative to rice and corn. The crop's demand for labor seems to be at its highest from August to November when labor is needed for weeding, spraying and, at the end of the period, for picking the cotton. Usually, the cotton growing season starts in June and ends in December. The information on labor and power requirements for cotton production was taken from 82 sample farms. Out of this sample, only 4 farms from Phetchabun province were used since other farms in the province had experienced complete crop failure. The other 78 sample farms

were located in Sukhothai and Loei provinces with the data obtained from the farm management accounting results assembled by the Production Section, Agricultural Economics Division. The average labor requirements at each stage of farm operation is derived as a weighted average for each changwat and then recomputed as a simple average over changwats. The average labor required in weeding and cultivation was 62.76 hours per rai and the labor required for the peak season of harvesting was 79.87 hours per rai.

Information on tractors and animal power was calculated by the same procedure as described previously. There was no animal power used in Loei and Phetchabun. However, animal power was used in Sukhothai during plowing and cultivation. The information obtained from the farm management accounting survey reported average hours of work per rai, so conversion was not needed. The tractor average time per hour was reported in Sukhothai and Loei provinces while Phetchabun province reported the number of rais plowed by tractor. Thus the tractor time required to complete plowing one rai was used as a multiplier for unit conversion. The land preparation for cotton did not require much power because cotton is planted in rows, with three to six seeds to each hill. In the manner of other crops, however, cotton was planted on a flat rather than on raised beds.

Other physical inputs required in cotton production are insecticides, fuel and seeds. No fertilizer was used on cotton. Even without fertilizer the rich soils often lead

to the production of vegetative growth and consequent physical difficulties in applying insecticides. A weighted average for all inputs was computed for each changwat, then these results were averaged over changwats. Machine fuel requirements for spraying machines will be discussed in a later section. Labor and other input requirements to produce one rai of cotton are summarized in Tables 3.5 and 3.6.

The cost of insecticides used per rai varied widely among different changwats. For example, the variation was from 37 baht in Phetchabun to 306 baht in Sukhothai province. This variation would also likely increase yield variation in the different changwats.

Critical Inputs and Additional Labor Required Under Modern Method of Cotton Production

The modern practice of cotton production is quite different from other field crops. The soil fertility level in the cotton producing area is such that fertilizer is not needed. A study at Takfar area shows most yield response resulting from fertilizer to be insignificant.[6] Insect damage is the most important cause of low cotton yields. Cotton's most serious enemies are the sucking insects, such as jassid, that feed on the leaves of young plants, and the

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[6]R. J. Grimble, The Economics of Cotton Production, Foreign and Commonwealth Office, London: Overseas Development Administration, November 1971, pp. 21-22, 48-50.

Table 3.5. Hours of Labor and Power Sources Required to Produce One Rai of Traditional Cotton in Changwats, Sukhothai, Loei and Phetchabun, 1972.

Changwat	Land Preparation	Planting	Weeding and Cultivation	Fertilization	Spraying	Harvesting	Packing	Tractor[1]	Buffalo
Sukhothai	0.93	5.24	68.65	-	22.15	43.84	4.64	.24	3.87
Loei	34.77	13.97	91.25	-	56.95	133.72	3.92	.19	--
Phetchabun	--	8.77	28.39	-	11.48	62.06	10.97	.33	--
Average	11.9	9.33	62.76	-	30.19	79.87	6.51	.25	1.29

[1]The time required for 65 hp. tractor in plowing one rai is 0.39 hours. This figure was used as a multiplier for an average tractor plowing in each changwat.

Loei, Survey Report 1972. (Mimeograph in Thai).

Total labor hours required for one rai is 200.56 hours, approximately 25 days.

Source: Report on Cost of Cotton in Production in Changwats, Sukhothai and Loei, 1972.

Table 3.6. Average Variable Costs of Traditional Cotton Production Per Rai in Selected Changwats, 1972.

Changwat	Yield	Seeds		Fertilizers		Insecticides		Herbicides	
	Kg/rai	Quantity Kg	Cost (Baht)	Quantity Kg	Cost (Baht)	Quantity Liter	Cost (Baht)	Quantity Liter	Cost (Baht)
Sukhothai	276.94	3.94	9.22	--	--	11.86	306.22	--	--
Loei	281.6	1.69	4.12	--	--	7.4	152.85	--	--
Phetchabun	195.16	1.47	3.67	--	--	1.2	37.06	--	--
Average	251.23	2.37	5.67	--	--	6.82	165.38	--	--

Source: Taken from a Survey Data.

bud and boll eating caterpillars such as the American Bollworm. Insect control, while not increasing a crop's potential yields, is intended to allow this potential to be realized. The modern method of production as defined in this study is characterized by the different methods and numbers of sprayings. In other words, improved management in spraying and scheduling spraying has an impact on cotton yield.

Cotton is sprayed far more intensively than any other crop. If, in the event of rain, it is not possible for the farmer to spray the entire field at one time, it will be necessary to have more than one spraying schedule on a given farm. The study in Sukhothai and Loei indicate that the average farmer will spray 10 times per crop.[7] Some farmers take good care of their plants by spraying up to 15 times while the other farmers sprayed only six times. Most of the farmers do not follow the recommendation given by Agriculture officers resulting in less use of insecticides and consequently a lower yield than would be the case had the recommendation been followed.

Modern practice for the purpose of this study is based on experimental work conducted by Field Crop Division, Department of Agriculture. This division has one section working

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[7]J. Ditapanya,"Resource Productivities of Cotton Production in Changwats Sukhothai and Loei, 1971-72 Crop Year." Thesis submitted to the Faculty of Economics and Business Administration, Kasetsart University, 1973.

on the effectiveness of chemical insecticides, spraying methods and spray schedules for cotton production. Experiments have been conducted on experiment stations in each of four changwats namely, Loei, Sukhothai, Saraburi and Suphanburi. Spraying at different times has been studied namely, spraying every seven days and spraying at 5, 10 and 20 percent insect incidence. It was found that spraying, with insects at an incidence level of 20 percent, resulted in higher yield and lower cost per unit of output than when spraying takes place at the 10 percent level. However, this conclusion is not practical under farm condition because the farmers will not have enough time to count insects every day before spraying. Spraying every 7 days has proved to be quite satisfactory from both a practical and functional point of view. Toxaphene-DDT was used in the experiment. Labor and other input requirements under modern method will be analyzed with regard given to the variables most likely to determine the success of insect control and hence the economics of the whole crop. The cost of insecticides and labor per rai from the experimental result is tabulated in Table 3.7.

Almost all cotton farmers used their own equipment for spraying and several of the more prosperous farmers owned more than one spraying machine. Knapsack spraying machines are commonly used. Motorized spraying machines are not popular. Motorized sprayers have a higher initial cost and require fuel to operate but their work rate is much higher

Table 3.7. Costs and Yields of Cotton Resulting From Different Spraying Times, 1972.

Treatment	Time Spray	Insecticide Use (liter/ rai)	Price of Insecticide (฿/rai)	Labor Cost (฿/rai)	Total Cost (฿/rai)	Yield Kg/rai
Every 7 days	12	17.45	349	120	469	485.5
At 5% Insects	13	17.90	358	130	488	475.5
At 10% Insects	10	13.8	276	100	376	499.5
At 20% Insects	7.5	11.30	226	75	301	517.5

Source: Agricultural Department, Field Crops Division, Reports on the Effective Insecticides and Application on Cotton at Four Experiment Stations, Loei, Sukhothai, Saraburi, Supanburi, 1972 (Mimeograph in Thai).

Note: Labor cost 10 ฿/rai.
Insecticide 20 ฿/liter.
Use Toxaphene-DDT at 400cc/20 liter of water.

and requires less labor. It is assumed that on the average, 70 percent of the farmers use knapsack sprayers and 30 percent use motorized sprayers. The time required for spraying and fuel needed will be discussed later.

The average yield response with spraying every 7 days was 485.5 kg. per rai. The difference between traditional and modern yield was 234.27 kg. per rai. The increased time during harvesting and packing is calculated on the straight line basis.

The increased time for harvesting:

$$\frac{79.87}{251.23} \times 234.27 = 74.48 \text{ hours}$$

The increased time for packing:

$$\frac{6.51}{251.23} \times 234.27 = 6.07 \text{ hours}$$

The total time required for 12 times spraying is 18 hours. The total time increased under modern practice is 68.36 hours or approximately 8.5 days.

Labor and Fuel Requirement in Spraying

Spraying time is a function of the age and size of the plant. As the plant size increases spraying time per rai will also increase. The experiment on the spraying time required at different ages of cotton had been conducted by the Agricultural Economics Division, Ministry of Agriculture.

The weighted average of knapsack sprayers and motorized sprayers was 5.52 rai per day, approximately 1 rai per hour.[8] (See Table 3.8).

The fuel required for motorized sprayers was 2 liters per hour.[9] But it was previously assumed that only 30 percent of motorised sprayers, the average fuel consumption will only be 600 c.c. per hour.

Spraying requires preparation of insecticide before spraying can be done. Usually, farmers spray 5 hours per day and spend 2-3 hours to prepare insecticides. It is assumed that the average time for insecticides preparation is 30 minutes per rai. So the total time required to complete spraying one rai is 1 hour and 30 minutes. This will apply to cotton production only. The rice and corn production did not require intensive spraying. The ordinary knapsack sprayers can do the job. It was assumed that rice and corn farmers did not use motorized sprayers.

Input Cost

The cost of inputs used in production were computed using 1972 prices and the following additional conditions.

Land

The productivity of land is important to the individual

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[8] Somchai Vanitkobjinda. The Use of Insecticides and Sprayers for Disease Control. Agricultural Economics Division, Ministry of Agriculture, 1973 (Mimeograph in Thai).

[9] Ibid., p. 18.

Table 3.8. Labor Required in Spraying at Different Ages of Cotton.

Spraying Times	Age of Cotton (Days)	Ordinary Air Pressure Spray Rai/Day	Engine Spray Rai/day
1	8 - 15	7.82	14.88
2	16 - 23	6.77	13.69
3	24 - 31	5.87	13.22
4	32 - 39	4.48	10.03
5	40 - 47	4.34	8.83
6	48 - 55	4.25	8.18
7	56 - 63	3.59	7.39
8	64 - 71	3.48	7.41
9	72 - 79	3.21	6.03
10	80 - 87	2.94	5.13
11	88 - 95	2.93	5.02
12	96 - 103	2.90	4.99
13	104 - 111	2.88	5.01
Total	---	55.46	109.81
Average	---	4.27	8.45
Adoption Rate	---	70%	30%
Total weighted	---	298.90	253.50
Weighted Average	---	5.52	5.52

Source: S. Vanitkobjinda. The Use of Insecticides and Sprayers for Disease Control, Agricultural Economics Division, Ministry of Agriculture (Mimeography in Thai), June 1973, p. 19.

farmer from the standpoint of valuation and farm size, but, the task of maximizing output is to optimally allocate labor and capital resources among particular crops. Thus, the choice is to select the crop and crop system that optimizes the return over additional costs to owned land and family labor. Thus, it is not necessary to calculate the accounting cost of land and family labor in making the choice among crops, even though such estimates are important for other purposes.

Labor

The labor is homogeneous in the study area. The production of rice, corn and cotton utilizes the same skills and age grouping. The existing wage rate of labor in the locality was used to determine the price of hired labor. The average wage rate for hired labor is 10 baht per day.[10] Family labor was considered on the same basis as hired labor.

Tractors and Animal Power

The cost is based on the average custom rate per rai in the designated area. The average rent of tractors was taken from the sample survey in 10 changwats. The average rate of plowing for rice, corn and cotton was 20, 24 and 32 baht per rai, respectively (see Table 3.9). Given the rate per rai and the average time required to complete plowing one rai, the cost of tractor services can be calculated.

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[10]Author inquired with several Agriculture Extension officers in that area.

Table 3.9. Average Cost of Tractor Power for Land Preparation, 1972.

Changwat	Rice Power Cost ฿/rai	Corn Power Cost ฿/rai	Cotton Power Cost ฿/rai
Saraburi	13.50	27	--
Petchabun	33	31	33
Phitchit	17.50	--	--
Phitsanulok	20	20	--
Uttaradit	20	20	--
Chainat	18.72	--	25
Sukhothai	20	20	20
Nakhonrajsima	--	--	--
Lopburi	--	28	--
Loei	--	--	50
Average	20	24	32

Source: Taken from a Survey Data.

The rent of buffalo is 10 baht per 6 hours work.[11] This will serve as a cost of buffalo power.

Seeds, Fertilizers, Insecticides and Fuel

The cost of seeds, fertilizers, insecticides and herbicides per rai previously calculated will be used for traditional practice. The cost of fertilizers and insecticides used under modern practice was based on the other sources of information.

[11]Ministry of Agriculture, Agricultural Economics Division, Basic Data in Farm Management, 1971. Also, author inquired with agriculture officers in the field.

There is no information on the kinds of fertilizers used from the raw data, nor on the kinds and quantities of insecticides and herbicides used. This is because the farmers do not understand about brand names. They buy what is available in the stores as "rice fertilizer" or "corn fertilizer." The information on fertilizer prices was taken from the study done by the Agricultural Economics Division, Ministry of Agriculture. The data are tabulated in Table 3.10.

