ANALYSIS OF FACTORS AFFECTING THE INCOME OF FARMERS GROWING CORN, NAKONRAJASIMA, THAILAND

by

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TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLES

Table Page

Table Page

ANALYSIS OF FACTORS AFFECTING THE INCOME OF FARMERS GROWING CORN, NAKONRAJASIMA, THAILAND

CHAPTER I

INTRODUCTION

The Problem:

Thailand has been recognized as a rice-producing country from time immemorial. Besides being a staple food, rice has been the exported product that earned the most foreign exchange which has been badly needed for the economic development of the country. Since the end of the second world war, many countries have been able to produce rice sufficient for their consumption. Some have become rice-exporting countries. Thai rice has had to compete with rice from other countries for the available export markets. Furthermore, the population of the country has been increasing at the rate of about two percent per year. This implies the need for more domestic rice to feed an increasing number of mouths. In addition, the area planted to rice has been varying because of uncertain rainfall, drouth and flood damage. The prospect of Thai rice for the foreign market has been uncertain and fluctuating. The situation can be seen clearly by the following statistics.

The area planted to rice during the period of 1950 to 1959 ranged from a low of 31,740,000 rai[1/] in the relatively low rainfall year of 1957 to a high of 38,575,000 rai in 1953. (12, p. 36-37). No secular trend in area planted is indicated by the plantings during the period. Considering the amount of rice exported and the value earned in the same period, the amount of rice exported varied from a low of 919,780 tons in 1959 to a high of 1,548,513 tons in 1952 while the value earned fluctuated from a low of 1,672,274,000 baht[2/] in the year 1950 to a high of 3,746,778,000 baht in 1953. (12, p. 107).

At present, the population of Thailand is about 25 million and has been increasing at the rate of about two percent per year. Therefore, there is a population increase of about 500,000 per year. It is estimated that one person eats about 132 kilograms of white rice per year, equivalent to 204.5 kilograms of paddy per year. (11, p. 2). Therefore, the amount of white rice required for present consumption is about three million tons, equal to five million tons of paddy. The additional amount of rice required by the increasing population is about 56,000 tons per year, equivalent to 102,250 tons of paddy per year. In the last two years both the

1 / Rai is a unit of land area. One rai is equal to 0.395 acres or 0.16 hectares.

2 / Baht is the Thai monetary unit. About twenty-one bahts are equal to one dollar.

amount and value of rice exported declined. The problem will become more serious in the future if the rate of population growth exceeds the rate of increase in rice production.

When the problems of rice are formulated and related to this study, two relevant problems take shape:

(1) The amount of foreign exchange earned by rice is tending to decrease.

(2) The relatively low rainfall areas cannot achieve successful production of rice.

These two formulated problems lead to the questions: Is there any crop that can replace rice in the dry areas of Thailand? Is there any crop that can compensate for the decreasing amount of foreign earnings from rice? Fortunately indeed, Thailand has other upland crops such as corn or maize, ground nuts, kenaf, kapok, castor beans, etc., which have shown a promising potentiality to offset the two problems simultaneously. Among those crops mentioned, corn seems to be the most promising. Corn recently has come to play an important role in Thailand's exporting economy and in providing employment for the farmers in the area too dry to grow rice, particularly in the Northeast region of the country. The importance of corn can be further justified by the following paragraph.

During the period of 1950 to 1959, the area planted to corn was increased from 218,000 rai to 347,000 rai in 1956 and to 1,249,000 rai in 1959. (12, p. 43). It was also estimated that in 1960, the

area planted to corn was increased to 2, 080, 000 rai. In terms of value of production contributing to the national income and value of exports, corn is relatively more important than the data of area planted indicates. The value of production was 29. 1 million baht in 1950 and it was increased to 133. 2 million baht in 1956 and to 317. 2 million baht in 1959. (12, p. 43). In the same period, the value of exported corn increased from 10. 5 million baht to 96. 1 million baht and 249. 5 million baht respectively. (12, p. 108). The value of corn exported in 1959 was about 12 percent of the value of rice exported during the same year. The most recent statistics of the Department of Customs revealed that the value of corn exported in 1960 was 514, 266 tons or equivalent to 550 million baht which was twice the value of exported corn in 1959.

About 80 percent of the corn exported was shipped to Japan, and the rest was sold to Singapore, Hongkong, Borneo, Malaya, etc. In addition, about 80 percent of the corn produced was exported while only 20 percent was consumed domestically. In contrast, other corn-producing countries such as the United States, Brazil, Mexico and Argentina, etc. produced corn largely for their own consumption and a relatively small percent of their corn was exported. Thai corn has had an important share in the world market and is becoming important in the economy of the nation.

Agricultural income and foreign exchange therefore may be increased by the increase of rice production or by the other possible alternative --the increase of corn production. Thus more economic data are needed to properly evaluate this alternative. Thailand has never had complete data of corn production at both the farm and outside farm sectors, and other necessary information pertaining to the problems of production and marketing. Therefore a research program must be conducted in order to have factual data as a basis of evaluating the economic feasibility of promoting corn production throughout the country. As a consequence, in 1960 a joint program of research was established and conducted with the cooperation of the Ministries of Agriculture and Economic Affairs of the Thai Government, Kasetsart University and the Council on Economic and Cultural Affairs of New York to study the production and marketing problems affecting the expansion of corn growing all over the country. This thesis is based on one segment of the corn research project.

The information on which this thesis is based was collected by the survey method and is confined to the problems at the farm level only. Nakonrajasima province in the Northeast of Thailand was chosen as the study area. The reason for choosing this province was twofold: (1) the Northeast region is the least favorable region of

the country and urgently needs to be developed both economically and socially, and (2) Nakonrajasima is the only province in the region that has produced corn commercially and significantly.

Purposes of Study:

(1) To determine and describe the processes and inputs required to produce field corn in the Northeastern part of Thailand.

(2) To isolate those factors that directly affect the income of farmers growing corn.

(3) To estimate the costs associated with producing corn.

(4) To determine, insofar as possible, the optimum size of enterprise for producing corn by methods common to the area.

Methodology:

The Department of Agricultural Economics, Kasetsart University, was in charge of conducting the research from the beginning of the project.

Preliminary consideration: Many specialists in the field and others concerned in the Ministries of Agriculture, Economic Affairs, Interior and Cooperatives were consulted and asked for

their opinions as to the problems of corn production and area planted to corn as a basis of learning the characteristics of the population growing corn.

Population of corn growers: The research workers from Kasetsart University and the officials from the different cooperating ministries went to the region and enumerated the number of farmers growing corn in every province which reported having grown corn. However, the population obtained did not represent all corn growers because of limitation of time, personnel, and financial resources and also it was very difficult to get to every locality.

The population enumerated from Nakonrajasima Province, the study area, was composed of 610 farmers. Seventy-one farmers were chosen as the size of sample to be drawn at random from the population. As a result of incompleteness of information on some field schedules, the number of observations on which this thesis is based was reduced to 37 farms. A table of random numbers was used to draw the original sample.

Questionnaire: The Department of Agricultural Economics, Kasetsart University, formulated the field questionnaire which was tested before using it in the field. The enumerators were all students of Kasetsart University. The orientation for enumerators was given by the department one week before the survey was made.

Five enumerators were sent to conduct the survey in Nakonrajasima, with the author of this thesis as a supervisor.

Period of study: The farmers were interviewed and asked for the production and other information concerning the crop year 1959. The study began in April, 1960 and ended late in the same year.

Empirical data and analysis: The author obtained raw data from the field questionnaires and has pursued the analysis by himself. Therefore, this thesis is not a duplicate of the research analyses made by the Department of Agricultural Economics, Kasetsart University.

CHAPTER II

DESCRIPTION OF THE AREA FROM WHICH THE SAMPLE WAS DRAWN

Nakonrajasima is one of the fifteen provinces of the Northeast region of Thailand. (Figure 1). The Northeast region comprises an area of 104, 415, 000 rai or 32.5 percent of the whole kingdom. It is the second largest region in the country. The area planted to upland crops in 1959 is reported as 1, 934, 000 rai which also represents the second largest area of upland crops in the country. (12, p. 151). The most important crops grown in the region are: corn, castor beans, ground nuts, kenaf, radishes, kapok, sugar cane, etc. Due to lack of information concerning Nakonrajasima province, some physical characteristics can be best described in terms of the entire region. The important characteristics considered in this Chapter are soils, topography and rainfall.