The information on the brand names of the insecticides used by farmers is not available. Farmers will buy insecticides according to easily recognized symbols like the "skull and bones" which is used on the packages of Folidol. Other brands have different symbols which the farmers use to identify the insecticides. Brook Greene, studying innovation in 1968, reported that there were less than fifty percent of the farmers using insecticide, who knew the brand name of the insecticide they were using.[12]

According to Dr. Wongsiri, Head of the Entomology Division of Agriculture Department, the recommendations for the application of insecticides for rice were the use of B.H.C. and either Sevin or Folidol. Generally, if a farmer adopts the use of insecticides he will apply B.H.C., since it is a general insecticides and the granules are easily spread on the fields. Sevin and Folidol, used mainly to control flying

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[12]Brook A. Greene. Rate of Adoption of New Farm Practices in The Central Plains, Thailand. Occasional Paper No. 41, A Joint Project of Kasetsart University and Cornell University, Bangkok: Kasetsart University, October 1970, pp. 110-2.

Table 3.10. Fertilizer Prices in Bangkok and Local Market, 1971-1973.

Fertilizer	1971			1972			1973		
	C.I.F.	Bangkok Wholesale	Local Market	C.I.F.	Bangkok Wholesale	Local Market	C.I.F.	Bangkok Wholesale	Local Market
Ammonium Sulphate 21% N	1.17	1.34	1.85	1.17	1.34	1.85	1.62	1.93	2.31
Urea 40% N	1.81	2.64	2.80	1.91	2.58	2.80	2.59	3.02	3.53
Super phosphate 20% P_2O_5	1.12	1.35	1.62	1.15	1.38	1.66	1.57	1.87	2.24
Potassium Chloride 60% K_2O	1.29	1.55	1.86	1.38	1.65	1.98	1.86	2.19	2.63
16 - 20	1.40	1.67	2.01	1.53	1.82	2.18	2.23	2.61	3.13
14-14-14	1.60	1.90	2.28	1.65	1.95	2.35	2.20	2.58	3.09
15-15-15	1.68	2.00	2.39	1.77	2.09	2.51	2.32	3.71	3.25
12-24-12	1.82	2.15	2.58	1.91	2.25	2.70	2.57	3.00	3.60

Source: Agricultural Economics Division, Problems of Fertilizers to Increase Agriculture Productivity, Ministry of Agriculture, Bangkok 1973, Unpublished Report (in Thai).

Note: 16-20 recommended for rice.
14-14-14 recommended for corn.

insects carrying diseases and locusts, must be sprayed and, therefore, fewer farmers apply these chemicals. Folidol is used to a greater extent than is Sevin. The farmers that apply Folidol or Sevin also apply B.H.C. because Folidol and Sevin do not control the stem-borer.

The Field Crop Division recommends Endrin or Sevin for corn. However, Folidol is popular with the farmers and some substitute Folidol for Endrin or Sevin even though it is not recommended for corn, the price is higher and is considered less effective than the other products. Thus, these three insecticides were considered for use in corn. The only insecticide recommended for cotton is Toxaphene-DDT, and the farmers do not substitute Folidol in their cotton production. The details are tabulated in Table 3.11.

Table 3.11. Recommended Insecticides and Quantity Use Per Rai.

Crops	Insecticides	Recommended Rate/rai (c.c.)	Use Per Crop Kg. or c.c.
Rice	6% BHC	2 kg.	6 kg.
	Sevin 85%	350 gm.	300 c.c.
	Folidol	250 c.c.	
Corn	Endrin 19.5%	300 c.c.	
	Sevin 85%	350 gm.	300 c.c.
	Folidol	250 c.c.	
Cotton	Toxaphene-DDT	1.3 liter	15.8 liter

Source: (1) Ministry of Agriculture, Department of Agriculture Extension.

(2) Ministry of Agriculture, Department of Agriculture, Entomology Division.

The Bangkok retail prices of these insecticides were obtained from two surveys of both wholesale and retail shops. The first survey was taken in early 1972 and the second was in early 1973. The average retail price in Bangkok is about 12-15 percent above wholesale prices. Local market distributors received orders from Bangkok's wholesale shops on a discount basis. The percentage discount was assumed to be offset by the transportation cost. The local market price was assumed simply as a mark up of 10 percent over the retail price in Bangkok.

The percentage of adoption was based on information from the Entomology Division, Ministry of Agriculture.[13] For simplicity, it was assumed that farmers practicing modern methods will adopt insecticides carrying these brand names. The weighted average price for B.H.C. is 11 baht per kg. The weighted average price of insecticides for rice is 78.32 baht per liter, for corn it is 30.80 baht per liter. The weighted average price is tabulated in Table 3.13.

Production Costs of Rice, Corn and Cotton

The variable costs of production can be derived from the physical units of inputs and labor required in producing one rai of rice, corn, and cotton. The variable costs of corn is lowest, while the variable costs of cotton is highest at both

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[13]Author interviewed Dr. Thanongchit Wongsiri, Head, Entomology Division, Department of Agriculture.

Table 3.12. Bangkok's Retail Prices of Insecticides, 1971-1973.

Insecticides	Quantity	Retail Prices (Baht)		
		1971	1972	1973
B.H.C. 6%	1 kg.	9	10	12
Sevin 85%	1 kg.	70	70	75
Folidol	1 liter	70	72	80
Endrin 19.5	1 liter	42	45	50
Toxaphene DDT	1 liter	25	28	35

Source: Survey of wholesale and retail shops in Bangkok.

Note: It is a per unit price, percentage discount will be given on large quantity purchased.

technology levels. The variable costs of rice is in between the two crops. Production costs of corn, rice and cotton under traditional practice are 105.22, 120.46 and 450.04 baht, respectively, while under modern practice are 269.75, 279.88 and 909.52 baht, respectively. Detailed information is summarized in Tables 3.14, 3.15 and 3.16.

Bangkok Wholesale and Local Market Prices

Local price is the price received by farmers in different changwats. Local prices are effected by two important factors: (1) distance from the changwats to Bangkok market. The price received in the local market is inversely related to distance because of transportation costs. (2) The demand and supply condition in Bangkok which will signal price change to local market, usually it will move in the same direction. The average local price from the

Table 3.13A. Weighted Average Prices of Insecticides Commonly Used in Rice, Corn, and Cotton, 1972.

Crops	Insecticides Used	Quantity	Percentage Adoption	Retail Price (฿)	Weighted Price (฿)
Rice	B.H.C. 6%	1 kg.	100	10	10
	Folidol	1 liter	60	72	4320
	Sevin 85%	1 kg.	40	70	2800
Weighted Average Price	--	--	--	--	71.20
Corn	Sevin 85%	1 kg.	40	72	2880
	Endrin 19.5%	1 liter	35	45	1575
	Folidol	1 liter	25	72	1800
Weighted Average Price	--	--	--	--	62.55
Cotton	Toxaphene-DDT	1 liter	100	28	2800
Weighted Average Price	--	--	--	--	28

Source: Calculated from Table 3.12.

Table 3.13B. Mark-up Price in Local Shops.

Commodities	Insecticides	Weighted Average Price (฿)
Rice	B.H.C. 6%	11
	Folidol, Sevin	78.32
Corn	Sevin, Endrin, Folidol	68.80
Cotton	Toxaphene-DDT	30.80

Source: Calculated from Table 3.13A.

Table 3.14. Production Costs of Rice Under Traditional and Modern Practices.

Technology Level	Yield Kg/rai	Labor[1] Cost (฿)	Power Cost		Fertilizer[2] (฿)	Insecticides[2] (฿)	Herbicides[2] (฿)	Total Variable Cost (฿)
			Tractor (฿)	Buffalo (฿)				
Traditional	342.42	95	10.90	11.28	2.52	.26	.50	120.46
Modern	556	135	10.90	11.28	32.70	89.50	.50	279.88

Sources: [1]From Tables 3.1 and 3.2. Wage rate was based on average market rate which is 10 baht per 8 hours work.

[2]Traditional method was generated from Table 3.2. Modern method uses the recommended rate of fertilizers and insecticides. Fertilizers and Insecticides prices were taken from Tables 3.10 and 3.13.

Table 3.15. Production Costs of Corn Under Traditional and Modern Practices.

Technology Level	Yield Kg/rai	Labor[1] Cost (฿)	Power Cost		Fertilizer (฿)	Insecticides (฿)	Herbicides (฿)	Total Variable Cost (฿)
			Tractor (฿)	Buffalo (฿)				
Traditional	406.2	67.50	35.69	.92	.53	.58	--	105.22
Modern	751	95	35.69	.92	117.50	20.64	--	269.75

Source: [1]Wage rate was 10 baht per 8 hours work. From Tables 3.3 and 3.4.

Table 3.16. Production Costs of Cotton Under Traditional and Modern Practices.

Technology Level	Yield Kg/rai	Labor[1] Cost (฿)	Power Costs		Insecticides (฿)	Herbicides (฿)	Fuel[2] (฿)	Total Variable Cost (฿)
			Tractor (฿)	Buffalo (฿)				
Traditional	251.23	250	20.51	2.15	165.38[3]	---	12	450.04
Modern	485.5	335	20.51	2.15	537.46	---	14.40	909.52

Source: [1]Wage rate was 10 baht per 8 hours work. From Tables 3.5 and 3.6.

[2]Benzene cost 2 baht per liter.

[3]It was assumed that number of spray was 10 times under traditional practice and consumed 6 liters of fuel.

areas studied will be used in the analysis. The average commodities price received by farmers in 1972 for rice, corn and cotton are .94, .86, and 4.35 baht per kilogram, respectively.

The information on farm and Bangkok wholesale prices of rice, corn and cotton was taken from weekly commodities price reports issued by Agricultural Economics Division, Ministry of Agriculture. The yearly average of prices were taken from 11 changwats during the period 1970 to 1972. The average price of rice was taken from all grades of paddy namely 100 percent, 5 percent and 10 percent[14] while both corn and cotton each have only one grade report. Total weekly prices were divided by number of weeks to get the yearly average price for each changwat. Finally, the average commodities prices were derived from the sum of the changwats' average prices divided by total number of changwats. The Bangkok wholesale price was taken from yearly average wholesale prices. The commodities price is tabulated in Tables 3.17, 3.18, and 3.19.

Farmers' Revenue and Marketing Margin

The marketing margins for rice, corn and cotton were estimated by computing the difference in the prices if one

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[14]Paddy rice grade is classified according to impurity percentage of undeveloped seed.

Table 3.17. Average Local Price by Changwats 1970-1972 (Baht/Ton for Rice. Baht/Kilogram for Corn and Cotton).

Changwat	Commodity	1970	1971	1972
Phetchabun	Rice	886.14	700.28	1,070.95
	Corn	.85	.78	.98
	Cotton	3.17	4.52	4.81
Uttaradit	Rice	828.0	622.25	877.94
	Corn	.83	.76	.82
	Cotton	3.50	3.82	4.00
Phitsanulok	Rice	819.45	523.15	905.39
	Corn	.79	.74	.72
	Cotton	3.55	---	5.00
Nakhonrajsima	Rice	903.37	692.09	908.57
	Corn	---	.74	.82
	Cotton	3.27	3.94	4.19
Lopburi	Rice	929.0	944.93	1,043.14
	Corn	.97	.67	.74
	Cotton	---	5.00	4.46
Saraburi	Rice	1,113.75	826.0	1,042.76
	Corn	.85	.86	.98
	Cotton	---	4.78	4.00
Chainat	Rice	884.56	753.14	747.00
	Corn	.86	.84	0.72
	Cotton	---	---	---
Loei	Rice	793.50	551.20	922.84
	Corn	.74	.74	.69
	Cotton	4.10	3.95	4.65
Sukhothai	Rice	821.96	622.65	894.91
	Corn	.84	.72	.92
	Cotton	3.71	3.84	4.13
Kamphangphet	Rice	830.21	768.00	945.81
	Corn	.84	.79	1.09
	Cotton	3.39	4.70	4.02
Phitchit	Rice	853.20	603.00	979.21
	Corn	1.00	.67	.95
	Cotton	---	---	4.28

Source: Generated from "Commodities Price by Changwats and Bangkok Wholesale Prices Weekly Report".

Table 3.18. Average Price Received by Farmers for Rice, Corn and Cotton, 1972 (Baht/Kg.)

Changwat	Rice	Corn	Cotton
Phetchabun	1.07	.98	4.81
Uttaradit	.88	.82	4.00
Phitsanulok	.90	.72	5.00
Nakhonrajsima	.91	.82	4.19
Lopburi	1.04	.74	4.46
Saraburi	1.04	.98	4.00
Chainat	.75	.72	--
Loei	.92	.69	4.65
Sukhothai	.89	.92	4.13
Kamphangphet	.95	1.09	4.02
Phitchit	.98	.95	4.28
Average	.94	.86	4.35

Source: Generated from Table 3.17.

Table 3.19. Average Wholesale Prices in Bangkok, 1970-1972 (Baht/Ton for Rice, Baht/ Kilogram for Corn and Cotton).

Commodity	1970	1971	1972
Rice	1,222.61	900.00	1,127.00
Corn	1.23	1.19	1.14
Cotton	3.88	4.91	5.40

Source: Ministry of Agriculture, Agricultural Economics Division, Commodities Price by Changwats and Bangkok Wholesale Prices, Weekly report (various issues).

unit of production, first using Bangkok wholesale prices and then using local farm prices. Then marketing costs were computed by multiplying marketing margins by yield per rai. Marketing costs include transportation, storage, distribution costs, and entreprenuer profit. The marketing cost of modern rice, corn and cotton are 190, 280, and 1,050 baht per ton, respectively and 65, 114 and 264 for these crops, respectively under traditional. This wide range is explained by supply/demand factors in the market and upon costs and profit margins in transportation and marketing industries. In turn, costs and profit margins in these industries are affected by scale of operation and competition among firms. The scale of operation for cotton is small with little competition in this business, unlike the marketing system for rice and corn which is well developed. (See Table 3.20).