Soils:

According to Pendleton (8, p. 164-169), the soils of Nakonrajasima are typified by the Korat fine sand loams. These soils are coarse textured and moderate in depth. They are formed residually over sandstones and shales which are commonly known

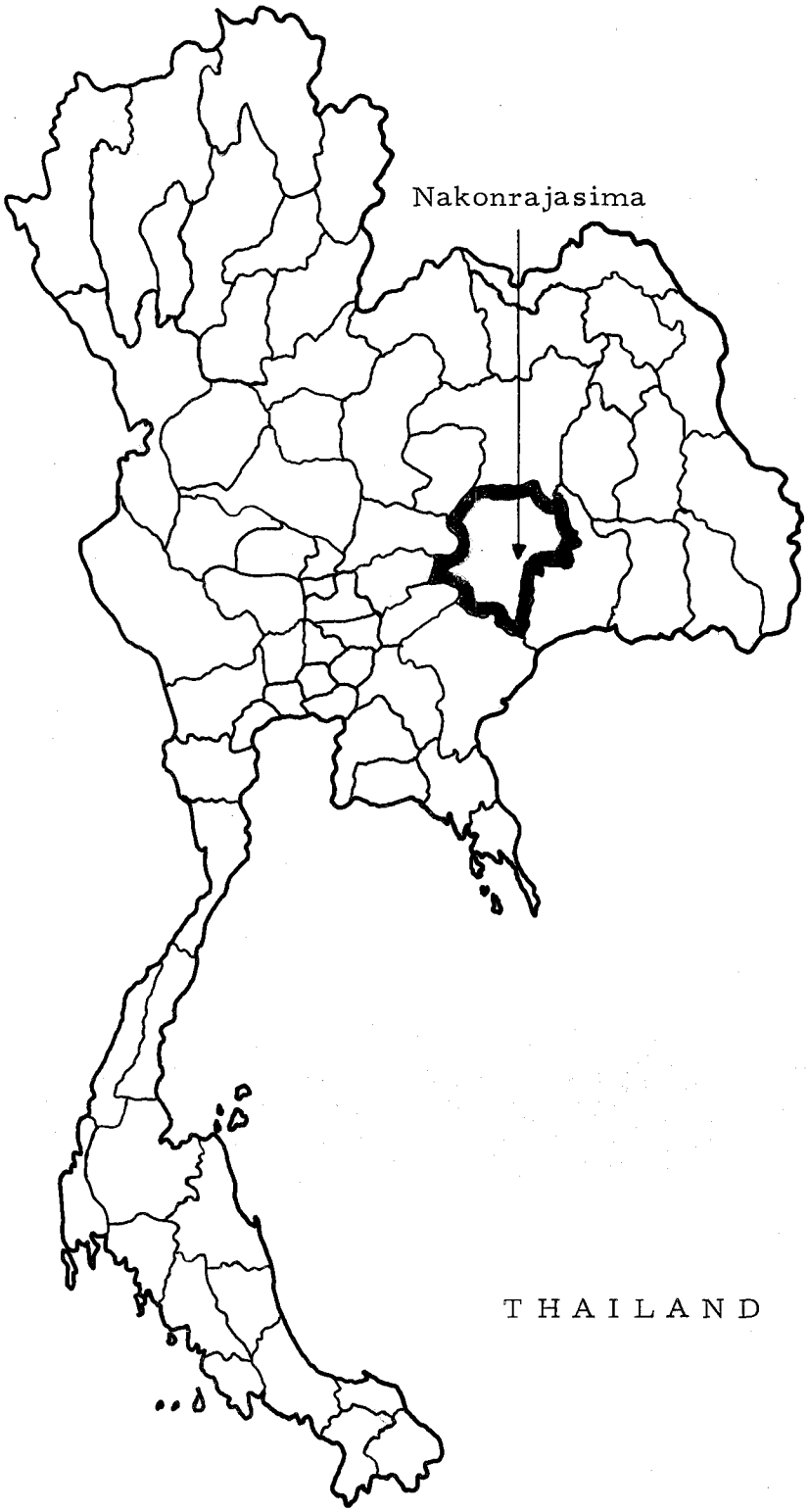

Figure 1. Map of Thailand Showing the Area from Which the Sample Was Drawn.

as "red beds". Accumulations of pisolistic laterite are found in the subsoils. These soils are considered to be infertile for even upland crops to grow. They are very low in plant nutrients and in capacity of retaining moisture. However, down to the southwest of this province, the Pakchong loams are found. These soils are residual, of good depth to bedrock and are more fertile than the formerly described soils. They are more suitable to the growing of upland crops such as corn, castor beans, ground nuts and sugar cane.

Topography:

Since a topographic survey of the country has not been completed, it is not possible to present the exact degree of slopes and elevation of the region or province. Generally speaking, the region is made up of hilly lands and undulant plateaus and bounded by the Mekhong River and Dong Praya Yen Mountains. (9, p. 58). The steep elevation of the region supports the rapid flow of water from rainfall into the bounding river. Therefore it is difficult for the region to conserve natural water for growing crops as is done in the central plain. It is only the narrow river basin at the bottom of the valley on which rice can be grown in the region. Because of scarce underground water, a tank irrigation system

has just been developed, but is not adequate to solve the moisture problem for crops needing much water.

Rainfall:

The rainy season generally begins in May and continues through September. In this period, the southwest monsoon from the Indian Ocean brings in the warm moist air and causes the abundant rain over the Northern, Northeastern, Central and the west coast of the Southern part of the country. (8, p. 15). However, the Northeast part comparatively has the lowest rainfall in the country. The annual rainfall in selected provinces, including Nakonrajasima, by geographical zones is presented in Table 1. It appears that the average annual rainfall for ten years at Nakonrajasima is 122 days with an amount of rain of 1251 millimeters or about 50 inches which is lower than the other provinces'. With the unfavorable topography and soils, the northeast region becomes more dreary and limited than is indicated by the rainfall data.

Table 1. Annual rainfall at selected locations by geographical zones, Thailand, 1950-1959.

	Northeastern				Northern				Central				Southern			
	Nakon-rajasima		Roi-et		Chiengmai		Chiangrai		Bangkok		Lopburi		Chumporn		Songkla	
Year	days	mm.	days	mm.	days	mm.	days	mm.	days	mm.	days	mm.	days	mm.	days	mm.
1950	127	1142	112	1716	132	1618	127	1554	16	1636	13	1256	200	1704	164	2160
1951	121	1304	121	1498	129	1473	127	2202	125	1600	99	1368	186	1938	170	2289
1952	123	1193	121	1350	116	1364	112	1682	143	1516	105	1246	188	2098	155	2021
1953	139	1333	123	1244	136	2032	105	1907	150	1577	120	1775	183	2329	158	2383
1954	111	1192	95	1248	114	981	96	1663	132	1501	96	1201	164	2037	171	2026
1955	116	1312	90	1116	136	1258	109	1979	126	1514	103	1352	163	2388	167	2244
1956	125	1261	108	1501	128	1324	117	2020	137	1338	110	1436	175	2297	183	2329
1957	122	1099	100	1189	110	1151	129	1763	138	1957	100	1937	159	1320	167	1545
1958	118	1272	97	1238	112	1129	126	1669	125	1298	102	1246	166	1518	153	1581
1959	119	1400	97	1376	136	958	167	1764	118	1275	115	1310	183	2110	168	2217
Average	122	1251	106	1348	125	1329	121	1820	121	1521	96	1413	177	1974	166	2079

Source: (12, p. 134-137).

CHAPTER III

CHARACTERISTICS OF FARMERS

Characteristics of farmers considered in this chapter are age of farm operators, educational attainment, farm experience and size of family. These characteristics are disguised factors that tend to influence behavior of the farmers and simultaneously their decision-making processes in farming. The different attitudes of farmers toward farm operations and technology possibly are outgrowths from the interaction of these characteristics. However, this chapter of necessity is limited to a description of these characteristics and treated as a general background to an understanding of the farmers themselves.

Age of Farm Operators:

The age of the thirty-seven farm operators interviewed ranged from 26 to 59 years, Table 2. The majority of farmers was found to be between the ages of 31 and 40 years. That is, 27 percent of them were between 31 and 35 years old and 30 percent were in the age bracket of 36 to 40 years. These two age groups totaled 57 percent of all farmers interviewed. The youngest group of farmers,

26 to 30 years, accounted for 16 percent of the farm operators. The oldest group exceeded 51 years but included only five percent of the farm operators. The next to the oldest class, 46 to 50 years and 41 to 45 years, accounted for 8 and 13 percent of the farm operators respectively. The average age was 37.6 years.

Table 2. Frequency distribution of age of farm operators growing corn, Nakonrajasima, 1959 - 1960.

Age of operators (years)	Frequency	Relative frequency Percent	Accumulative frequency Percent
26-30	6	16	16
31-35	10	27	43
36-40	11	30	73
41-45	5	13	86
46-50	3	8	94
51-above	2	5	99*
Total	37	99*	

*Not equal to 100 because of rounding.

Range	26-59
Average	37.6
Median	36

From the age groups presented, it is seen the farmers were relatively young. About 86 percent of them were below 45 years old. This evidence no doubt characterizes the typical farmers who grew corn in the region. The following brief historical sketch will explain the evidence. Within the last decade, or approximately since the end of the second world war, the northeast region has been awakened by the widespread communication system and economic development programs launched by every successive government. Because of being a comparatively dry region of the country, many upland crops, including corn, were introduced to the region. Furthermore, in 1954 the Northeast Highway Project was actively developed and carried out by the State Highway Department to fill the missing gaps in the region. (8, p. 51). The finest land along the highway was opened to grow upland crops and corn has been grown commercially since then. Younger farmers seemed to be more free to move onto these lands and to accept the growing of upland crops in place of rice.