Comparing the performance in terms of net returns per rai, among these three crops we see that lowest returns are received by rice farmers and highest returns by cotton farmers at two levels of technology. The return to rice and corn farmers is only 201 and 244 baht per rai, while return to cotton farmers is 642 baht per rai under traditional methods. The return to rice under the modern method relative to corn is small, the difference is only 41 baht per rai for rice and 132 baht per rai for corn, respectively. The return to cotton farmers is almost double under modern methods. (See Table 3.21.)

Table 3.20. Farmers' Revenue and Marketing Margins at Two Levels of Technology.

Commodities	Traditional Method					Modern Method		
	Yield Kg/rai	Local Price ฿/rai	Revenue at Farm Level ฿/Kg.	Marketing Margin	Marketing Costs ฿/rai	Yield Kg/rai	Revenue at Farm Level ฿/Kg.	Marketing Costs ฿/rai
Rice	342.42	.94	321.87	.19	65.06	556.0	522.64	105.64
Corn	406.2	.86	349.33	.28	113.74	751.0	645.86	210.28
Cotton	251.23	4.35	1,092.85	1.05	263.79	485.5	211.92	509.78

Source: From Tables 3.14, 3.15 and 3.16. Revenue generated from average yield and price from Tables 3.18 and 3.19.

Table 3.21. Costs and Return Per Rai to Farmers at Two Levels of Technology.

Commodities	Traditional Method					Modern Method				
	Yield Kg/rai	Local Price ฿/Kg	Revenue ฿	Total Variable Costs ฿	Net Return ฿	Yield Kg/rai	Local Price ฿/Kg.	Revenue ฿	Total Variable Costs ฿	Net Return ฿
Rice	342.42	.94	321.87	120.46	201.41	556.0	.94	522.64	279.88	242.66
Corn	406.2	.86	349.33	105.22	244.11	751.0	.86	645.86	269.75	376.11
Cotton	251.23	4.35	1092.85	450.04	642.81	485.5	4.35	2111.92	909.52	1202.40

Source: From Tables 3.20 and 3.14, 3.15 and 3.16.

Note: Net Return is defined as a return after reduction of family labor and depreciation from gross margin. Gross Margin is defined as total revenue minus cash cost.

Modern methods of production required import inputs having foreign exchange components. Since the crops showed higher net return per rai under modern methods, the foreign exchange cost and revenue per rai should be disaggregate in order to evaluate the net foreign exchange earnings under two levels of technology. This will be undertaken in the next chapter.

CHAPTER IV

FOREIGN EXCHANGE COSTS AND RETURNS

The objective of this chapter is to develop a framework for analysis of the foreign exchange components of imported inputs used in the production of the selected crops. The ultimate objective is to be able to answer questions about the prospects of increasing foreign exchange earnings or savings by making adjustments in the regional production pattern for these crops. Before this can be done, however, unit calculations determined thus far must be aggregated to a regional basis. Then by making certain assumptions about the rate of which farmers in the areas will adopt modern practices and move up the ladder on yield potential, alternative government policies, pertaining to changing crop production patterns and their foreign exchange implications can be evaluated.

Foreign Exchange Components of Import Inputs

Fertilizers and Insecticides

Fertilizer and insecticide imports have increased substantially. Insecticide imports have increased from about 3 million kilograms in 1962 to 10 million kilograms

in 1967; however, they declined to 7 million kilograms in 1972. Fertilizer imports increased from .06 million tons in 1962 to .25 million tons in 1970 and reached .39 million tons in 1972.[1]

Close examination of nutrient imports shows that nitrogen fertilizers were mostly imported in the early period. A change in the composition of fertilizer imports began to take place in 1967 which may be explained by the common recommendation of the formula 16-20-0 for rice fertilization by the Rice Department. Secondly, a government policy to control the importation of single nitrogen fertilizer has caused importers to change their orders for mixed fertilizers.[2] In addition, the use of other fertilizer analyses has become widespread. For example, the analysis 14-14-14 is recommended for corn by the Field Crop Division, Ministry of Agriculture.

The c.i.f. price per kilogram of imported fertilizers was taken from reports prepared by Agricultural Economics Division,[3] which reported a c.i.f. price for 16-20 fertilizer

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[1]Generated from the import statistics, Department of Customs, Bangkok, Thailand.

[2]Thailand has a fertilizer plant which is limited to the production only of ammonium sulfate and urea from lignite. The cost of manufacturing is higher than that produced abroad. To protect the industry, the government put controls on nitrogen fertilizer imports.

[3]Ministry of Agriculture, Agricultural Economics Division, Problems of Fertilizers to Increase Agriculture Productivity. Bangkok, 1973. (Manuscript in Thai).

of 1.52 baht per kilogram and of 1.65 baht per kilogram for 14-14-14 fertilizer in 1972.

A lack of quoted c.i.f. prices for the recommended insecticides under study, and the fact that the Statistical Division, Department of Customs keeps records only by major groupings rather than brand name has made disaggregation of the foreign exchange component difficult and with low reliability. If the price range within a group is wide, average price would not be a good estimate. However, if the price range is narrow the average price would be quite reliable. It was decided to let the average price for a group containing the recommended insecticide serve as the c.i.f. price of the insecticide involved.

B.H.C. insecticide is imported as containing 20 percent active ingredients whereas recommended dosage is with only 6 percent active ingredients. So a straight line interpolation was used to derive the appropriate price. Endrin is diolefin based, Folidol belongs to organic phosphate and Sevin belongs to the carbamate group. The c.i.f. price per unit imports for each insecticide was derived from total imported value and quantities imported in 1972. Details are tabulated in Table 4.1 and 4.2.

Tractors and Attachments[4]

The majority of tractors are owned by the more prosperous farmers and local businessmen. Most owners have

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[4]The details of this section are largely taken from W. J. Chancellor, Mechanization of Small Farms in Thailand

Table 4.1. Quantities and Values of Different Insecticide Imports, 1970-1972.

Type of Active Ingredients	C.I.F.					
	1970		1971		1972	
	Quantity (Kg)	Value ($)	Quantity (Kg)	Value ($)	Quantity (Kg)	Value ($)
Hydrocarbon DDT	3,388,675	34,724,433	6,905	98,045	65,282	836,783
B.H.C. 20%	1,192,831	3,465,371	1,369	50,046	104,000	1,001,525
Diolefin Based (Endrin)	168,951	5,418,239	444,891	7,670,697	56,069	1,289,365
Organic Phosphate (Folidol)	139,451	4,229,580	22,536	1,255,557	292,919	7,439,379
Carbamate (Sevin)	62,205	1,211,373	390	56,112	4,950	129,266
Others	4,607,915	100,887,044	2,772,860	71,284,224	7,092,142	130,383,151

Source: Department of Customs Reports (various issues).

Table 4.2. Average C.I.F. Price of Insecticides in 1972.

Active Ingredients	Quantity Imports (Kg)	Value C.I.F. (฿)	Unit Price (฿/Kg.)
DDT	65,282	836,783	12.82
BHC 20%	104,000	1,001,525	9.63[1]
Diolefin based	56,069	1,289,365	33.00
Organic Phosphate	292,919	7,439,379	25.40
Carbamate	4,950	129,266	26.11
Others	7,092,142	130,383,151	18.38

[1]BHC 6% active ingredients cost 2.89 baht per kg. calculation based on a straight line extrapolation.

Rice: weighted average price of Folidol and Sevin is 25.68 baht per liter.

Corn: weighted average price of Folidol, Sevin and Endrin is 28.34 baht per liter.

Source: Calculated from Table 4.1.

only one tractor, though some own two or three. Plows with three or seven discs and disc harrows are the most common implements but other auxillary equipment including maize shellers and trailers for the carriage of crops are also used extensively.

Over the last few years ownership of tractors has continued to increase steadily. At the same time, however, demand for tractor work has not grown at the same pace. The overall demand for tractor work is now likely to be relatively

and Malaysia by Tractor Hire Services, Rice Policy Conference, International Rice Research Institute, May 9-14, 1971, p. 3-15.

"inelastic"; the competitive nature of the market has meant that demand for the use of individual tractors is probably almost "perfectly elastic." Chancellor reports that most tractor owners indicated that farmers were very price-conscious, and that any slight increase in charge rates by an individual tractor owner would result in a sharp reduction in demand for his services.

Tractor owners have been forced to look for other ways of more fully using their machines by sending their machines to work where tractor density is lower and competition is weak. During slack months tractors are temporarily sent to work in areas where the seasonal demand for tractors is complementary, rather than competitive, with the demand in the locality. During peak season, that is late April to early June, tractors may be running up to 20 hours a day by employing drivers to work in shifts.

Tractors are busy about 5 months a year, working about 12 to 24 hours per day, with annual hours of operation averaging about 1,360 hours. Travel consumes 24 percent of the operating time of a 4-wheel tractor. Tractors breakdown causes a reduction in the potential working time by 26 percent. The average hours spent in the field is 1,205 per year. Annual depreciation due to wear is 16 percent and annual repair cost is 12 percent.[5]

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[5]Chancellor, ibid., p. 9-14.

The c.i.f. prices of imported tractors, disc plows and disc harrows were calculated by the Department of Customs for 1972. Usually, tractor size as measured by horsepower ranges from 42 to 77. But the most commonly used size for hiring purposes was in the 60 to 70 horsepower range. So the quantities imported of these two models is larger than for the other models. The average c.i.f. price was computed from the total value imported divided by number of tractors imported. The same procedure was also applied to disc plows and disc harrows (see Tables 4.3 and 4.4).

Table 4.3. Quantities and Values of Tractors and Attachment Imports, 1970-1972.

Kinds	C.I.F.					
	1970		1971		1972	
	Quantity	Value (฿)	Quantity	Value (฿)	Quantity	Value (฿)
Tractors	99	2,919,678	1,367	82,750,184	109	4,969,739
Plows	24	108,008	12,114	8,624,334	926	5,417,411
Harrows	--	---	202	421,894	46	320,891

Source: Department of Customs Reports (various issues).

The life expectancy of tractors is 5 years. Repair costs and depreciation were computed on a straight line basis.[6] The repair cost reported by Chancellor was 12 percent per year.

[6]The author interviewed the sales managers of Massey Ferguson Company and Ford Motor Company for these estimates.

But with a short life expectancy the amount required for imported parts is small. It was assumed that 15 percent of the foreign exchange component based on c.i.f. price of tractors will be spent on parts during a 5 year period. On this basis, the total foreign exchange for parts is 6,839 baht. The life expectancy of disc plows and disc harrows is 7 years without any requirement for imported parts.

Table 4.4. Average Import Price of Tractors and Attachments, 1972.

Kinds	Quantity	Value C.I.F. (฿)	Unit Price (฿)
Tractors	109	4,969,739	45,594
Disc Plows	926	5,417,411	5,850
Disc Harrows	46	320,891	6,976

Source: Calculated from Table 4.3.

The c.i.f. price per hour of work by tractors was computed by adding up foreign exchange costs of parts to c.i.f. price of tractors and dividing by the total number of hours worked. The c.i.f. price per hour of work for disc plows and disc harrows was computed by dividing c.i.f. price by the number of hours worked. But the tractor cannot pull both disc plow and disc harrow at the same time, so it was assumed that both will be used equally. Thus, the average c.i.f. price of both will be used for further analysis. (See Table 4.6).

Spraying Machines

In general, farmers own at least one knapsack sprayer except for those farmers who cultivate only 5 to 10 rais and would not purchase a sprayer. The farmers seldom own motorized sprayers unless they cultivate more than 100 rais of land or happen to be fruit farmers or cotton farmers.

The rice and vegetable farms apply insecticides more extensively than other field crops on the average. A report of the Agricultural Economics Division in 1969 shows that 1,522 farms out of 2,774 sample farms reported using insecticides The total number of sample farms was 7,668, with an average of 36 percent using insecticides. The percentage of rice farms using insecticides is about 55 percent. The number of vegetable farms using insecticides was 921 or about 33 percent, whereas only 2 percent of the corn farmers used insecticides.[7]

The most common type of sprayer owned by rice and vegetable farmers is the knapsack sprayer. The capacity of work is about 2 rais per hour.[8] These crops do not require as much spraying as cotton. Cotton was sprayed far more intensively than any other crop, and with the importance of timing, the capacity of spraying machines has a correlation with cultivated area.[9] Some of the cotton farmers own

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[7]S. Vanitkobjinda. The Use of Insecticides and Sprayers for Disease Control. Agricultural Economics Division, Ministry of Agriculture, June 1973, p. 13 (Mimeograph in Thai).

[8]Ibid., p. 4.

[9]Grimble, op. cit., p. 33.

motorized sprayers (30 percent), whereas 70 percent used knapsack sprayers. The capacity of motorized sprayers is sufficient to cover up to 8 rais per day depending upon the height of the plants.[10] It was assumed for this study that rice and corn farmers own only ordinary knapsack sprayers and that ownership of motorized sprayers is not significant.

The average c.i.f. price of knapsack sprayers and motorized sprayers was compiled from statistical section reports, Department of Customs. The total value imported in 1972 was divided by the total number of machines to get the average c.i.f. price of sprayers (see Table 4.5). A life expectancy of 5 years was assumed for these machines without any imported parts required within the study period. Likewise the repair cost will be all domestic costs having no foreign exchange component in it.

The sprayers have an effective use of 5 months a year with 5 hours of work per day.[11] The average c.i.f. price per hour was derived from the average price per sprayer divided by total number of hours worked in 5 years (see Table 4.6).

Oil (Fuel)

As a country undergoes the process of economic development, the demand for energy increases. Oil is the major source of energy in the world. Agriculture requires oil as a source of energy for mechanization and transportation.

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[10] Vanitkobjinda, op. cit., p. 4

[11] Ibid., p. 7.

Table 4.5. Quantities and Values of Knapsack Sprayers and Motorized Sprayers (Knapsack Sprayer Duster Engine), 1972.

Months	Quantities	Value C.I.F. (฿)	C.I.F. Price Per Unit (฿)
January	---	---	---
February	5	6,240	1,248
March	5	6,240	1,248
April	5	6,240	1,248
May	156	314,038	2,013
June	736	820,936	1,115.50
July	4	746	186.50
August	315	297,467	944.40
September	132	181,860	1,377.72
October	562	120,156	213.80
November	120	86,417	720.14
December	49	9,941	202.88
Total	2,089	1,850,281	885.73

Source: Statistical Section, Department of Customs.

The purpose of this analysis is to find out the foreign exchange component of the benzene, diesel and lubrication oil required for tractors and sprayers. The average conversion ratio from crude oil to benzene and diesel fuel is 24.6 and 27.8, respectively (see Tabl3 4.7). During the refinery process both benzene and diesel fuel will be extracted from crude oil.

Table 4.6. Life Expectancy of Farm Machines and Total Numbers of Hours Worked.

Kind of Machine	Life Expectancy (Years)	Number of Hours Work Per Year	Total Number of Hours Work	C.I.F. Price Per Unit (฿)	Foreign Exchange Per Hour of Work (฿)
Tractors	5	1,205	6,025	52,433	8.70
Disc plows	7	1,205	8,435	5,850	.69
Disc harrows	7	1,205	8,435	6,979	.83
Sprayers	5	750	3,750	885.73	.24

(1) It is assumed that sprayers have effective use 5 months a year. The number of hours work per day is 5 hours.

(2) Engine spray consumes 2 liters of gasoline per hour. But it has only 30 percent of the total number of sprayers used. So it consumes only 600 c.c. of gasoline per hour of work.

(3) Tractors consume 2.5 liters of diesel fuel and 100 c.c. of oil per rai (Delane Welsch 1971).

(4) Since a tractor can draw one attachment at a time, so disc plow and disc harrow is assumed to be equally used in land preparation. The average foreign exchange per hour of work is .76 baht.

(5) C.I.F. price of tractors including costs of parts imported is (45,954 + 6839) 52,433 baht.

Table 4.7. Conversion Rate of Crude Oil from Three Different Sources.

Kinds	Conversion Rate (Percentage)			Average Percentage
	Syria/Miri	Quavata	Kuwait	
Benzene	33.1	23.4	17.4	24.6
Diesel	29.2	28.3	26	27.8

Source: C. Chanchaiyasuk and P. Anantapakorn, Oil. Ministry of Finance, 1973, (Mimeograph in Thai).

(1) Government imposes excise tax of .80 baht on benzene and .12 baht on diesel.

(2) Conversion rate from crude oil to benzene and diesel is 52.4 percent.

(3) In 1972, total consumption of diesel oil in Thailand was 2,815 million liters. The total imports are only 6.3 million liter. So it is not significant in terms of c.i.f. price difference.

(4) Foreign exchange component of diesel and benzene fuel is .17 baht per liter.

The total conversion ratio is 52.4 percent. So the foreign exchange component of benzene and diesel fuel is the same except that the domestic price is different because the government imposes unequal rates of excise tax on them. The excise tax imposed on benzene is .80 baht per liter while it is only .12 baht per liter on diesel fuel.

The major consumption of fuel in Thailand is diesel fuel. Domestic refineries cannot produce enough supply to meet domestic demand. Diesel fuel is imported every year. However, relative to total consumption, the quantity imported

was insiginificant in 1972.[12] The total diesel fuel consumption in Thailand was 2,815 million liters while imports were only 6.3 million liters. The foreign exchange component of other oil products was derived from the average c.i.f. price (see Tables 4.8 and 4.9). C.I.F. prices per liter will be used as the foreign exchange components of these inputs.

Foreign Exchange Costs of Imported Inputs

The total foreign exchange costs component of import inputs is computed in terms of costs per rai. The previously discussed total time of tractor plowing is multiplied by the average c.i.f. price of tractors and attachments which is 9.46 baht per hour of work. Thus, the foreign exchange costs of tractor services is obtained. The foreign exchange component of sprayers is computed by the same procedure. The foreign exchange component of insecticides, fertilizers is based on the average units used and the c.i.f. price per unit, also the quantities of gasoline and oil used (see Table 4.10). From these the cost of foreign exchange component per rai was computed.

The foreign exchange component costs of producing rice under both technology levels is lowest when compared with

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[12] C. Chanchaiyasuk and P. Anantapakorn. Oil. Ministry of Finance, unpublished article, 1973, p. 11-15.
Calculation on percentage consumption of diesel fuel based on total consumption and import.

Table 4.8. Quantities and Values of Oil Products Imports, 1970-1972.

Types of Oil Product	C.I.F.					
	1970		1971		1972	
	Quantity	Value (₱)	Quantity	Value (₱)	Quantity	Value (₱)
Lubricating Oil (liter)	113,142,209	294,233,061	75,596,784	185,952,560	93,135,616	232,592,381
Lubricating Grease (Kg)	6,912,239	79,126,955	5,647,183	26,494,485	4,177,322	20,401,981
Hydraulic Fluid (liter)	3,604	29,218	38,812	294,026	2,091	17,453
Crude Oil (100 liter)	38,284,546	1,030,392,274	50,946,108	1,542,492,630	62,987,771	2,012,980,479
Diesel Oil (100 liter)	9,943,692	467,138,060	7,841,218	360,080,873	6,305,427	309,171,104

Source: Department of Customs Reports (various issues).

Table 4.9. Average C.I.F. Prices of Oil Products Imports, 1972.

Types of Oil Product	Quantity Imports	Value C.I.F. (฿)	Price per Kg. or Liter (฿)
Lubricating Oil (Liter)	93,135,616	232,592,381	2.50
Lubricating Grease (Kg)	4,177,322	20,401,981	4.88
Hydraulic Fluid (liter)	2,091	17,453	8.35
Crude Oil (100 liter)	62,987,771	2,012,980,479	.32
Diesel Oil (100 liter)	6,305,427	309,171,104	.49

Source: Calculated from Table 4.8.

corn and cotton. There are only 4.20 baht of foreign exchange costs under traditional methods and 50.34 baht per rai under modern methods of rice production. The foreign exchange costs on corn production under traditional and modern methods are 6.04 and 97.91 baht, respectively. The foreign exchange spending on cotton production is highest. It is 93.66 baht under traditional and 230.62 baht per rai under modern methods.

Import and Export Prices of Commodities

The information on import of rice and corn, also import of cotton, was obtained from the Department of Customs report. The average c.i.f. (import) and f.o.b. (export) is simply the average price obtained by dividing the total value by total quantities. The f.o.b. price for rice[13] is 2.10 baht per kg.,

[13]Rice export in terms of milled rice, the transformation rate is 66 percent. The paddy has to be converted into milled rice.

Table 4.10. Foreign Exchange Cost in Producing One Rai of Rice, Corn and Cotton Under Two Levels of Technology.

Commodities	Tractors and Attachments		Sprayers		Fertilizers		Insecticides		Fuel		Oil		Total Foreign Exchange (฿)	Dollars
	Hour of Work (Min)	Foreign Exchange (฿)	Hour of Work (Min)	Foreign Exchange (฿)	Quantity (Kg.)	Foreign Exchange (฿)	Quantity (Liter or Kg.)	Foreign Exchange (฿)	Quantity (Liter)	Foreign Exchange (฿)	Quantity (Liter)	Foreign Exchange (฿)		
TRADITIONAL METHOD														
Rice	11	1.73	.26	.10	1.3	1.99	---	---	1.38	.23	.060	.15	4.20	.21
Corn	35	5.52	.32	.13	---	---	---	---	3.80	.65	.152	.38	6.04	.30
Cotton	15	2.37	10 hrs.	2.40	---	---	6.82	87.43	7.63	1.30	.065	.16	93.66	4.68
MODERN METHOD														
Rice	11	1.73	1.0	.24	15	22.95	6kg + .3	(17.34 + 7.70) = 25.04	1.38	.23	.060	.15	50.34	2.52
Corn	35	5.52	1.5	.36	50	82.50	.3	8.50	3.80	.65	.152	.38	97.91	4.90
Cotton	15	2.37	12 hrs.	2.88	---	---	17.45	223.71	8.83	1.50	.065	.16	230.62	11.53

Notes: (1) Diesel Fuel - include both tractors and sprayers, because of equal foreign exchange component.

(2) Average spraying time under traditional practice (Table 3.5) is 30.19 hours. This includes time required for insecticide preparation which is assumed to be 20 hours, so the use of spraying machines is only 10 hours.

corn is 1.13 baht per kg. and cotton is 14.98 baht per kg.[14] With the information on yields under both levels of technology the foreign exchange earnings or savings can be computed. The foreign exchange revenue is tabulated in Table 4.11.

Foreign Exchange Earnings or Savings Per Rai Among The Commodities

Under traditional practice, rice receives better foreign exchange earning per rai than corn. Rice earns 470 baht while corn earns only 452 baht per rai. However, the return to farmers is better in the case of corn. Corn earns more foreign exchange as well as revenue to farmers relative to rice under modern practice. Cotton shows very good foreign exchange savings under both levels of technology (see Table 4.12).

At this point, the question of which crops should be emphasized can be analyzed. However, the information on earnings and savings per rai is not sufficient to show the potential and performance of crops in aggregate form. The regional aggregation will give a clearer picture of potential limiting factors and bottlenecks than would be the case of analyzing only on the basis of one rai for each crop.

Rice is the staple food of Thai people and farmers always allocate a certain portion of their land for the growing of rice in order to assure a year-round supply of

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[14]Cotton import in terms of lint cotton. Lint figure is obtained by taking cotton seed figure and multiplying by 33.3 percent.

Table 4.11. Foreign Exchange Revenues Per Rai Under Two Levels of Technology.

Commodities	Traditional			Modern		
	Yield-Kg. Per Rai	C.I.F. or F.O.B. per Kg. (฿)	Total Foreign Exchange (฿)	Yield-Kg. Per Rai	C.I.F. or F.O.B. per Kg. (฿)	Total Foreign Exchange (฿)
Rice	226	2.10	474.60	366.96	2.10	770.62
Corn	406.2	1.13	459	751	1.13	848.63
Cotton	83.66	14.98	1253.22	161.67	14.98	2421.84

Note: (1) Paddy transform to milled rice, with 66 percent transformation rate.

(2) Cotton lint figure has been obtained by taking 33.3 percent of figures for seed cotton.

Table 4.12. Foreign Exchange Earnings or Savings Under Two Levels of Technology.

Commodities	Rai					
	Traditional			Modern		
	Foreign Exchange Revenue (฿)	Foreign Exchange Cost (฿)	Earn or Save (฿)	Foreign Exchange Revenue (฿)	Foreign Exchange Cost (฿)	Earn or Save (฿)
Rice	474.60	4.20	470.40	770.62	50.34	720.28
Corn	459.0	6.04	452.96	848.63	97.91	750.72
Cotton	1253.22	93.66	1159.56	2421.84	230.62	2191.22

Source: Generated from Tables 4.10 and 4.11.

rice for their families. The previous analysis showed that return to investment on rice is lower than corn and cotton in the designated areas. Also, foreign exchange earnings from rice are lower under modern methods of production and insignificantly higher than corn under traditional methods. However, rice does not compete with corn and cotton for the same cultivated areas. Rice will continue to be cultivated in these areas but will not have much influence on foreign exchange earnings.

Aggregation of Corn-Cotton Production Areas

The major location of corn production in Thailand is on the upper portion of the Central Region. There are eight changwats which have more than 70 percent of the total corn production areas and production in Thailand, namely, Lopburi,

Phetchabun, Nakorn Sawan, Saraburi, Sukhothai, Loei, Kamphangphet and Phitsanulok. The other remaining area of corn cultivation is scattered around Central, Northern and Northeastern Regions.[15] The major location of cotton production is also the same as for corn. Cotton areas in Sukhothai, Loei and Lopburi constitute 65 percent of the total production area in the country.[16] The production areas under rice, corn and cotton in these changwats were gathered from Agricultural Extension Department reports. The total rice areas have declined since 1969, from 6.6 million rais to 5.3 million rais in 1971, but increased to 5.5 million rais in 1972. The production areas under corn have increased since 1969, from 2.6 million rais to 5.1 million rais in 1972. The cotton areas have declined from .53 million rais in 1969, to .27 million rais in 1971, increasing to .31 million rais in 1972. (See Tables 4.13 and 4.14.) There seems to be limited virgin land for further expansion of corn areas. Hence, we can expect the total area in corn to remain near the 1972 level. However, certain government programs to encourage modern methods of production of corn and cotton may intensify the competition for land between these two crops as well as competition for the

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[15]Thailand, National Corn and Sorgham Program, Annual Report, Department of Agriculture, Kaseteart University, Bangkok, Thailand, 1971, p. 3.

[16]Grimble, op. cit., p. 1.

Table 4.13. The Cultivated Areas of Rice, Corn and Cotton in Selected Changwats, 1969-1972.