Though the farmers were rather young, it was difficult to obtain information from them. They hardly kept any records of their business. The only place for keeping records was their memory. However, many of them were enthusiastic and cooperative in their response to the questions.

Education of Farm Operators:

Elementary education in Thailand is compulsory for every child and it takes four years to complete this education. One who finishes grade four, the final grade of compulsory education, is assumed to be literate. The majority of farm operators finished grade four, Table 3. That is, twenty-seven farm operators, or 73 percent, finished elementary education. Only three farm operators, or eight percent, did not complete grade four. They attended school but did not complete all four grades. Also eight percent of the farm operators reported having secondary education in addition to elementary education. However, four farm operators, 11 percent, were found to be illiterate. Most of the illiterate farmers were above 40 years old.

About 73 percent of the farm operators completed the compulsory education grade four. This percent seemed relatively high for the ages of farmers interviewed in the region, since the Compulsory Education Act was not revised until 1936 to require children throughout the country to attend school from the age of eight to the age of fifteen. (8, p. 64). When the situations in the last decade are considered together, it is recognized that a campaign to a certain extent was made by the succeeding governments to improve the

region as demanded by the people. It is reasonable to conceive that young men with normal education were positively responsive to such a campaign. Some of them with whom the writer became acquainted were graduates from an agricultural vocational school. However, the evidence of educational attainment in no way refutes the belief that the agricultural extension service working through various kinds of media could make significant contributions to the economic welfare of the people of the area.

Table 3. Educational attainment of farm operators growing corn, Nakonrajasima, 1959-1960.

Educational attainment	Frequency	Relative frequency Percent	Accumulative frequency Percent
Illiterate	4	11	11
E-1	1	3	14
E-3	2	5	19
E-4	27	73	92
S-5	1	3	95
S-6	2	5	100
Total	37	100	

E-1 elementary education, grade one
E-3 elementary education, grade three
E-4 elementary education, grade four
S-5 secondary education, grade five
S-6 secondary education, grade six

Farm Experience:

Farm experience can be explained in terms of number of years spent in farming. More years spent in farming should mean more experience gained by farmers. All farm operators have been engaged in farming for a certain time. However, the range in number of years of experience was large. The range was from 2 to 35 years, Table 4. Ten farm operators, or 27 percent reported having been farming for 11 to 15 years. Seven or 19 percent have been farming for 6 to 10 years. The other 19 percent had worked on farms for 16 to 20 years. Only one farm operator reported that he had been farming for more than 31 years. The average number of years of farm experience was 15.8.

Farm experience normally is first acquired while children on the farm. Farm children will get farm training from their parents at the early age of five to seven years. Children reared on farms should become well trained in all kinds of farm work by the age of 18 years. (4, p. 82).

All farm operators interviewed reported having had previous experience in growing corn by different means such as being children on farms, hired workers and renters, but mostly by being owner-operators. Most of them, about 51 percent, had not been growing

corn more than five years, Table 5. Eleven farm operators, or 30 percent, had grown corn for 6 to 11 years. Six reported growing corn for more than 16 years. The average number of years experience growing corn was 7.1 while the range was from 2 to 20 years.

Table 4. Frequency distribution of number of years experience in farming of farm operators growing corn, Nakonrajasima, 1959-1960.

Experience (years)	Frequency	Relative frequency Percent	Accumulative frequency Percent
0 - 5	5	13	13
6 - 10	7	19	32
11 - 15	10	27	59
16 - 20	7	19	78
21 - 25	3	8	86
26 - 30	4	11	97
31 - above	1	3	100
Total	37	100	

Range 2 - 35

Average 15.8

Median 15

Table 5. Frequency distribution of number of years that farm operators have been growing corn, Nakonrajasima, 1959 - 1960.

Experience growing corn (years)	Frequency	Relative frequency Percent	Accumulative frequency Percent
0 - 5	19	51	51
6 - 10	11	30	81
11 - 15	6	16	97
16 - above	1	3	100
Total	37	100	

Range 2 - 20

Average 7.1

Median 5

Size of Family:

Size of family refers to the number of members within a family. The member of the family is a major source of farm labor and it is certainly fixed in supply in the short run. Its role as a source of labor is still important even in the well-mechanized farming areas of Thailand. This fixed supply of labor is necessary to be allocated to meet seasonal requirements of farm work. (2, p. 169-171).

From Table 6, it is seen that the range in size of family was from 3 to 11 members. But the most prevalent size was 6 members. Nine families, or 24 percent, were of that size. The families with 4, 5 and 7 members each comprised 16 percent of all families. But the families with 9, 10 and 11 members each accounted for only three percent of all families. The family size of eight members was 11 percent and the smallest family size with only three members was also eight percent of all families. The average size of all families was 6.0 members.

Not all members within these family groups were able to work. Workable members that assumed an important role in performing farm operations are shown in Table 7. The number of workable members ranged from 1 to 8. But 16 families, or 43 percent, had only two workable members. The next most frequent situation was 3 workable members per family. Twelve families, or 32 percent of all families, reported this number of workers. Three families, or 8 percent, had 4 workable members. Only two families reported having 1 workable member and 2 families reported having 7 workable members. The largest number of workable members reported in a family was 8 but only 1 family, or 3 percent, was comprised of this number.

Table 6. Frequency distribution of size of farm families growing corn, Nakonrajasima, 1959 - 1960.

Members in family Number	Frequency	Relative frequency Percent	Accumulative frequency Percent
3	3	8	8
4	6	16	24
5	6	16	40
6	9	24	64
7	6	16	80
8	4	11	91
9	1	3	94
10	1	3	97
11	1	3	100
Total	37	100	

Range 3 - 11

Average 6.0

Median 6.0

Table 7. Frequency distribution of farm families having specified number of workable members, Nakonrajasima, 1959-1960.

Workable members number	Frequency	Relative frequency Percent	Accumulative frequency Percent
1	2	5	5
2	16	43	48
3	12	32	80
4	3	8	88
5	1	3	91
6	0	0	91
7	2	5	96
8	1	3	99*
Total	37	99*	

* Not equal to 100 because of rounding.

Range 1 - 8

Average 3.0

Median 3.0

An attempt was made to correlate the number of workable members within a family with the size of farm operated. A general relationship is shown in Table 8. A correlation coefficient was determined and obtained by the procedure described in the statistical text of Jerome C. R. Li. (5, p. 265-268). The computing method used is presented in the Appendix, Table 1. The correlation coefficient obtained was only 0.0214. This value though positive was too low to warrant concluding any relationship of the number of workable members to the size of the farm. Thus, the greater number of workable members in the family was not necessarily the cause of the larger size farms or vice versa. This evidence, however, might be construed to indicate that the larger size of farms would utilize the family workable members to a fuller extent.

Table 8. Average workable members and average size of farm classified by size of family, Nakonrajasima, 1959-1960.

Size of family	Number of farms	Average workable members	Average size of farm rai
3	3	2.00	20.33
4	6	2.50	29.67
5	6	2.00	29.17
6	9	2.33	44.44
7	6	3.83	23.83
8	4	4.25	50.50
9	1	5.00	10.00
10	1	3.00	80.00
11	1	7.00	400.00
Total	37	2.94	44.57

CHAPTER IV

FACTOR INPUTS AND PRODUCTION PROCESSES

The two general categories of factors that affect farm income are physical and economic forces. The physical force is made up of soil type, climatic conditions, size of farm, yield of crop or livestock, labor use, equipment use, fertilizer use, etc. The economic force is prices of both input and output factors at the farm level and the efficiency with which the production process is carried on. The economic force plays an important role in the success or failure of the farm business. Some of the physical forces, such as soil type and climatic conditions are beyond the control of the farmer. In other words, some of these physical elements are relatively fixed which makes it necessary for crops and livestock to be adjusted to the limits imposed by them. (1, p. 72). Needless to say, a farmer cannot deliberately control all economic forces either. Only one thing the farmer can do is to adjust his farm business to them. His business then can possibly become tolerable to such a situation. However, this chapter is devoted to an analysis of physical factors in addition to those mentioned in Chapter II. That is, factor inputs reported and other production aspects will be discussed.

Size of Farm:

Size of farm can be measured in many ways. According to Yang (15, p. 59-60), the measurement of the size of farm depends on the purpose of analysis and the type of farm. As for a farm having crops as a major source of income, he suggests four methods, namely; total farm area, crop area, crop acreage area and "area devoted to one or two of the most important kinds of crops on a cash crop farm." The crop area refers to the land area used for crop production, whereas the crop acreage area is the total acrea of crops grown in the year. In this study, corn-grown area or cultivated area which is equivalent to "crop acreage area" suggested by Yang is used. The corn-grown area reported was used to grow corn only.

The number of rai used to grow corn was obtained by interviewing farmers. The thirty-seven farmers grew corn only once a year. However, on some farms interplanted crops in the field with corn were grown and they certainly contributed to the income of the farm. This will be discussed Chapter V and VI.