Year	Sukhothai	Loei	Lopburi	Kamphaingpet	Petchabun	Pitsanuloke	Nakorn Sawan	Saraburi
				RICE (Rai)				
1969	447,000	198,000	891,000	656,000	548,000	1,130,000	1,874,000	713,000
1970	481,000	138,000	620,000	633,000	516,000	1,192,000	1,762,000	855,000
1971	616,000	173,000	607,000	687,000	527,000	637,000	1,628,000	501,000
1972	448,000	95,000	666,000	586,000	519,000	764,000	1,943,000	508,000
				CORN (Rai)				
1969	337,028	39,370	631,534	195,500	389,190	168,618	871,566	510,240
1970	416,843	86,517	461,700	202,000	333,390	182,254	1,112,984	516,181
1971	498,204	97,596	829,501	217,400	467,859	270,187	1,160,000	563,219
1972	427,152	118,050	1,290,000	227,480	1,195,879	277,353	1,058,893	584,539
				COTTON (Rai)				
1969	282,362	153,957	33,835	11,200	57,150	4,085	4,025	6,550
1970	109,139	85,034	6,623	8,300	21,800	970	1,277	11,572
1971	106,959	92,928	32,182	11,049	15,970	2,546	4,150	11,377
1972	123,152	108,050	33,065	11,480	15,879	2,353	4,893	14,539

Source: Agricultural Economics Division, Ministry of Agriculture, Rice (Mimeograph)
Agricultural Extension Department, Corn and Cotton (Mimeography).

Table 4.14. The Total Areas of Rice, Corn and Cotton in Selected Changwats, 1969-1972.

Year	Rice	Corn	Cotton
	----------Rai----------		
1969	6,686,000	2,643,046	553,164
1970	5,998,000	3,311,869	244,715
1971	5,376,000	4,103,966	277,161
1972	5,529,000	5,179,346	313,411

Source: Generated from Table 4.13.

use of labor. The analysis in the next section will focus on the potential of foreign exchange earnings and savings between corn and cotton under assumptions of fixed land areas and availability of labor resources on corn and cotton production. Assumptions about projections on modern practices will also be needed in the analysis.

Total Net Farm Return and Net Foreign Exchange Earnings and Savings Under Corn and Cotton Production with Projections to 1977

The analysis on total net farm return and net foreign exchange earnings and foreign exchange savings on selected alternative assumptions will serve as a guideline for policy recommendations. Land and labor are the two major constraints in the production of corn and cotton. To increase land for cotton production will reduce corn areas and vice versa. Labor becomes a constraint because the two crops are produced

at the same time period. Corn production is labor extensive in nature while cotton production is labor intensive. Thus, other things constant, corn farmers will have more time for leisure or alternative employment than those in cotton production.

A five year projection with 1972 as a base will be made for net foreign exchange under five sets of policy assumptions. Assumptions will pertain to crop area as well as proportion of crop under modern practice. Results of the analysis will be discussed in detail with appropriate implication in the concluding chapter. The alternative assumptions are as follows.

Alternative A

It is assumed that:

(1) Total cotton land will increase at a slow arbitrary rate of 2 percent each year.

(2) Cotton production under modern practice will increase at a rate of 2 percent of total cotton area each year. In other words, the first year will be 2 percent, the second year 4 percent, the third year 6 percent, and so on. This is based on the fact that modern cotton production has high risk associated with it and requires a high level of technical knowledge on the part of farmers. Even though with encouragement and the provision of incentive by the government, it is expected

Table 4.15. Labor Requirements, Cost, Revenue, Net Return and Net Foreign Exchange Earnings per Rai Under Two Levels of Technology.

	Traditional Corn	Modern Corn	Traditional Cotton	Modern Cotton
Yield (Kg/rai)	406.2	751.0	251.23	485.5
Labor Requirement (Days)	6.75	9.5	25.0	33.5
Revenue (฿)	349.33	645.86	1092.85	2111.92
Variable Cost (฿)	105.22	269.75	450.04	909.52
Net Return[1] per rai (฿)	244.11	376.11	642.81	1202.40
Cotton (Lint Figure) kg.	---	---	83.66	161.67
Foreign Exchange Revenue (฿)	459.0	848.63	1253.22	2421.84
Foreign Exchange Cost (฿)	6.04	97.91	93.66	230.62
Net Foreign Exchange (฿)	452.96	750.72	1159.56	2191.22

[1]Gross value - (Variable Cost + Total Labor Charge).

Source: Based on Tables 3.20, 3.21 and 4.12.

that modern cotton production will not exceed an accumulated rate of 2 percent per year.

(3) Total corn area will be equal to the residual after computing total cotton area.

(4) Total available labor is equal to the total estimated corn and cotton labor used in 1972 plus 15 percent of the corn labor assuming that it was not fully utilized. This estimate was computed by multiplying per rai labor requirements for corn and cotton by the 1972 crop area for these crops, respectively. No allowance has been made for other farming

activities in the region. However, it was assumed that if 1972 peak season labor requirements were met and if there was some slack in the use of corn labor then the estimate of total available labor for use on the two crops would be reasonable for the present analysis.

The analysis shows that the net foreign exchange increase would amount to 446.24 million baht in 1977, without fully utilizing all labor available. Further results are summarized in Tables 4.16a and 4.16b.

Alternative B

Supply of labor is the limiting factor in considering expansion of cotton production using modern methods. For this alternative the total cotton area will be increased 10 percent each year and modern cotton will be allowed to increase by an accumulated 10 percent of total cotton area each year (this is an increase of 10 percent on the first year, 20 percent on the second, 30 percent on the third, and so on). This is considered to be a maximum rate of annual increase even with concerted effort on the part of the government to encourage cotton production which would be appropriate if the goal is to reduce cotton imports.

The total corn area will be equal to the residual after determining total cotton area. The area of corn under modern practice is assumed to start from zero and to increase each year by an additional arbitrary 5 percent of total corn

Table 4.16a. Land and Labor Requirement Under Alternative A.

Unit: 1,000 rais and 1,000 days

Land and Labor	1972	1973	1974	1975	1976	1977
Traditional cotton area	313.4	313.27	313.02	312.62	312.09	311.41
Modern cotton area	0	6.39	13.04	19.95	27.14	34.60
Total cotton areas	313.4	319.67	326.06	332.58	339.23	346.01
Traditional corn area	5,179.3	4,914.38	4,649.97	4,386.10	4,122.77	3,860.02
Modern corn area	0	258.65	516.66	774.02	1,030.69	1,286.67
Total corn areas	5,179.3	5,173.03	5,166.64	5,160.12	5,153.47	5,146.69
Labor required for traditional cotton	7,835.0	7,831.75	7,825.5	7,815.5	7,802.25	7,785.25
Labor required for modern cotton	0	214.06	436.84	668.32	909.19	1,159.1
Total labors required for cotton	7,835.0	8,045.81	8,262.34	8,483.82	8,711.44	8,944.35
Labor required for traditional corn	34,961.0	33,172.06	31,387.30	29,606.17	27,828.70	26,055.13
Labor required for modern corn	0	2,457.17	4,908.27	7,353.19	9,791.55	12,223.36
Total labors required for corn	34,961.0	35,629.23	36,295.57	36,959.36	37,620.25	38,278.49
Total supply of labor	48,039	48,039	48,039	48,039	48,039	48,039
Unused labor	5,243	4,363.96	3,481.09	2,595.82	1,707.31	816.16
Total area	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7

Source: Based on survey data and assumptions previously explained in the text.

Table 4.16b. Net Return and Net Foreign Exchange Under Alternative A.

Unit: Million Baht

Net Return and Net Foreign Exchange	1972	1973	1974	1975	1976	1977
Net return from traditional cotton	201.46	201.37	201.21	200.95	200.61	200.18
Net return from modern cotton	0	7.68	15.68	23.99	32.63	41.60
Total net return from cotton	201.46	209.05	216.89	224.94	233.24	241.78
Net foreign exchange from traditional cotton	363.41	363.25	362.96	362.50	361.89	361.10
Net foreign exchange from modern cotton	0	14.0	28.57	43.71	59.47	80.2
Total net foreign exchange from cotton	363.41	377.25	391.53	406.21	421.36	441.30
Net return from traditional corn	1,264.32	1,199.65	1,135.10	1,070.69	1,006.41	942.27
Net return from modern corn	0	97.28	194.32	291.12	387.65	483.93
Total net return from corn	1,264.32	1,296.93	1,329.42	1,361.81	1,394.06	1,426.20
Net foreign exchange from traditional corn	2,346.01	2,226.02	2,106.25	1,986.73	1,867.45	1,748.43
Net foreign exchange from modern corn	0	194.17	387.87	581.07	773.76	965.93
Total net foreign exchange from corn	2,346.01	2,420.19	2,494.12	2,567.80	2,641.21	2,714.36

Source: Based on survey data and assumptions previously explained in the text.

area. Under this policy alternative, the government would put higher priority on modern cotton production, even though corn export can provide foreign exchange earnings. Some farmers in the area will adopt modern production but it is expected that the adoption rate will not be more than what has been assumed.

Given these assumptions, the analyses show that the net foreign exchange increase amount to 766.84 million baht in 1977. However, there will be a labor shortage after 1975, amounting to 1,739,190 labor days. Thus, other things held constant, there would be no labor available for corn and there would be idle land. This would bring some decline in net foreign exchange in 1977. Further results are summarized in Tables 4.17a and 4.17b.

Alternative C

Shortage of labor resulted from rapid cotton expansion as determined by Alternative B. With these results, it seemed advisable to study the effect of increasing modern corn production at a faster rate than in Alternative B. This alternative assumes that initially the total corn area is unchanged and the cotton area and technology remain unchanged. The corn area under modern practice will be allowed to increase each year by an additional arbitrary 10 percent of total corn area with the residual left as corn under traditional practice.

Table 4.17a. Land and Labor Requirement Under Alternative B.

Unit: 1,000 rais and 1,000 days

Land and Labor	1972	1973	1974	1975	1976	1977
Traditional cotton area	313.4	310.27	303.37	293.19	275.30	252.36
Modern cotton area	0	34.47	75.84	123.94	183.54	252.36
Total cotton area	313.4	344.74	379.21	417.13	458.84	504.72
Traditional corn area	5,179.3	4,890.56	4,602.14	4,313.24	4,027.08	3,740.98
Modern corn area	0	257.40	511.35	761.33	1,006.77	1,247.0
Total corn areas	5,179.3	5,147.96	5,113.49	5,075.57	5,033.86	4,987.98
Labor required for traditional cotton	7,835.0	7,756.75	7,584.25	7,329.75	6,882.5	6,309.0
Labor required for modern cotton	0	1,154.74	2,540.64	4,151.99	6,148.59	8,454.06
Total labor required for cotton	7,835.0	8,911.49	10,124.89	11,841.74	13,031.09	14,763.06
Labor required for traditional corn	34,961.0	33,011.28	31,064.44	29,121.12	27,182.79	25,251.61
Labor required for modern corn	0	2,445.3	4,857.83	7,232.63	9,564.31	11,846.5
Total labor required for corn	34,961.0	35,456.58	35,922.27	36,353.75	36.747.10	37,098.11
Total supply of labor	48,039.0	48,039.0	48,039.0	48,039.0	48.039.0	48,039.0
Unused labor	5,243	3,670.39	1,991.84	203.51	-1,739.19	-3,822.17
Total areas	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7

Source: Based on survey data and assumptions previously explained in the text.

Table 4.17b. Net Return and Net Foreign Exchange Under Alternative B.

Unit: Million Baht

Net Return and Net Foreign Exchange	1972	1973	1974	1975	1976	1977
Net return from traditional cotton	201.46	199.44	195.01	188.47	176.96	162.22
Net return from modern cotton	0	41.45	91.19	149.02	220.69	303.44
Total net return from cotton	201.46	240.89	286.20	337.49	397.65	465.66
Net foreign exchange from traditional cotton	363.41	359.78	351.78	339.97	319.23	292.63
Net foreign exchange from modern cotton	0	75.53	166.18	271.58	402.17	552.97
Total net foreign exchange from cotton	363.41	435.31	517.96	611.55	721.40	845.60
Net return from traditional corn	1,264.32	1,193.83	1,123.43	1,052.91	983.05	913.21
Net return from modern corn	0	96.81	192.32	286.34	378.65	469.01
Total net return from corn	1,264.32	1,290.64	1,315.75	1,339.25	1,361.70	1,382.22
Net foreign exchange from traditional corn	2,346.01	2,215.23	2,084.58	1,953.72	1,905.64	1,694.51
Net foreign exchange from modern corn	0	193.24	383.88	571.55	755.80	936.15
Total net foreign exchange from corn	2,346.01	2,408.47	2,468.46	2,525.27	2,661.44	2,630.66

Source: Based on survey data and assumptions previously explained in the text.

The results of analysis show that the net foreign exchange is almost the same as alternative B; it increases the amount to 771.10 million baht in 1977. Again, there is a shortage of labor under this alternative. However, the difference between utilization and the supply of labor is small in 1976 (only 452,410 labor days). If modern corn were allowed to expand at the rate indicated until 1977, cotton production would need to be reduced because of labor shortage. Further results are summarized in Tables 4.18a and 4.18b.

Alternative D

Given the labor shortage resulting from Alternative C, it was decided to evaluate the condition of having no modern corn production and having total corn area be equal to the residual after computing cotton area where the cotton area was assumed to increase by a compounded 10 percent rate computed on total cotton area each year.

The results show that the net foreign exchange increases only 395.54 million baht in 1977, which is the lowest among the previous ones, with the shortage of labor supply in 1977 amounting to 392,920 labor days. Further results are summarized in Tables 4.19a and 4.19b.

Alternative E

This alternative assumes cotton area will decline by 20 percent of total cotton area each year in keeping with recent trends. The level of technology under cotton will

Table 4.18a. Land and Labor Requirement Under Alternative C.