The thirty-seven farms ranged in size from 3 rai to 400 rai. The farms were divided into three size groups, namely; small, medium and large with the ranges of 3 - 15 rai, 18 - 60 rai and 70 rai and over respectively. The criteria used in making the size

division were partly number of rai used to grow corn itself and partly total production resulting from that amount of rai. When the numbers of cultivated rai were arranged in ascending order, the author observed that the 15-rai farms and the 18-rai farms produced different amounts of product. The same was true of the 60-rai farms and the 70-rai farms. In other words, these farm sizes showed discontinuous grouping. Therefore, it seemed justifiable to group the farms accordingly for analysis. By so doing, the small size group included 13 farms or 35 percent of all farms, the medium size group included 18 or 49 percent and the large size group includes 6 farms or 16 percent. The average size of small, medium and large farms was 10.4 rai, 30.8 rai and 160 rai respectively. The thirty-seven farms had a total area of 1649 rai of cultivated land of which 135 rai or 8 percent belonged to the small size group, 554 rai or 34 percent to the medium size group and 960 rai or 58 percent to the large size group, Table 9. In Table 9, harvested rai of each of the three size groups also was included in order to be referred to in the course of further discussion.

During the year for which the farmers were asked to supply information, some farmers had crop failures. The harvested area, therefore, was not identical to the cultivated area. The harvested area of small, medium and large groups was 129 rai or 96 percent

Table 9. Size of farms, number of rai of corn grown and harvested on farms growing corn, Nakonrajasima, 1959-1960.

Items	Size of farms			All
	small	medium	large	
Size range (rai)	3 - 15	18 - 60	70 - above	3 - 400
Number of farms	18	16	6	37
Percent of total number of farms	35	49	16	100
Mean (average, rai)	10.4	30.8	160.0	44.6
Median (rai)	10.0	21.5	90.0	20.0
Number of rai of corn grown	135	554	960	1649
Percent of total rai of corn grown	8	34	58	100
Harvested area (rai)	129	510	760	1399
Percent harvested area is of corn-grown area	96	92	79	85

of cultivated area, 510 rai or 92 percent and 760 rai or 79 percent respectively. The total harvested area was 1399 rai or 85 percent of the total cultivated area.

Amount of Seed Used:

Generally, farmers in the study area grew two types of corn, namely; Dent (Guatemala variety) and Flint (native variety). However, Dent was mostly grown because it gave more yield than Flint. In addition, Dent corn was in great demand for foreign markets while Flint corn was used entirely at home.

Information as to how many seeds per hill and what space between plants and rows was not known. However, the space between plants and rows was assumed to be equal on all farms for convenience in the course of analysis.

From Table 10, it appeared that the medium farm group used more seed per rai than the corresponding two groups. The large group used the least amount of seed. The amounts of seed used per rai by the small, medium and large farms were 2.75, 3.30 and 2.63 kilograms respectively. For all farms, the average amount of seed used per rai was 2.95 kilograms.

The standard deviation was employed to measure the variation in the amount of seed used and was based on the method in the

Table 10. Amount of seed used per rai classified by size of farm growing corn, Nakonrajasima, 1959-1960.

Items	Size of farms			All
	small	medium	large	
Average size (median), rai	10.00	21.50	90.00	20.00
Number of farms	13	18	6	37
Rai of corn grown (average)	10.38	30.78	160.00	44.57
Total seed used (kg)	353.00	1990.00	2837.00	5180.00
Seed used per rai (kg)	2.75	3.30	2.63	2.95
Standard deviation	1.22	1.35	0.60	1.25
Coefficient of variability	44	41	23	42

statistical text of Jerome C. R. Li. (5, p. 64-65). However, according to Pearson and Bennet, the standard deviation alone could not be compared with one another directly. The coefficient of variability or standard deviation expressed in percentage of its respective mean was comparable and meaningful. (10, p. 51). So the coefficient of variability also was computed. The standard deviations of the three means were 1.22, 1.35 and 0.60 respectively. The coefficients of variability of the corresponding means were 44, 41 and 23 respectively.

The variability in the amount of seed used varied inversely with the size of farm. But the small and medium farms maintained comparatively the same variability. The cause of difference might have been chance because the number of observation was small in the large farm size group.

The significance of difference of the three average amounts of seed used per rai was tested through the analysis of variance method contained in the text of Jerome C. R. Li again. (5, p. 176-177). Procedures are shown in the Appendix, Tables 2, 3. The computed F-value of the three means was only 1.5214 with 2 and 34 degrees of freedom. It was smaller than the F-value from the F-table at five percent level of significance. Therefore all three corresponding farm size groups used the same amount of seed per rai.

Farm Equipment Used and Production Processes:

Farm equipment refers to all equipment used in corn production which was reported by farmers. There were not many items of equipment used. They were simple, relatively low in cost, necessary and common to all farms. One piece of equipment can be used in more than one activity of production. Some activities at times need no equipment at all. With two hands, such activities could be fulfilled.

Items of equipment used can be listed and discussed with respect to the processes of corn production as follows:

Production processes	Equipment used
I. Planting period	
clearing land	knives, hoes, axes
ploughing	plough, buffaloes, tractor
planting	knives, hoes
II. Growing period	
replanting	hands
thinning	hands
cultivating	knives, hoes
III. Harvesting period	
picking	hands
drying	hands
storing	hands, storage
shelling	hands, shelling machine

In the planting period, clearing land was the first activity performed. It required only knives, hoes and axes. Generally, all surveyed farms had grown various kinds of crop all the year around. Ground nuts, castor beans, job's tear, soy beans, radish, etc. were reported as crops often grown before corn. When it was time to grow corn, clearing land was only to remove stocks and some materials left by such previous crops. If new lands were opened, additional needed equipment was not beyond axes, spades and saws used to cut down the trees. The stocks of trees were burned. Some farmers therefore required much time to clear the land.

No farmer interviewed owned a farm tractor. But a tractor was used to plough land on some farms by custom work. Native ploughs together with buffaloes also were used to plough land. As a matter of fact, some farms in the province have tractors and accessory parts of their own. In addition, a few groups of farms share a tractor together. Neither of these two situations was found among the sample farms. From observation, due to an expensive first outlay in purchasing a tractor, custom work has become more practical in the province.

As for the planting method, sample farms did not use a tractor and planting machine at all. Knives and hoes were used in the process and undoubtedly, a large labor force was required. The detail of equipment used within each size of farm for the planting period is shown in Table 11.

After seeding corn, farmers had other jobs in caring for the plants which were growing up. This period might be called a growing period. It was composed of such activities as replanting, thinning, cultivating. The pressure of work during the period seemed to be somewhat relaxed. As for replanting and thinning, no equipment was reported in use. But farmers responded that they had performed these activities. So it is logical to assume that farmers did the job with their own hands. In addition, these processes of

Table 11. Kinds of equipment used during the planting period classified by size of farms growing corn, Nakonrajasima, 1959-1960.

Items	Size of farms			All
	small	medium	large	
Number of farms	13	18	6	37
Land clearing:				
Knives, no. reported	48	61	229	338
Number of farms reporting	12	12	6	30
Percent of frams reporting	92	67	100	81
Hoes, no. reported	80	135	87	302
Number of farms reporting	13	14	4	31
Percent of farms reporting	100	78	67	84
Axes, no. reported	2	-	-	2
Number of farms reporting	1	-	-	1
Percent of farms reporting	8	-	-	8
Ploughing:				
Ploughs, no. reported	2	1	-	3
Number of farms reporting	1	1	-	2
Percent of farms reporting	8	5	-	5
Buffaloes, no. reported	2	1	-	3
Number of farms reporting	1	1	-	2
Percent of farms reporting	8	5	-	5
Tractor	C*	C	C	C
Number of farms reporting	1	6	3	10
Percent of farms reporting	8	33	50	27
Planting:				
Knives, no. reported	17	-	96	113
Number of farms reporting	3	-	2	5
Percent of farms reporting	23	-	33	13
Hoes, no. reported	74	146	45	265
Number of farms reporting	13	16	4	33
Percent of farms reporting	100	89	67	89

* C means tractor custom work.

production were not so complex that some special equipment was needed. In the phase of cultivating, knives and hoes were essentially used again. Cultivating provided good aeration within the soil and contemporaneous weeding was achieved. When the plants became taller, the hoe seemed to be more proper to cultivate the soil between plant stands and between rows. The detail of kind of equipment used and the farms using equipment is shown in Table 12.

The harvesting period was the final stage of corn production. From the date of seeding, it required about four months for corn to be ready for reaping. This period, though shortest, was a very busy one for the farmers. This stage was associated with the following activities: picking, drying, storing and shelling. A picking machine was not found in the province and so was not available to the sample farms. Hand labor was employed in picking corn. It was not difficult to remove corn ears from their stems by hand because both stalk and ears had become dried and brittle.

A large labor force was no doubt hired to do the harvesting in order to finish before the rainy season. After picking, some of the corn ears or perhaps all of them still having high moisture content would be placed, with mat underneath, in the open field or the compound of the home and exposed to sunshine for a certain period. This was the natural method used by the farmers to dry

Table 12. Kinds of equipment used during the growing period classified by size of farms growing corn, Nakonrajasima, 1959 - 1960

Items	Size of farms: small	medium	large	All
Number of farms	13	18	6	37
Replanting:				
No equipment used				
Number of farms reporting	5	7	3	15
Percent of farms reporting	38	39	50	40
Thinning:				
No equipment used				
Number of farms reporting	5	6	2	13
Percent of farms reporting	38	33	33	35
Cultivating:				
Knives, no. used	9	-	17	26
Number of farms reporting	2	-	1	3
Percent of farms reporting	15	-	17	8
Hoes, no. used	68	137	91	296
Number of farms reporting	13	16*	5	34
Percent of farms reporting	100	89	83	92

* Two farms reported cultivating but did not mention kind of equipment used.

their corn. Though sunshine was plentiful, the area was subject to climatic conditions which were often uncertain. A drying machine would render best service in case of such emergency. Also foreign markets have complained about the moisture content of Thai corn.

Some big farms used a type of drying machine with circulating hot air. Recently an office of government has become concerned and some factories have developed experimental drying machines. Farmers will or will not accept this innovation depending upon its cost relative to their income and amount of corn produced. The possibility might be that in the foreseeable future, custom drying of corn with machine can be adopted.

Storing is the next activity performed in the harvest stage. After drying, corn must be brought to be kept in storage. How long the crop was stored was not certain. It depended upon how soon it could be sold. Mostly corn was stored in the form of whole ears without shelling. If it was kept in the form of grain, many gunny bags would be needed. Two types of storage were reported - permanent and temporary. Storage was permanent in the sense that it could be used for more years than one and was made of strong materials. Temporary storage was opposite to the permanent. Regarding both types of storage, some were extended parts of house-buildings and some were isolated from the house buildings. The

storage facilities were not only used to keep corn but also other equipment and components of farm and of home.

The shelling operation was performed when corn was sold. However, corn was also sold in the form of whole ears. Shelling methods were of two types --by machine and by hand. Only one farm in the large size group of the sample owned a shelling machine. The rest of them did the shelling by hiring workers, or the farmers themselves and their families did the job with their hands and/or by custom work of a shelling machine. It was observed that to shell corn by hand required more time but the shelled kernels were of better quality than when shelled by machine. With these motives, farmers therefore still used both methods. The detail of equipment used and farms using such equipment is shown in Table 13.

It was interesting to note that very few farmers used modern equipment such as tractors and shelling machines in producing corn. This did not mean that the majority of farmers were self-willed and resisted new technology. Instead, they could not afford to adopt modern equipment and if they ever resisted, their resistance was merely a temporary one.

Table 13. Kinds of equipment used during the harvesting period classified by size of farm growing corn, Nakonrajasima, 1959-1960.

Items	Size of farms			All
	small	medium	large	
Number of farms	13	18	6	37
Picking:				
Hands only				
Number of farms reporting	13	18	6	37
Percent of farms reporting	100	100	100	100
Drying:				
No equipment used				
Number of farms reporting	11	9	2	22
Percent of farms reporting	85	50	33	59
Storing:				
Permanent storage, no. reported	1	5	2	8
Number of farms reporting	1	5	2	8
Percent of farms reporting	8	28	33	59
Temporary storage, no. reported	6	7	4	17
Number of farms reporting	6	7	4	17
Percent of farms reporting	46	39	67	46
Shelling:				
Machines	C*	C	C	C
Number of farms reporting	2	11	5**	18
Percent of farms reporting	15	61	83	49
Hands only				
Number of farms reporting	11	6	-	17
Percent of farms reporting	85	33	-	46

* C means custom shelling.

** One farmer in the large group owned a shelling machine.

Labor Utilization:

This section will discuss two features of labor utilization. The first will deal with the number of family laborers and hired workers with respect to the processes of production. The second will explore labor input for each process of production of the three groups of farms.

Family Laborers vs Hired Workers: Due to the small amount of mechanization, much labor was employed in producing corn. Two main sources of labor existed: family laborers and hired workers. The amount of family labor was dependent on the number of workable members within a family as discussed in Chapter III. Hired workers were obtained in the local and nearby provinces in the northeast region.

In the planting period, for the thirty-seven farms, 15.3 workers per farm were hired to clear the land. The ratio of hired workers to family labor was 5.3. (Table 14). As for the three groups of farms, the revelation was that the medium, small and large groups hired 6, 7.9 and 48.7 additional workers per farm respectively. The ratio of hired workers to family labor of those respective groups was 1.9, 3.4 and 16.2.

Table 14. Number of family laborers and hired workers per farm employed during the planting period classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Rai of corn grown (avg.)	10.38	30.78	160	44.57
Number of farms	13	18	6	37
Clearing land:				
Family laborers	2.3	3.2	3.0	2.9
Number of farms reporting	13	17	6	36
Hired workers	7.9	6.0	48.7	15.3
Number of farms reporting	8	15	6	29
Ratio	3.4	1.9	16.2	5.3
Ploughing*				
Family laborers	1	1	-	1
Number of farms reporting	1	1	-	2
Hired workers	1	1.5	1	1.3
Number of farms reporting	1	6	2	9
Ratio	1.0	1.5	-	1.3
Planting:				
Family laborers	2.3	3.2	3.4	2.9
Number of farms reporting	13	18	5	36
Hired workers	7.7	12.8	68.7	23.7
Number of farms reporting	6	16	6	28
Ratio	3.3	4.0	20.2	8.2

* Ploughing: Hired workers mean farmers ploughed their land through custom work by tractor.

Only eleven farms reported ploughing land before seeding. Of this number, two were in the small size group, six were in the medium size group and three were in the large size group, Table 14. All reporting farms in the medium and large size group and one in the small group ploughed the land through custom work by a tractor. Therefore hired workers in this respect were tractor operators whose payment was included in the service cost of tractors. One of the two responding farmers in the small group ploughed the land himself with a pair of buffaloes and a wooden plough. Also one farmer in the medium size group, in addition to the custom work service, ploughed the land himself with buffaloes and a wooden plough. Therefore the ratio of family laborer to hired workers was small for this operation.

Why did so few of the farmers plough their land? The answer to this question might be found in the characteristics of the soils of this province. As shown in Chapter II, the soils of this province are Korat fine sandy loams. Their structures are so loosely formed that they can be dug easily with simple equipment. Therefore it is not difficult for the farmers to insert the kernel into the soils when seeding. So ploughing is not practised by the farmers.

Planting was the other activity which required comparatively much labor. The number of workers to do the planting increased as the size of the farm increased. That is, the small, medium and large farms hired 7.7, 12.8 and 68.7 additional workers per farm respectively for the planting operation. But the average additional workers hired for all farms was 23.7. The ratio of hired workers to family labor for the three groups of farms was 3.3, 4.0, and 20.2 respectively. The ratio for all farms was 8.2.

During the growing period, the pressure of work was gradually minimized. The number of workers was somewhat reduced. However, this period covered the longest time, probably 3 to 4 months. Only fifteen farms reported replanting corn and ten of them hired additional workers to do the work, Table 15. Hired workers averaged 10 for all reporting farms. The ratio of hired workers to family labor was 2.0.

It appeared that the number of hired workers for replanting corn was inversely related to the size of the farm. The small, medium, and large farms employed 6, 5, and 4.7 hired workers per farm respectively. The ratio of hired workers to family labor was these three corresponding groups of farms was 2.3, 2.1, and 1.7. The reason the smaller farms used relatively more workers might be accounted for by improper seeding, degenerated seeds and damage

to first seedlings. Therefore it was necessary to hire more additional workers to finish the jobs as soon as possible in order to let these new seedlings reach maturity at nearly the same time as the earlier seedlings.

Twleve farms reported thinning corn when too many plants per stand were found. Of this number, only seven farms, all in the medium and large groups, hired additional workers, Table 15. The other five farms in the small farm group used only family laborers. The large farms used more hired workers than the medium size farms. The medium and large farms hired 3.8 and 5.5 workers per farm respectively. The ratio of hired workers to family labor was 1.7 and 2.2 respectively. The number of workers varied with the size of farm.

Thinning is essential when there are too many plants per stand. Too many plants compete with each other to exhaust natural plant nutrients and moisture in the soil rather rapidly. As a consequence, it will affect the crop yield unless additional plant nutrients such as fertilizers or green manure are applied.