Unit: 1,000 rais and 1,000 days

Land and Labor	1972	1973	1974	1975	1976	1977
Traditional corn area	5,179.3	4,661.37	4,143.44	3,625.51	3,107.98	2,589.65
Modern corn area	0	517.93	1,035.86	1,553.79	2,071.32	2,589.65
Total corn areas	5,179.3	5,179.3	5,179.3	5,179.3	5,179.3	5,179.3
Total cotton area	313.4	313.4	313.4	313.4	313.4	313.4
Total areas	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7	5,492.7
Labor required for traditional cotton	7,835	7,835	7,835	7,835	7,835	7,835
Labor required for traditional corn	34,961	31,464.25	27,968.22	24,472.19	20,978.87	17,480.14
Labor required for modern corn	0	4,920.34	9,840.67	14,761.01	19,677.54	24,601.68
Total labor required for corn	34,961	36,384.59	37,808.89	39,233.20	40,656.41	42,081.82
Total supply of labor	48,039	48,039	48,039	48,039	48,039	48,039
Unused labor	5,243	3,819.41	2,395.11	970.80	- 452.41	-1,877.82

Source: Based on survey data and assumptions previously explained in the text.

Table 4.18b. Net Return and Net Foreign Exchange Under Alternative C.

Unit: Million Baht

Net Return and Net Foreign Exchange	1972	1973	1974	1975	1976	1977
Total net return from cotton	201.46	201.46	201.46	201.46	201.46	201.46
Total net foreign exchange from cotton	363.41	363.41	363.41	363.41	363.41	363.41
Net return from traditional corn	1,264.32	1,137.89	1,011.45	885.02	758.69	632.16
Net return from modern corn	0	194.80	389.60	584.39	779.04	973.99
Total net return from corn	1,264.32	1,332.69	1,401.05	1,469.41	1,537.73	1,606.15
Net foreign exchange from traditional corn	2,346.01	2,111.41	1,876.81	1,642.21	1,407.79	1,173.01
Net foreign exchange from modern corn	0	388.82	777.64	1,166.46	1,554.98	1,944.10
Total net foreign exchange from corn	2,346.01	2,500.23	2,654.45	2,808.67	2,962.77	3,117.11

Source: Based on survey data and assumptions previously explained in the text.

Table 4.19a. Land and Labor Requirement Under Alternative D.

Units: 1,000 rais and 1,000 days

Land and Labor	1972	1973	1974	1975	1976	1977
Traditional cotton area	313.4	310.27	303.37	293.19	275.30	252.36
Modern cotton area	0	34.47	75.84	123.94	183.54	252.36
Total cotton areas	313.4	344.74	379.21	417.13	458.84	504.72
Total corn areas	5,179.3	5,147.96	5,113.49	5,075.57	5,033.86	4,987.98
Labor required for traditional cotton	7,835	7,756.75	7,584.25	7,329.75	6,882.5	6,309
Labor required for modern cotton	0	1,154.74	2,540.64	4,151.99	6,148.59	8,454.06
Total labor required for cotton	7,835	8,911.49	10,124.89	11,481.74	13,031.09	14,763.06
Total labor required for corn	34,961	34,748.73	34,516.06	34,260.10	33,978.55	33,668.86
Total supply of labor	48,039	48,039	48,039	48,039	48,039	48,039
Unused labor	55,243	4,378.78	3,398.05	2,297.16	1,029.36	- 392.92

Source: Based on survey data and assumptions previously explained in the text.

Table 4.19b. Net Return and Net Foreign Exchange Under Alternative D.

Unit: Million Baht

Net Return and Net Foreign Exchange	1972	1973	1974	1975	1976	1977
Net return from traditional cotton	201.46	199.44	195.01	188.47	176.97	162.22
Net return from modern cotton	0	41.45	91.19	149.02	220.69	303.44
Total net return from cotton	201.46	240.89	286.20	337.49	397.66	465.66
Net foreign exchange from traditional cotton	363.41	359.78	351.78	339.97	319.23	292.63
Net foreign exchange from modern cotton	0	75.53	166.18	271.58	402.18	552.98
Total net foreign exchange from cotton	363.41	435.31	517.96	611.55	721.41	845.61
Total net return from corn	1,264.32	1,256.67	1,248.25	1,239	1,228.81	1,217.61
Total net foreign exchange from corn	2,346.01	2,331.82	2,316.21	2,299.03	2,280.14	2,259.35

Source: Based on survey data and assumptions previously explained in the text.

remain unchanged. The total corn area equals the residual after computing the reduction of the cotton area. Modern corn production is allowed to increase each year by an additional arbitrary 10 percent of total corn area.

The results show a favorable net foreign exchange position; the increase amounting to 653.58 million baht with a labor surplus in 1977 amounting to 1,677,930 labor days. Further results are summarized in Tables 4.20a and 4.20b.

Table 4.20a. Land and Labor Requirement Under Alternative E.

Unit: 1,000 rais and 1,000 days

Land and Labor	1972	1973	1974	1975	1976	1977
Total cotton area	313.4	250.72	200.57	160.45	128.36	102.69
Traditional corn area	5,179.3	4,717.78	4,233.70	3,732.57	3,218.60	2,695.01
Modern corn area	0	524.20	1,058.43	1,599.67	2,145.74	2,695.0
Total corn areas	5,179.3	5,241.98	5,292.13	5,332.25	5,364.34	5,390.01
Labor required for traditional cotton	7,835	6,268	5,014.25	4,011.25	3,209	2,567.25
Labor required for traditional corn	34,961	31,845.01	28,577.47	25,194.85	21,725.55	18,191.32
Labor required for modern corn	0	4,979.9	10,055.08	15,196.86	20,384.53	25,602.5
Total labor required for corn	34,961	36,824.91	38,632.55	40,391.71	42,110.08	43,793.82
Total supply of labor	48,039	48,039	48,039	48,039	48,039	48,039
Unused labor	5,243	4,946.09	4,392.23	3,636.04	2,719.92	1,677.93

Source: Based on survey data and assumptions previously explained in the text.

Table 4.20b. Net Return and Net Foreign Exchange Under Alternative E.

Unit: Million Baht

Net Return and Foreign Exchange	1972	1973	1974	1975	1976	1977
Total net return from cotton	201.46	161.17	128.93	103.14	82.51	66.01
Total net foreign exchange from cotton	363.41	290.72	232.57	186.05	148.84	119.08
Net return from traditional corn	1,264.32	1,151.66	1,033.49	911.16	785.69	657.88
Net return from modern corn	0	197.17	398.09	601.65	807.03	1,013.62
Total net return from corn	1,264.32	1,348.83	1,431.58	1,512.81	1,592.72	1,671.50
Net foreign exchange from traditional corn	2,346.01	2,136.96	1,917.70	1,690.70	1,457.90	1,220.73
Net foreign exchange from modern corn	0	393.53	794.58	1,200.90	1,610.85	2,023.19
Total net foreign exchange from corn	2,346.01	2,530.49	2,712.28	2,891.60	3,068.75	3,243.92

Source: Based on survey data and assumptions previously explained in the text.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

This dissertation has focused on the international trade and farm income implications of changing agricultural production patterns of major crops in a primary agricultural production area in Thailand. For many years heavy reliance has been placed on agriculture exports as a source of foreign exchange. The productivity of the agricultural sector in increasing the productivity of the major agricultural crops is far less than its potential. This is due in part because Thailand has not experienced food deficits and has not been under pressure to adopt more modernized forms of farming.

Aside from rice, which has long been a major export of the country, corn is becoming a more favorable source of exports. Corn has little domestic demand because it is not a staple food in Thailand and because the livestock industry is still small. Total production of cotton has declined from about 117,000 tons of seed cotton production in 1968 to only 49,400 tons in 1972. This decline comes at a time when domestic demand has leaped due to a 100 percent expansion of the textile industry.

Problems arise for policy makers faced with the question as to what crop production pattern should be emphasized and what policies should be used to improve resource allocation for the purpose of increasing farm income as well as increasing net foreign exchange earnings.

The objective of this study was to analyze the domestic and foreign exchange costs and returns per rai for the selected crops under two levels of technology and to aggregate them for a corn-cotton production region in order to analyze the performance of alternative crop production patterns on farmers' net return and net foreign exchange earnings to the nation.

The approach to this problem was to assemble production costs and revenues per rai from sample data based on 1972 market and production conditions. The foreign exchange component of inputs used was generated from Department of Customs reports and previous studies available. The foreign exchange costs and revenues per rai were calculated and aggregated for a major corn and cotton production areas. Five alternative strategies involving shifts in production patterns and technology levels for corn and cotton were evaluated.

Alternative A. Increase modern corn and modern cotton at a slow rate with certain allowances made for shifting the corn area to traditional cotton production.

Alternative B. Increase modern cotton production at a more rapid rate than modern corn production, while modern corn production increases at a slow rate with allowances made for shifting the corn area to traditional cotton production.

Alternative C. Increase modern corn at a rapid rate leaving total area and traditional cotton area and production techniques unchanged.

Alternative D. Increase modern cotton production at a rapid rate with rapid shifting of corn area to traditional cotton production, leaving the residual corn area and production techniques unchanged.

Alternative E. Increase modern corn production at a rapid rate with shifting of cotton area to traditional corn production, leaving the residual cotton area and production techniques the same.

The results of analysis and their implications will be discussed in the next section.

Conclusions and Implications

The conclusion of this study are based on the analysis of five alternative strategies involving patterns of corn and cotton production on increasing net foreign exchange and return to farmers. Assumptions and results are summarized in Table 5.1. Alternative E, with further decline in cotton production and a corresponding increase in corn production with an increased modern proportion would bring about the

Table 5.1. Assumptions and Results of Alternatives A through E.

ALTERNATIVES I. Assumptions	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Corn Area	Residual (Total Area - Cotton Area)	Residual (Total Area - Cotton Area)	No Change - (1972)	Residual (Total Area - Cotton Area)	Total Area in 1972 and Residual
Modern Corn Proportion	Additional 5% each year of corn total	Additional 5% each year of corn total.	Additional 10% each year of corn total	No Change	Additional 10% each year of corn total
Cotton Area	Increased by compounded 2% of total cotton each year	Increased by compounded 10% of total cotton each year	No Change	Increased by compounded 10% of total cotton each year	Decreased 20% of total cotton each year
Modern Cotton Proportion	Accumulated by 2% each year of cotton total	Accumulated by 10% each year of cotton total	No Change	Accumulated by 10% each year of cotton total	No Change
Labor Supply	Cotton labor and corn labor + 15% slack labor of corn	Same as A	Same as A	Same as A	Same as A
II. Results					
Net foreign exchange in 1972 (million baht)	2709.42	2709.42	2709.42	2709.42	2709.42
Foreign Exchange Earnings in 1977	2714.36	2630.66	3117.11	2259.35	3243.92
Foreign Exchange Savings in 1977	441.3	845.60	363.41	845.61	119.08
Net return to farmers in 1977	1667.98	1847.88	1807.61	1683.27	1737.51
Labor situation in 1976 (1,000 days)	1707.31	-1739.19	-452.41	1029.36	2719.92
Labor situation in 1977 (1,000 days)	816.16	-3822.17	-1877.82	-392.92	1677.93
Increase foreign exchange in 1975 (million baht)	264.59	428.4	462.66	201.16	368.23
Increase foreign exchange in 1976 (million baht)	353.15	673.42	616.76	292.13	508.17
Increase foreign exchange in 1977 (million baht)	446.24	766.84	/71.10	395.54	653.58

Source: Based on Tables 4.16a, 4.16b, 4.17a, 4.17b, 4.18a, 4.18b, 4.19a, 4.19b, 4.20a and 4.20b and assumptions previously stated in the text.

Labor Situation: (+ sign) imply excess supply which has unutilized labors in the model.
(- sign) imply excess demand, labor in the model is not sufficient to do the work.

highest foreign exchange earnings to the country amount to 3,243.92 million baht in 1977. The foreign exchange savings would amount to 119.08 million baht and the net foreign exchange would amount to 653.58 million baht in 1977.

Alternatives B and D considered rapid adoption of modern cotton production, but with a slow rate of modern corn production in Alternative B and with technology on corn remaining unchanged in Alternative D. The results showed that foreign exchange savings were highest in Alternative B, amounting to 845.60 million baht. The net foreign exchange was highest in Alternative B amounting to 766.84 million baht and lowest in Alternative D , amounting to 395.54 million baht. However, there were labor shortages in Alternative B starting in 1976 amounting to 1,739,190 labor days and Alternative D starting in 1977 amounting to 392,920 labor days.

Alternative C considered expansion of modern corn production with areas under corn and cotton remaining unchanged and cotton technology remaining unchanged, bringing about the highest net foreign exchange amounting to 771.10 million baht. The foreign exchange earnings would amount to 3,117.11 million baht and foreign exchange savings would amount to 363.41 million baht in 1977. The net return to farmers would amount to 1,807.61 million baht. There was a labor shortage in 1974 amounting to 452,410 labor days.

Alternative A considered increasing modern corn with modern cotton production increasing at a slow rate. The foreign exchange earnings and savings in 1977 would amount

to 2,714.36 and 441.3 million baht respectively, with net foreign exchange amounting to 446.24 million baht. The net return to farmers would amount to 1,667.98 million baht.

Implications for Policies and Future Research

Limitation of the Study

Assumptions concerning the total available supply of labor and the total production area have been made for the purpose of the analysis based on the 1972 situation.

The labor shortage issues occur in Alternatives B, C and D. Alternatives B and D considered rapid expansion of modern cotton production with modern corn production expansion either at a slow rate or unchanged. The results showed a labor shortage in 1976 while Alternative C with rapid expansion of modern corn production with unchanged technology for cotton production revealed a labor shortage starting in 1977.

Labor Supply Implications

Labor supply conditions in the study are not related to the total population. Labor supply was defined as the total labor utilized for corn and cotton in the 1972 crop season. The total labor supply is equal to the estimated corn and cotton labor used in 1972 plus 15 percent of the corn labor assuming that it was not fully utilized. This estimate was computed by multiplying the labor requirement for corn at 6.75 days per rai with the total areas amounting

to 5,197,300 rai and labor requirements for cotton at 25 days per rai with total area amounting to 313,400 rai in 1972 respectively.