Cultivating required additional workers too. The small, medium and large farms hired 12.6, 10.1 and 32.3 workers per farm respectively, Table 15. Therefore the number of hired workers for cultivating did not vary directly with the size of farm. The small

Table 15. Number of family laborers and hired workers per farm employed during the growing period classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items	size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Rai of corn grown (avg.)	10.38	30.78	160	44.57
Number of farms	13	18	6	37
Replanting:				
Family laborers	2.6	2.4	2.7	2.5
Number of farms reporting	5	7	3	15
Hired workers	6.0	5.0	4.7	10.0
Number of farms reporting	1	6	3	10
Ratio	2.3	2.1	1.7	2.0
Thinning:				
Family laborers	2.6	2.2	2.5	2.4
Number of farms reporting	5	5	2	12
Hired workers	-	3.8	5.5	4.3
Number of farms reporting	-	5	2	7
Ratio	-	1.7	2, 2	1, 8
Cultivating:				
Family laborers	2.2	3.2	3.4	2.9
Number of farms reporting	12	18	5	35
Hired workers	12.6	10.1	32.3	18.4
Number of farms reporting	5	14	6	25
Ratio	5.7	3.2	9.5	6.3

farms used more hired workers than the medium farm. The ratio of hired workers to family labor for the three corresponding farm sizes was 5.7, 3.2 and 9.5. But the ratio for all farms reporting was 6.5. If we assume that cultivating achievements were attained to the same extent, the small group certainly used too many hired workers for cultivating, which implied inefficient use of the labor force. This becomes logical when it is realized that the lowest yield per rai was found in this group, which will be discussed in the next section. On the other hand, it is probable that because of less seed bed preparation prior to planting, more cultivating would be required on the small size farms.

The harvesting period was the shortest one. But a large labor force was used in picking corn. Twenty-seven farms reported hiring workers, Table 16. For all reporting farms, the average number of hired workers was 15.3 per farm. The small, medium and large farms used 10.7, 7.9 and 38.5 hired workers per farm respectively. The ratio of hired workers to family labor used on the three corresponding size farms was 4.6, 2.5, and 11.3. There is indication that small farms used more hired workers than medium farms but less than large farms. The small farms used comparatively too many workers for the work accomplished. It certainly contributed to inefficient utilization of the labor force within the farm.

Table 16. Number of family laborers and hired workers per farm employed during the harvesting period classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items	Size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Rai of corn grown (avg.)	10.38	30.78	160	44.57
Number of farms	13	18	6	37
Picking:				
Family laborers	2.3	3.2	3.4	2.9
Number of farms reporting	13	16	5	34
Hired workers	10.7	7.9	38.5	15.3
Number of farms reporting	6	15	6	27
Ratio	4.6	2.5	11.3	5.3
Drying:				
Family laborers	2.4	2.2	2.5	2.3
Number of farms reporting	11	8	2	21
Hired workers	-	10.7	12.5	11.4
Number of farms reporting	-	3	2	5
Ratio	-	4.9	5.0	4.9
Storing:				
Family laborers	2.2	2.7	2.5	2.4
Number of farms reporting	12	12	4	28
Hired workers	2	5	25.3	11.4
Number of farms reporting	1	5	3	9
Ratio	0.9	1.8	10.1	4.7
Shelling:*				
Family laborers	-	-	-	-
Number of farms reporting	9	3	-	12
Hired workers	-	-	-	-
Number of farms reporting	2	5	-	7
Ratio	-	-	-	-

*Shelling: All farms in the large size group did shelling by custom work of shelling machines. Two of the small and 11 of the medium size farms also had their corn custom shelled. Number of family laborer and hired worker were not obtained for small and medium size groups.

Only five farms hired additional workers for drying corn, Table 16. Of these five farms, three were medium size and two were large. The small farms used only family laborers. The ratio of family labor to hired workers on the medium and large farms hiring workers was 4.9 and 5.0 respectively. The medium farms used comparatively more hired workers than the large farms, provided that the amount of corn dried varied with the size of farm.

Storing required only a small labor force. The number of workers hired was in proportion to the size of farm. Only nine farms reported hiring additional workers to perform the storing operation, Table 16. The small, medium and large farms hired 2, 5 and 25.3 workers per farm. Number of workers certainly was based on the amount of corn to be stored. The indicated relation of number of workers to farm size seem justified.

Shelling was the final activity performed before selling the product. Twelve farms reported using only family labor to do this job, Table 16. But the number of family laborers used was not told. Of this number, nine were in the small size group and three were in the medium size group. Seven farms responded as hiring additional workers to shell corn without reporting the number of workers hired. All farms in the large size group reported shelling corn by machine

through custom work as also did two of the small farms and eleven of the medium size farms.

Some workers were hired for a whole crop season but most were hired only for a certain process of production. Hired workers were not too difficult to find. They usually moved around intentionally or unintentionally in search for work. But the unique difficulty often felt by farm operators was that they could hardly keep some hired workers at the farm as long as a production process required or through the crop season. Whenever these workers were paid, they would leave the farm immediately without informing the farm operators. Many of them would move down country to Bangkok as a main destination and possibly further to the southern part of the country. Many farms had experienced this situation and had to apply some methods to persuade hired workers to stay longer at the farm. One method that seemed to be most effective was that the hired worker would not be paid until finishing the crop season. This phenomena was a real challenge to social research workers and government office people concerned.

Hired workers, like farm operators themselves, inherited different aptitudes, physical strength, and mental capacity. Therefore, it is not realistic to assume that they possessed equal proficiencies at their work. When the problem of hired workers became

serious, mechanization was often recommended to the farmer. As already observed, mechanization was certainly applicable to the province as adopted by some farmers. However, some equipment might affect the supply of workers for other production processes and/or other crops which can not yet be mechanized. (14, p. 91). For example, if a harvesting machine for corn was introduced to the region, certain numbers of workers formerly used to harvest both corn and, say, castor beans would be shifted to harvest castor beans alone or the number of workers would have to be reduced to a necessary amount for the castor beans. If no other employment was available, this would lead to unemployment of the worker and as a consequence, other social and economic problems of the community would develop. A consideration of all aspects of mechanization should be taken by both the agricultural sector and the rest of the community and finally by the government.

Labor Input and Working Period: Before going further to the main subject of this section, some terminologies and aspects of production must be clearly understood.

"Labor input" refers to a unit of labor force employed in each process of production. This unit, if meaningful, must be necessarily standardized so that it can be applied to all farms and activities of production. "Mandays per rai" was therefore selected

as a standard unit used in every process of production from clearing land up to picking corn in the harvesting period. But the standard unit of labor input for storing and drying activities in the harvesting period would be more appropriate if based on the weight of corn rather than the number of rai grown. Therefore "mandays per 100 tang[1] of corn" was developed. "Mandays" means the number of day equivalents spent to finish a task as though it were done by only one worker.

Specific dates of performing different activities were not obtained. Therefore "working period" means the months reported by farmers during which a particular activity was performed. The months reported were grouped together into time periods or ranges. The most frequent month ranges reported are presented. The month ranges for many activities analyzed overlapped one another. This is because the farmers did not attempt to complete one activity before moving to another; rather they performed two or three activities simultaneously. This can best be explained by the example:

> A farm unit contains 10 rai. As soon as the operator has finished clearing a portion of the land, he will begin to plough that portion, while continuing with clearing operation on the rest of the farm. Then, later on, he will begin planting the first portion, while continuing to clear and

[1] Tang is a unit to measure quantity of corn. One tang is equal to approximately 15 kilograms.

plough the remainder. All three activities would be performed until the entire farm is planted.

This procedure was followed by all farms in the province; therefore the "working periods" inevitably became super-imposed on each other.

Labor input and working periods are conveniently presented with respect to the processes of production. Statistical analysis of variance was again employed to test the significant difference of the three different inputs of mandays on the three corresponding farm size groups. The analysis of variance was used because of its easiness and capability of testing more than two series simultaneously. The small, medium and large farm groups were treated as three samples with different sizes. The procedure was taken from the statistical text of Jerome C. R. Li. (5, p. 175-177).

Clearing land was performed approximately during the range of February to May for all farms reporting. The small, medium and large farms performed this activity during February to March, February to April and March to May respectively. However, a few farms reported starting to clear land late in 1958. The average mandays per rai for all farms reporting clearing land was 11.27, Table 17. But the small, medium and large farms used 13.95, 8.42 and 13.44 mandays per rai respectively. The analysis of

Table 17. Approximate working period, number of workers and mandays used clearing land classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	13	17	6	36
Percent of farms reporting	100	94	100	97
Rai of corn grown (avg.)	10	31	160	45
Working period	February to March	February to April	March to May	February to May
Labor force days	270	480	402	
Number of workers in labor force	93	145	310	
Total mandays	1904	3954	15715	
Mandays per rai	14.0	8.4	13.4	11.3

* All calculations are based on number of farms reporting.

variance (Appendix, Tables 4, 5, 6). indicated that the computed F-value of the three means was 4.7494 with 2 and 33 degrees of freedom. This value was larger than the F-value from the F-table at five percent level of significance. But as for the two means of small and large farms, the computed F-value was only 0.0145 with 1 and 17 degrees of freedom and smaller than the F-value from the F-table at five percent level of significance. Therefore the small and large farms used the same amount of mandays per rai in clearing land but more than the medium size farms. This could be explained by the fact that the medium farms did not have much material left on the land from the previous crops. Less labor input was needed to remove these materials.

Ploughing land was performed by only 11 farms or 30 percent and mostly through custom work of a tractor, Table 18. This activity was done during February to May for all farms reporting. During the months of February, March and February to May were obtained as ploughing periods for the small, medium and large farms respectively.

Mandays per rai used in ploughing land was relatively small because of being performed by a tractor. The small, medium and large farms used only 1.03, 0.19 and 0.18 mandays per rai respectively. For all farms, average mandays used was 0.46.

Table 18. Approximate working period, number of workers, and mandays used in ploughing land for corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	2	6	3	11
Percent of farms reporting	15	33	50	30
Rai of corn grown (avg.)	10	31	160	45
Working period	February	March	Feb.-May	Feb.-May
Labor force days	16	25	50	
Number of workers in labor force	2	11	2	
Total mandays	16	27	50	
Mandays per rai	1.03	0.19	0.18	0.46

* All calculations are based on number of farms reporting.

The analysis of variance (Appendix, Tables 7 and 8), showed that the computed F-value of the three means was only 0. 2316 with 2 and 7 degrees of freedom and smaller than the F-value from the F-table at five percent level of significance. Therefore the three groups of farms employed comparatively the same amount of labor input in ploughing land. This is justified because common equipment, a tractor, was mostly employed.

Some farmers who did not plough their land, would proceed to plant earlier than the farmers who did ploughing. Planting was performed during the months of March, April and March to May for the three groups of farms respectively, Table 19. The average mandays per rai in planting corn for the three corresponding size from the smallest to the largest groups was 2. 25, 4. 45 and 7. 14 respectively. The analysis of variance (Appendix, Tables 9, 10), revealed that the computed F-value of the three means was 1. 2349 with 2 and 34 degrees of freedom. This value was smaller than the F-value from the F-table at five percent level of significance. The conclusion was that the same amount of labor input was used by the three groups of farms. The lack of significance with 2. 25, 4. 45 and 7. 14 mandays per rai resulted from the large variation within each size group.

The planting period mostly followed was from March to May. Corn seeded during this period was expected to be ready for harvest in July to September. Unfortunately from May to

Table 19. Approximate working period, number of workers and mandays used in planting corn by size of farms, Nakonrajasima, 1959 - 1960.

Items *	Size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	13	18	6	37
Percent of farms reporting	100	100	100	100
Rai of corn grown (avg.)	10	31	160	45
Working period	March	April	March to May	March to May
Labor force days	58	174	134	
Number of workers in labor force	76	262	429	
Total mandays	274	3551	81882	
Mandays per rai	2.25	4.45	7.14	4.11

* All calculations are based on number of farms reporting.

September, there is abundant rainfall over the Central, Northeastern and Northern parts of the country which is caused by the southwest monsoon from the Indian Ocean. Undoubtedly all farmers had to cope with the problem of how to finish picking corn during the rainy season. Some farms could not finish the harvesting operation. The mature corn ears germinated as many were moistened because of heavy rain. Crop failures or near failures caused by climatic conditions were often complained of by the farmers. The Department of Agriculture has been conducting experiments in certain areas, such as Tapra, Roi-et and Ubonrajathani, to find out the best planting period for corn. The results revealed that the periods of July 28 to August 11 and June 2 to June 16 were the most suitable for Tapra and Roi-et and Ubonrajathani respectively. (13, p. 12-13). These three areas have climatic conditions comparable to Nakonrajasima. A few attempts have been made to suggest to farmers in the study area that they plant corn during July and harvest it during December and January when the weather is clear and sunny. This would provide opportunity to produce corn of good quality with low moisture content. However, farmers have not yet adopted the suggestion because they have an opportunity to grow other crops such as soybeans, ground nuts, radish, castor beans and job's

tear before the dry season. These after-corn crops, like other crops, depend completely on rainfall for growth. Any attempt to change the planting period of corn must consider the following:

(1) To what extent will incomes from crops after corn be affected?

(2) Can the additional income earned by corn from changing the planting period offset income lost from crops grown after corn?

(3) To what extent can irrigation be developed to provide ample water for at least the crops after corn?

(4) Possibility of establishing a demonstration farm in the province.

After corn had been planted at least one to two weeks, replanting or thinning would be performed. Fifteen farms or 40 percent reported replanting corn, Table 20. Replanting was done during April to June by all farms reporting. The small, medium and large farms performed this activity during the months of April, May and April to June respectively. Replanting did not require much labor because not every plant stand needed to be replanted. The small, medium and large farms used only 1.36, 2.04 and 0.45 mandays per rai respectively. The average mandays per rai for all farms was 1.49. The analysis of variance (Appendix, Tables 11, 12), indicated that the computed F-value of the three different means was only 0.9764 with 2 and 12 degrees of freedom. This

Table 20. Approximate working period, number of workers and mandays used in replanting corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	5	7	3	15
Percent of farms reporting	38	39	50	40
Rai of corn grown (avg.)	10	31	160	45
Working period	April	May	April-June	April-June
Labor force days	18	65	18	
Number of workers in labor force	19	47	19	
Total mandays	66	365	132	
Mandays per rai	1.36	2.04	0.45	1.49

*All calculations are based on number of farms reporting.

value was smaller than the F-value from the F-table at the five percent level of significance. Therefore, the three groups of farms used the same amount of labor in replanting corn.

Thinning was done during the same time as replanting. The two operations usually went together. Thirteen farms reported thinning corn, Table 21. The small, medium and large farms performed the activity during the months of April, May and April to June respectively. Therefore all reporting farms thinned corn during April to June. This activity also required only small amounts of labor input. The small, medium and large groups of farms used 1.04, 2.05 and 0.39 mandays per rai respectively in thinning corn. The average mandays per rai for all farms reporting thinning was 1.40. The computed F-value of the three means by analysis of variance (Appendix, Tables 13, 14), was only 0.8093 with 2 and 10 degrees of freedom. It was smaller than the F-value from the F-table at the five percent level of significance. This indicates all three groups of farms had employed the same amount of labor in thinning corn.

Cultivating was performed by all farms, Table 22. The reported ranges of months during which the activity was performed by the three corresponding farm size groups were April to May, May and April to July. The month ranges for all farms cultivating

Table 21. Approximate working period, number of workers and mandays used in thinning corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	5	6	2	13
Percent of farms reporting	38	33	33	35
Rai of corn grown (avg.)	10	31	160	45
Working period	April	May	April-June	April-June
Labor force days	16	59	8	
Number of workers in labor force	13	30	16	
Total mandays	42	292	74	
Mandays per rai	1.04	2.05	0.39	1.40

* All calculations are based on number of farms reporting.

Table 22. Approximate working period, number of workers and mandays used in cultivating land for corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	13	18	6	37
Percent of farms reporting	100	100	100	100
Rai of corn grown (avg.)	10	31	160	45
Working period	Apr.-May	May-May	Apr.-July	Apr.-July
Labor force days	128	402	131	
Number of workers in labor force	90	259	211	
Total mandays	602	6147	4886	
Mandays per rai	4.92	9.06	5.31	6.97

* All calculations are based on number of farms reporting.

the land was April to July. Mandays per rai of the three groups of farms were 4.92, 9.06 and 5.31 respectively. The average mandays per rai for all farms was 6.97. The computed F-value of the three means obtained by analysis of variance (Appendix, Table 15, 16), was 1.4001 with 2 and 34 degrees of freedom. This value was smaller than the F-value from the F-table at the five percent level of significance. Therefore it must be concluded that the three corresponding groups of farms used an equal amount of labor in cultivating corn.

Corn was harvested approximately four months after seeding. It did not ripen at the same time because of different dates of seeding. Corn which was seeded first would become mature and ready for harvest first. The farmers would gradually harvest corn as it became mature. The harvesting period generally was in the rainy season, so the farmers had to complete harvesting as soon as possible. However, many farms experienced having corn damaged by rainfall.

The harvesting period could be adjusted merely by adjusting the planting dates. The possibility of doing this was discussed earlier.

Harvest periods were found to be in July for the small and medium size farms and July to September for the large farms, Table 23. Mandays utilized in harvesting corn per rai for the three groups of farms were 3.94, 4.78 and 8.02 respectively. The

average mandays for all farms was 5.01. The analysis of variance, presented in Appendix, Tables 17, 18, showed the computed F-value of the three means as 3.3885 with 2 and 34 degrees of freedom. It was larger than the F-value of the F-table at the five percent level of significance. This indicates that the larger farms used significantly more labor per rai in harvesting corn than the smaller farms. In other words, labor input per rai used in picking corn was directly related to the size of farms. This might be attributed to a smaller amount of corn harvested per rai on the smaller farms, which will be discussed in the next section.

Drying corn took place after harvesting. Practically all corn subjected to drying contained a relatively high percent of moisture. Twenty-two farms, or 59 percent, reported drying corn, Table 24. Month ranges during which corn drying took place were July for the small and medium farms and July to September for the large farms. All farms dried corn during the months of July to September.