The labor force in the analysis was considered as merely the labor required in production activities for corn and cotton. If the contribution to the farm labor force from population growth is more than outmigration, resulting in an increased total labor force in the region, the labor shortage situation would be decreased. If the contribution to the farm labor force from population growth is less than outmigration, resulting in a decrease total labor force in the region, the labor shortage situation would be more serious. If a more precise measurement of available farm labor force is desired it will be necessary to know the regional population growth rates by age and sex composition, as well as the projected outmigration and immigration figures.

In developing countries, there is a growing tendency toward unemployment in urban areas. The rural population has migrated to urban areas searching for better employment opportunities than can be found in rural areas. This increase in unemployment in urban areas has created social welfare problems such as housing problems, health problems, public utility problems, etc. It is appropriate for the government to develop programs aimed at increasing agricultural production while encouraging the labor force to stay

in the rural areas. Cotton production is labor intensive. If labor utilization is an objective of the policy makers, keeping other factors constant, the government should increase cotton production.

The labor requirement for modern cotton production was based on the increased labor required for harvesting and packing as a result of yield increase. To the extent that yield per rai used in the analysis for cotton is overstated, so the total labor requirement is overstated. If we were to use a lower average yield of cotton per rai, the additional labor requirements for harvesting and packing would be less than estimated.

Finally, the assumption about homogeneity of labor may be subject to question. This assumption refers to the same level of skill in producing corn and cotton. However, it may not be ture that corn farmers can become good cotton farmers. It is more likely that cotton farmers can become good corn farmers. Hence, with higher labor skill required in cotton production and with the hazards associated with working with toxic chemicals in cotton production, the labor shortage may in fact be higher than the present analysis indicates.

In summary, if farm labor force grows the labor shortage would be less than indicated. Conversely, if the farm labor declines, then the labor shortage would be more acute. Cotton yields are overstated to the extent that the

additional labor required for harvesting and packing is also overtated. If insufficient consideration has been given to the higher skills required in cotton production and to the hazards from handling toxic chemicals, then the labor shortage would be more serious than the results indicated.

Cost Accounting Implications

The following cost accounting implications will be discussed: (1) fixed costs; (2) tractor services; (3) risk factors for corn and cotton accounting; (4) average yield and (5) hired labor and family labor accounting.

Fixed costs were not considered in the analysis because it was assumed that the farmers would allocate their labor and capital to maximize return by producing certain crops. This analysis focused primarily on the possibility of increasing foreign exchange to the country with less emphasis on the problem of intra-regional resource allocation. If the fixed assets were considered in the analysis, the transformation of production patterns between corn and cotton would have to consider fixed asset problems. For example, if land value had been taken into account and if the land value for corn production is higher than land value for cotton, then total costs of production would be increased more on corn, relative to cotton. As an additional example, if the cotton farmers want to switch to corn production, they may want to sell some of their equipment which is necessary in cotton production but not required for corn

production. The salvage price of the equipment would be lower than acquisition price and the total cost of transformation from cotton to corn production would be increased.

The average cost of tractor services was derived from the sample data which considered all the tractor services on a hiring basis. If the farmers owned and operated their tractors without service rendered to other farmers, the cost per unit for their operation may be higher than for custom services because of the scale of operation for their own tractor is limited. However, a farmer might also sell custom services and have a lower cost than was assumed.

Recalling that tractor services were charged at custom rates rather than costs of ownership, certain problems of aggregation arise:

1. In a micro sense, the operation costs of tractor ownership may be different from the assumed custom services charge. Because of the small farm units, tractor ownership is quite possibly more expensive than hiring tractor services, unless the tractor owner engaged in selling custom services. Without knowing the extent of tractor ownership and the extent of tractor owners selling custom services, little can be said about the effect of changing the machine charge on the final analysis.

2. In a macro sense, universal budgeting of custom services implies such services are available to all farmers. Such may not be the case.

Most farmers do not have enough capital for their farm operation and they must acquire capital by means of borrowing. In addition to normal farming risk, there is further risk associated with borrowing capital. The degree of risk may not be the same for corn and cotton production. Yield uncertainty of cotton is relatively higher than corn. A failure on cotton production would extend the loan repayment for at least another year. Risk associated with loan repayments would be higher for cotton farmers than for corn farmers. To the extent that this is the case, the cost of cotton production would be higher than was indicated.

The average yield used in the analysis was based on harvested areas and the production costs were based on planted areas. The corn sample did not show any failure but 16 cotton farms out of 20 in the original sample experienced crop failure. They were omitted from the average yield calculation. Instead, the average yield of 78 cotton farmers in another study was used. Their yields were above the national average. Obviously, if the planted areas had been included in the yield calculation, it would not have resulted in as much profit as was indicated from the analysis (nearly 3 times higher for cotton than for corn production). When this analysis is updated for future policy recommendations it is possible that new data will be available and that yields per planted acre as well as yield variability can be considered.

Even though for the region under study, the cotton yields appear higher than the regional average the selected data for these yield calculations was clearly the best available. (See Chapter III for comparison of alternative data dealing with the costs of cotton production.)

Summary and Policy Implications

A primary objective of Thailand is to increase net foreign exchange positions from the agriculture sector. Emphasis has been directed toward development of new technologies which would provide profits to farmers through increased productivity so that surpluses could be exported. Increased net foreign exchange could be derived from increased exports or from reduced imports through increased import substitution. The specific goal of the country could give priority to either one of them or both of them. Corn is an export crop while cotton is an import crop. The preferred alternative involving the mix of these two crops and/or the preferred rate of technical advance will depend on national goals.

The study was based on the production situation in 1972, with projection made for the five years up to 1977. It is not a demand and supply analysis but rather a look at the change in the foreign exchange position of the country over time if arbitrary rates of corn and cotton expansion are considered alternatively.

Prices are assumed static over time because the analysis focused on the net foreign exchange with different patterns of crop production holding everything constant except proportions of crops and technology levels. It is realized that price relationships do change over time, but the intent here was to evaluate the effect of alternative systems on the net foreign exchange without examining all forces which might bring these alternative systems into being.

Corn exports face a perfectly elastic demand so there would be no effect on price as exports increased because the price is determined by international demand and supply factors. Likewise, the price for cotton received by Thai farmers is tied to world market price and is not influenced by changes in cotton production area.

Before specifying policy recommendations it will be well to review the results from the analysis of alternative strategies.

Alternative A is a compromise position with a slow and probably programmatically feasible rate of increase in modern corn and cotton production. There is a reasonable increase in total farmers' return and net foreign exchange and this is feasible from the standpoint of labor supply.

Alternative B put more emphasis on modern cotton production with less emphasis on modern corn production. The foreign exchange savings would increase by 845.60

million baht while foreign exchange earnings would increase only 2,630.66 million baht. However, ceteris paribus, there would be quite a serious labor shortage as a result. Also, there would need to be a concerted government program to obtain an annual increase in cotton production equal to the assumed ten percent rate. These additional costs would need to be taken into account should this alternative strategy be followed.

Alternative C puts all emphasis on modern corn production with the areas and technology of cotton remaining unchanged. The net foreign exchange is the highest among other alternatives and the return to farmers is not as high as Alternative B but the difference is small. The foreign exchange savings are highest amounting to 845.61 million baht while the foreign exchange earnings remain the same. Also, there is a labor shortage but it is not as much as Alternative B.

Alternative D puts all emphasis on modern cotton production with technology on corn production remaining unchanged. The net foreign exchange increase is the lowest among the alternatives. The return to farmers is almost the same as Alternative A. The foreign exchange earnings are lower than the base period amounting to 87.66 million baht.

Alternative E puts high priority on modern corn production with reduction in cotton areas for corn production. This alternative is a favorable situation. The net foreign

exchange and the total return to farmers is quite high, only slightly different from Alternatives B and C. But there is a labor surplus for this alternative.

With a different weight given to the modern corn and cotton production in each alternative, decision makers are allowed to put the degree of priority on each of them as they deem appropriate. For example, if the primary goal is to increase net foreign exchange then they may put high priority on Alternative C. If the goal is to increase total net return they they may put high priority on Alternative B.

Short-Run Policy Consideration for Cotton

Cotton producers are faced with both a high risk associated with a yield uncertainty and a relatively high managerial skill requirement. The managerial skill requirement could met through an intensified educational programs. But the problems associated with risk such as drought and flood are beyond the farmers' control. Also, cotton producers face more hazards through use of toxic materials. Cotton production has declined since 1969. On the presumption that high risks in cotton production are largely responsible for this decline, steps could be taken to transfer some of these risks either to the government or to the textile industry. If the risk to farmers is to be transferred to the government, the following programs would be recommended:

1. Grouping cotton farmers in one large area by way of land consolidation in order to make possible the coordination of cotton spraying activities. The government could set up a spraying unit in this production and, with use of large spraying machines, spray all cotton farms in that area. This would solve the different spraying schedules among farmers which allows insects to move from one farm to another. In addition, educational programs involving cotton specialists could be organized to instruct farmers on recommended cultural practices such as time of planting and proper spacing.

2. Government crop insurance programs could assure the cotton producers a certain level of income if uncontrolled disaster such as flood and drought occurred to them. This kind of proposal may be needed to provide proper incentives for increased cotton production. It could be a very expensive program if low premium are charged and it could be very politically volatile because of questions of income inequities among farmers and the probable pressure to insure all crops.

If the risk is transferred to the textile industry it could be initiated as backward integration into cotton production. The textile industry with its demand for a dependable supply of raw materials may find it profitable to invest in its own program of cotton production in preference to buying an increasing proportion of its needs

in the form of cotton imports. To do so would require high costs of initial investments and programs similar to those proposed above where farmer risks are transferred, in this case to the industry. It is assumed that this vertical integration would be profitable in the long run, but some government assistance to the textile industry may be required in the initial phase of this program. Another alternative is not complete backward integration but the textile industry could contract with cotton producers to supply necessary inputs, namely; seeds, insecticides and spraying equipment with the producers selling the entire harvest to them in return. It might be more efficient if the textile industry would provide the contract cotton producers with wide area spraying instead of providing them with insecticides and spraying equipment.

These programs would increase costs to the government and/or the textile industry, depending upon who bears the transfer risk from the producers. If the government bears the risk its costs are borne by taxpayers in Thailand. However, if the textile industry bears the risk through backward integration into their own cotton production the cost would be passed along in the price to the consumer of the finished product. However, the textile industry in Thailand must compete with those in Japan and Korea and the price of finished material will be determined in this competitive market. Since the industries of Japan and

Korea must depend entirely on imported cotton, it is possible that an integrated cotton industry in Thailand would have a comparative advantage.

Short-Run Policy Consideration for Corn

Corn production requires less complicated managerial skills than cotton, but traditional production practices have caused exploitation of soil fertility resulting in declining yield. Continued corn production without fertilization will further decrease the corn yield. Therefore, increased productivity will rely heavily on the use of fertilizers. If the government puts a high priority in corn expansion the following policies would be recommended:

1. Pricing Policy: The world demand and supply will determine the international corn price which, in turn, determines the f.o.b. price of corn exported from Thailand. Corn export faces a perfectly elastic demand so that domestic price fluctuation follows the fluctuation of the world market. Price uncertainty and fluctuation can retard the expansion of corn production. A price support program could relieve some uncertainty and thus serve as an incentive to produce more corn. The level at which corn price should be supported is a difficult question. It would be an important political issue because we have to consider the need to expand corn in relation to other export crops.

2. Input Price Policy: The present policy of protecting domestic fertilizer plants which manufacture nigrogen, urea and mixed fertilizers at a high cost of operation needs careful evaluation. This policy has prohibited the importation of single nutrients and eliminated the economies resulting from importing high analyses for mixing into complete fertilizer within the country. This situation in combination with the protection of high cost production within Thailand has resulted in high fertilizer prices for farmers. The government should evaluate the alternatives of subsidizing fertilizer prices to corn farmers and of removing the protection policy so as to encourage private sectors to import high analysis single nutrient fertilizer to be mixed in Thailand.

Long-Run Policies for Corn and Cotton

In the long run, both corn and cotton production should be considered as potential for improving the foreign exchange situation by increased earnings and savings to the country. Long-run policies should be directed toward increasing modern corn and cotton production. The following policies would be recommended for the long-run perspective:

Production Policy

1. The continuation of corn and cotton breeding programs to develop disease resistant and high yielding varieties,

with improved seeds being produced and distributed to farmers in sufficient quantities.

2. An increase in both the numbers and in quality of extension officers. The number of farmers per extension worker could be reduced from the currently high level to one which is low enough to enable an extension agent to do his job of teaching farmers profitable technologies. This proposal would require the development of training schools and curricula to develop the trained personnel.

3. The expansion of an irrigation system to the production area to reduce crop damage or loss by drought or flood. At present, the dam can divert sufficient water to many areas but there are inadequate numbers of lateral canals to supply water to the production areas. Alternatively, or as supplemental irrigation, small projects such as tube well irrigation projects might be expanded to the production areas.

4. If irrigation is made available, farmers should be encouraged to plant beans after harvesting corn or cotton. This would increase their cash income and would improve soil fertility as beans increase nitrogen in the soil. The crop residual plowed down would increase organic matter in the soil and fertility would be improved for either corn or cotton production the following year.

Credit Policy

The majority of farmers are poor and capital is usually scarce during the planting season. The Bank for

Agriculture and Cooperatives and some commercial banks have extended their credit to farmers but they require collateral and most farmers cannot meet the requirements. This allows the rich farmers to get cheap credit while the poor farmers must turn to the more expensive sources of credit such as middlemen or merchants.

Government programs could alleviate the shortage of institutional credit by guaranteeing the loans made by commercial banks against drought, floods and other risks that can destroy the farmers' harvest. It is also possible for the government authority to guarantee the loans made by farmers' cooperatives in order to increase the flow of credit from commercial banks to the cooperative. In that case, the cooperatives can make allowances for farmers who have no collateral. On the other hand, such a program improperly conceived and administered could provide a major drain on the national treasury without appreciably increasing farmers' capacity to produce.

Marketing Policy

Since farmers do not have their own storage facilities they sell their corn immediately after the harvest. Usually, the prices are low during the harvesting season due to the excess of supply relative to demand. There is a high cost of transportation due to the size of the farms, the distance between farms, and the distance to the export silo.

The transportation cost from the production area can be reduced if a system of low cost and efficient transportation could be designed. Cost reductions from these development programs should bring about higher local prices, increasing the farmers' incentive to expand production.

It is expected that certain measures to reduce the transportation costs of cotton would also increase the competitiveness of the trading system. Cotton is bulky and requires expensive transportation. The encouragement of the textile industry to decentralize its ginning operation closer to the cotton production areas would increase employment during off-season cotton production and would permit the semi-finished cotton product to move more effectively and economically from the production area to their final use. On the other hand, if the economies to scale in the ginning operation are such as to favor centralization rather than decentralization, then the textile industry would not be encouraged to follow this proposal.

All of these policies need to be evaluated. A cost-benefit analysis of each program or package of programs is needed to determine the feasibility of each program and of a priority ranking of programs.

APPENDICES

APPENDIX A

Planted Areas, Harvested Areas, Yield Per Rai And Market Value of Rice, Corn and Cotton, 1949-1972

Table A.1. Areas Production and Market Value of Rice, 1949-1972.

Crop Years	Planted Area	Harvested Area	Average Yield[1]	Production	Wholesale Price[2]	Value
A.D.	1,000 Rai	1,000 Rai	Kg. per Rai	1,000 Tons	Baht per Ton	Million Baht
1948/49	32,573	30,812	222	6,835	723.85	4,947.5
1949/50	32,926	31,016	215	6,684	711.93	4,758.5
1950/51	34,626	33,091	205	6,782	765.35	5,190.6
1951/52	37,245	35,851	204	7,325	820.04	6,006.8
1952/53	33,551	32,064	206	6,602	729.81	4,818.2
1953/54	38,574	37,068	222	8,239	645.85	5,321.2
1954/55	34,732	28,274	202	5,709	825.00	4,709.9
1955/56	36,060	33,598	218	7,334	863.33	6,331.7
1956/57	37,648	36,013	230	8,297	859.32	7,129.8
1957/58	31,726	26,794	208	5,570	1,021.96	5,692.3
1958/59	35,987	32,306	218	7,053	830.77	5,859.4
1959/60	37,909	32,893	206	6,770	850.96	5,761.0
1960/61	37,008	35,270	222	7,834	910.81	7,135.3
1961/62	38,619	35,349	231	8,177	1,097.17	8,971.5
1962/63	41,617	38,696	240	9,279	955.08	8,862.2
1963/64	41,256	39,715	253	10,029	770.01	7,722.4
1964/65	40,872	37,316	256	9,558	839.16	8,020.7
1965/66	40,961	37,247	247	9,198	1,210.44	11,133.6
1966/67	47,095	43,431	276	11,975	1,232.72	14,761.8
1967/68	40,064	35,006	274	9,595	1,158.25	11,113.4
1968/69	44,662	39,117	275	10,771	1,100.00	11,848.1
1969/70	47,400	43,345	309	13,410	1,024.01	13,732.0
1970/71	46,100	42,045	315	13,270	992.83	13,174.8
1971/72	47,043	46,589	295	13,744	851.15	11,698.2

[1]From area harvested. [2]Wholesale price, from January-September

Source: Division of Agricultural Economics, Ministry of Agriculture, Agriculture Statistic No. 19, February 1972.

Table A.2. Areas, Production, and Market Value of Corn, 1949-1972.

Year	Area Planted	Area Harvested	Average Yield[1]	Production	Wholesale Price[2]	Value
A.D.	1,000 Rai	1,000 Rai	Kg. per Rai	1,000 Ton	Baht Per Kg.	Million Baht
1949	218	202	127	25.7	@	@
1950	226	211	127	26.9	1.08	29.1
1951	259	256	163	41.7	1.50	62.6
1952	281	271	165	44.8	1.03	46.1
1953	298	295	173	51.1	1.50	76.6
1954	331	326	191	62.3	1.30	81.0
1955	347	345	196	67.5	1.20	81.0
1956	514	510	225	114.8	1.16	133.2
1957	606	597	229	136.8	0.96	131.3
1958	792	783	238	186.3	1.04	193.8
1959	1,249	1,241	256	317.2	1.01	320.4
1960	1,785	1,779	306	543.9	1.02	554.8
1961	1,916	1,863	321	598.3	1.12	670.1
1962	2,050	2,009	331	665.4	1.01	672.1
1963	2,612	2,428	353	857.7	1.06	909.2
1964	3,449	3,384	276	935.1	1.04	972.5
1965	3,605	3,510	291	1,021.3	1.22	1,246.0
1966	4,083	3,689	304	1,122.4	1.22	1,257.1
1967	4,138	3,739	352	1,314.9	1.17	1,538.4
1968	4,193	3,789	398	1,507.5	0.97	1,462.3
1969	4,248	4,228	402	1,770.0	1.10	1,870.0
1970	5,183	5,172	377	1,950.0	1.23	2,398.5
1971	6,368	6,336	363	2,300.0	1.19	2,737.0
1972	6,231	6,213	211	1,315.0	1.14	1,479.0

[1]From round numbers of area harvested on this page. [2]Bangkok, maize shelled, yellow (Including gunny bags).

Source: Division of Agricultural Economics, Ministry of Agriculture, Agriculture Statistic No. 19, February 1972.

Table A.3. Areas, Production and Market Value of Cotton, 1949-1972.

Year	Area Planted	Area Harvested	Average Yield[1]	Production	Wholesale Price[3]	Market Value
A.D.	1,000 Rai	1,000 Rai	Kg. per Rai	1,000 Tons	Baht per Kg.	Million Baht
1949	191	176	87	15.3	@	@
1950	195	220	92	20.3	4.12	83.6
1951	229	249	103	25.7	3.15	81.0
1952	255	229	104	23.8	3.10	73.8
1953	254	252	101	25.5	3.22	82.1
1954	218	213	107	22.7	4.42	100.3
1955	205	200	125	25.0	4.20	105.0
1956	253	244	132	32.3	3.86	124.7
1957	262	256	142	36.5	3.85	140.5
1958	258	253	137	34.7	3.77	130.8
1959	301	298	125	37.4	3.68	137.6
1960	347	343	133	45.5	3.76	171.1
1961	358	330	116	38.3	4.38	167.8
1962	371	361	116	41.3	3.66	151.2
1963	456	435	112	48.6	3.35	162.8
1964	419	413	119	49.1	3.33	163.5
1965	471	453	132	59.8	4.01	239.8
1966	523	495	179	88.8	3.26	289.5
1967	782	604	134	80.7	3.76	303.4
1968	832	649	180	117.1	4.37	511.7
1969	583	508	86	43.7	4.09	178.7
1970	293	275	153	42.0	4.02	168.8
1971	288	277	146	40.5	4.91	198.9
1972	384	332	149	49.4	5.40	266.96

[1]From round numbers of area harvested and production on this page.

[2]With seeds. From a Research Survey of Agricultural Economics Division, cotton lint converted at 33.3 percent of the production.

[3]Bangkok, cotton seed.

Source: Division of Agricultural Economics, Ministry of Agriculture, Agriculture Statistic No. 19, February 1972.

APPENDIX B

Summary of Net Returns and Net Foreign Exchange Per Rai of the Selected Commodities

Table B.1. Summary of Net Returns and Net Foreign Exchange Per Rai of the Selected Commodities.

Commodities Net Returns and Foreign Exchange	Rice	Corn	Cotton
Average Yield Traditional (Kg/Rai)	342.42	406.2	251.23
Total Revenue Traditional (฿/Rai)	321.87	349.33	1092.85
Total Variable Costs Traditional	120.46	105.22	450.04
Net Return on Traditional	201.41	244.11	642.81
Average Yield Modern	556	751	485.5
Total Revenue Modern	522.64	645.86	2111.92
Total Variable Cost Modern	279.38	269.75	909.52
Net Return on Modern	243.26	376.11	1202.40
Increase Variable Cost on Modern	158.92	164.53	459.48
Increase Revenue on Modern	200.77	296.53	1019.07
Increase Net Return on Modern	41.85	132	559.59
Foreign Exchange Earnings or Savings (฿/Rai)	--	--	--
Foreign Exchange Cost Traditional	4.20	6.04	93.66
Foreign Exchange Revenue Traditional	474.60	459	1253.22
Foreign Exchange Cost Modern	50.34	97.91	230.62
Foreign Exchange Revenue Modern	770.62	848.63	2421.84
Foreign Exchange Cost Increase on Modern	46.14	91.87	136.96
Foreign Exchange Earnings on Traditional	470.40	452.96	--
Foreign Exchange Earnings on Modern	720.28	750.72	--
Foreign Exchange Savings on Traditional	--	--	1159.56
Foreign Exchange Savings on Modern	--	--	2191.22

Source: Taken From Tables 3.21 and 4.12

APPENDIX C

Power Utilization in Producing Rice and Corn

Table C.1. Power Utilization in Producing Rice and Corn from Changwats, Chainat, Saraburi and Lopburi.

Hours

Commodities	Tractors			Buffaloes			
	1st Plowing	2nd Plowing	Average	1st Plowing	2nd Plowing	Harrowing or Weeding	Average
Rice	0.28	0.22	.25	4.0	3.25	2.66	3.30
Corn	0.45	0.34	.39	4.75	1.68	2.96	3.13

Source: Agricultural Economics Division, Ministry of Agriculture, Basic Data for Farm Management, Bulletin No. 12, 1970, pp. 52-9.

(1) Rice plowing was done by 75 horsepower tractors which can plow faster than 65 horsepower tractors. It is assumed that 65 horsepower tractors can finish plowing on the average of .33 hours per rai.

(2) The time required for plowing cotton fields is assumed to be the same as corn because corn and cotton grow on the same type of land, also, the aggregation of production area is in the same region.

APPENDIX D

Comparison by Weight and Volume Among Different Insecticides

Table D.1. Comparison by Weight and Volume Among Different Insecticides.

Insecticides	Weight (Kg)	Volume (Liter)
Thimet 83%	1 Kg.	1153.16
B.H.C. 6%	1 Kg.	858.42
Dimicron 50%	1 Kg.	952.75
Metasystox 50%	1 Kg.	1004.67
Thiodan 35%	1 Kg.	1053.52
Sumithion 50%	1 Kg.	1111.26
Dimethoate 20%	1 Kg.	994.20
Average	1 Kg.	1018.28

Source: Agriculture Department, Entomology Division, Experimental Report. Bangkok, Thailand.

Note: From the experimental result, it is quite reasonable to assume that one liter of insecticide is equivalent to 1 Kg.

APPENDIX E

Foreign Trade, Import and Export Price of Rice, Corn and Cotton and Balance of Trade, 1962-1972

Table E.1. Foreign Trade and Payments (Total Value of Trade) (Millions of Baht).

Year	Exports (f.o.b.)	Imports (c.i.f.)	Trade Balance	Imports		Exports		Export Price (f.o.b.) ฿/Ton		Imports (c.i.f.)	
				Fertilizers and Pesticides	Tractors	Rice	Maize	Rice	Maize	Cotton	Import Price ฿/Ton
1962	9,529	11,504	- 1,975	135	133	3,240	520	2,534	1,063	---	---
1963	9,676	12,803	- 3,127	182	245	3,424	828	2,416	1,137	---	---
1964	12,339	14,253	- 1,914	236	328	4,389	1,346	2,315	1,176	---	---
1965	12,941	15,433	- 2,492	235	351	4,334	969	2,281	1,212	---	---
1966	14,099	18,504	- 4,405	361	456	4,001	1,520	2,650	1,247	---	---
1967	14,166	22,188	- 8,022	524	655	4,653	1,355	3,144	1,242	---	---
1968	13,679	24,103	-10,424	641	558	3,779	1,556	3,534	1,051	---	---
1969	14,722	25,966	-11,244	630	454	2,945	1,674	2,905	1,095	---	---
1970	14,772	27,009	-12,237	582	395	2,516	1,857	2,365	1,360	479	11,868
1971	17,281	26,794	- 9,513	503	478	2,909	2,186	1,846	1,220	680	14,146
1972	22,516	30,875	- 8,359	856	348	4,434	1,975	2,100	1,131	729	14,979

Source: Department of Customs Report and Bank of Thailand Annual Report, May 1973.

Note: Excluding military goods.

APPENDIX F

Employment in the Agricultural Sector of Thailand

Table F.1. Employment in the Agricultural Sector of Thailand (Million People).

Year	Total Labor Force	Number in Agriculture	Percent
1929	7.5	6.3	84
1937	6.8	6.0	89
1947	9.0	7.6	85
1954	10.2	9.0	87
1960	12.7	10.3	82
1966	14.6	11.6	79
1971	16.8	12.7	76

Sources: 1) 1929-1947 are from James C. Ingram. Economic Change in Thailand, 1850-1970, Stanford: Stanford University Press, 1971, p. 57.

2) 1954-1971 are from Bangkok Bank Monthly Review, 1972, p. 434.

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