The labor input unit used to measure labor efficiency was mandays per 100 tangs of corn which is more logical than on a per rai basis. This 100 tangs was the weight of shelled corn, (approximately 150 kilograms), which was also reported as a unit of yield by farmers. The three corresponding groups of farms, from

Table 23. Approximate working period, number of workers and mandays used in picking corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Number of farms reporting	13	18	6	37
Percent of farms reporting	100	100	100	100
Rai of corn grown (avg.)	10	31	160	45
Working period	July	July	July-Sept.	July-Sept.
Labor force days	87	308	149	
Number of workers in labor force	94	170	248	
Total mandays	476	2567	6297	
Mandays per rai	3.94	4.78	8.02	5.01

* All calculations are based on number of farms reporting.

Table 24. Approximate working period, number of workers and mandays used in drying corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			
	small	medium	large	All
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	11	9	2	22
Percent of farms reporting	85	50	32	59
Rai of corn grown (avg.)	10	31	160	45
Working period	July	July	July -Sept.	July-Sept.
Labor force days	82	85	25	
Number of workers in labor force	26	50	30	
Total mandays	190	318	390	
Mandays per 100 tangs of corn	29.54	5.24	10.81	17.90

* All calculations are based on number of farms reporting.

small to large, reported using 29.54, 5.24 and 10.81 mandays per 100 tangs respectively. The average mandays per 100 tangs for all farms reporting was 17.90. The analysis of variance (Appendix, Tables 19, 20) indicated the computed F-value of the three means as 2.5473 with 2 and 19 degrees of freedom. This value was smaller than the F-value from the F-table at the five percent level of significance. Therefore these three groups of farms used the same amount of labor in drying 100 tangs of corn. The lack of significance probably was because all farms relied on hand methods to dry their corn. They used sunshine entirely by spreading the corn on the ground. It took about 2 to 3 sunny days for corn to be dried enough. Using identical methods, labor input for drying 100 tangs of corn was not different for the three groups of farms.

Storing took place after drying, so the working period for placing the crop in storage was the same as the drying period, Table 25. Twenty-nine farms, or 78 percent, reported storing corn. The labor input in mandays in carrying 100 tangs of corn to storage and the accompanying storing services reported by the three groups of farms from small to large was 22.48, 6.44 and 5.22 respectively. The computed F-value of these three means from

Table 25. Approximate working period, number of workers and mandays used in storing corn by size of farms, Nakonrajasima, 1959 - 1960.

Items*	Size of farms			All
	small	medium	large	
Average size (median), rai	10	21.5	90	20
Number of farms	13	18	6	37
Number of farms reporting	12	12	5	29
Percent of farms reporting	92	67	83	78
Rai of corn grown (avg.)	10	31	160	45
Working period	July	July	July-Sept.	July-Sept.
Labor force days	70	62	54	
Number of workers in labor force	29	57	86	
Total mandays	182	347	1500	
Mandays per 100 tangs of corn	22.48	6.44	5.02	11.28

* All calculations are based on number of farms reporting.

analysis of variance shown in Appendix, Tables 21, 22, was 2.7863. It was smaller than the F-value from the F-table. Therefore it suggests there was no difference in the amount of labor required by the three groups of farms to store 100 tangs of corn.

Labor input in shelling corn was not determined because numbers of days worked and numbers of workers were not reported. The only information obtained was the method of shelling used which already has been explained in the section on equipment used in producing corn.

Total labor utilized in the three stages of corn production is shown in Table 26. It appears that the largest labor input was required during the planting period. The planting period accounted for about 52 percent of all labor utilized. The smallest amount of labor was used in the harvest period. In this period, only labor used in picking corn was included. This segregation was made because picking corn was considered the last process in actual production. The other processes of drying, storing and shelling were considered as processes associated with the marketing function. In addition, it was not logical to compute mandays of labor per rai for the last enumerated processes. Mandays per 100 tangs of corn were accordingly chosen to represent labor input requirements for the marketing processes. This measure did not

Table 26. Total mandays per rai used in three stages of corn production by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items	Size of farms: small	medium	large	All	Percent
	----------Mandays-------				
Planting period	17.23	13.06	20.76	15.84	52
Growing period	7.32	13.15	6.15	9.86	32
Harvesting period*	3.94	4.78	8.02	5.01	16
Total	28.49	30.99	34.93	30.71	100

* Only picking process was included.

correspond to mandays per rai and therefore the functions could not be combined. So for all farms to produce corn took only 30.71 mandays per rai. Considering the different sizes of farms, the small, medium and large farms used 28.49, 30.99 and 34.93 mandays per rai respectively in producing corn. From statistical tests already presented, these mandays were found to be approximately the same. Thus it can be said that when the production method is relatively constant and man labor is largely used, any scale of corn production is likely to require approximately equal

mandays per unit of land area. While differences seemed to exist, the variance within each size group was so great that it overshadowed differences among the three size group means.

In the analysis of factor inputs, fertilizers and insecticides were not found to be used by all farms. As for the insecticides, the farmers might not have used them because of no plant pests or harmful insects in the region. However, it would be safe to assume that whenever there are populations of harmful insects and pests to damage the corn, the farmers certainly would react to such a situation. Fertilizers, if used, would have increased the yield of corn to a certain extent as it was used successfully elsewhere. Commercial fertilizers would be rather expensive to the farmers. However, green manure could have been used to add to soil fertility. In this respect, extension workers and agricultural officials in the region could have been of great assistance.

Yield of Corn:

Yield of corn appeared to be a function of the factor inputs discussed previously. In addition, the quality of soils and agronomic characteristics of corn varieties influenced the quantity of corn produced. In turn, the yield of corn certainly affected farm income. However, it is not safe to assume that every attempt made

to increase yield does always increase the income of farmers. It is because any additional factor inputs involved in increasing yield requires an additional amount of money outlay. The increment of income resulting from increased yields may or may not offset the total outlay added. So any means of increasing yields needs a precise consideration before recommendations can be made. (7, p. 312 - 313).

From Table 27, the yield of corn per rai for the three sizes of farms from smalles to largest was 12.9, 20.4 and 27.4 tangs respectively. The average yield for all farms was 18.9 tangs. The coefficient of variability of the three means was 0.78, 0.51 and 0.25 respectively. The coefficient of all was 0.58. This indicated that among the observation yields of corn per rai, greater variation in reported yields existed among the smaller farms. This greater variability may be attributable to chance.

Analysis of variance was used to measure the significant difference of these three yield means, and the procedure followed the statistical text of Jerome C. R. Li (5, p. 175 - 177). The computed F-value of the three means was 4.7790 with 2 and 34 degrees of freedom. (Appendix, Tables 23, 24). This value was larger than the F-value from the F-table at five percent level of significance but smaller than the F-value at one percent level of

Table 27. Yield of corn by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items	Size of farms			All
	small	medium	large	
Number of farms	13	18	6	37
	----------tang----------			
Total production	1949	10458	20655	33062
Production per farm	142	445	3443	894
Yield per rai *	12.9	20.4	27.4	18.9
Standard deviation	10.1	10.5	6.8	11.0
Coefficient of variability	0.78	0.51	0.25	0.58

* Yield was computed on basis of rai harvested.

significance. This suggested that the larger farms obtained larger yields of corn than the smaller farms.

From previous analysis, it was found that the amount of seed used and the amount of labor input were relatively equal on all farms. The equipment used was simple and common to all farms. But relevant evidence was that fewer smaller farms ploughed the land before growing corn in comparison with the larger farms. The

small group of farms in particular, hardly ploughed the land at all. The larger farms ploughed the land mostly by tractor through custom work. Therefore ploughing and ploughing by tractor might be assumed to have a relevant role in making the average yields of the three sizes of farms different.

Based on this conclusion, smaller farms possibly could improve yields through the following:

(1) Plough the land by tractor, or

(2) Plough the land with a wooden plough and buffaloes.

In addition, the use of fertilizer undoubtedly would increase yields on all farms. However, an adequate analysis has not been undertaken to determine if the added value from increased yields would offset the added costs for any of three practices.

Physical Efficiency of Corn Production:

Generally, physical efficiency of agricultural production can be explained in terms of input factors or a means in relation to physical output or an end. According to Heady, the physical efficiency can be categorized into two types; namely: "the ratio of product output to variable factor input," and "the ratio of product output to fixed factor". (3, p. 97). In this study, the yield of corn per

rai was a physical efficiency of the second type outlined by Heady. The yield of corn per rai was discussed in the last section. It was revealed that the smaller farms had lower physical efficiency than the larger farms. In other words, physical efficiency based on fixed factor land was directly related to the size of farm.

An attempt has been made to measure the other type of physical efficiency which is based on a variable factor input of the first type suggested by Heady. The variable factor input selected was labor. The other variable factor inputs such as seed and equipment were found from previous analysis to be about equal and common to all farms. Therefore it was reasonable to assume those factors remain relatively constant. In addition, labor played an important role in every process of production and contributed a great share of the cost of production. Product output was yield of corn per rai while labor input was total mandays per rai shown in Table 28.

The ratio of product output to variable factor input labor for the three farm sizes was computed and is shown in Table 28. The ratio or the efficiency numbers of the three corresponding farm sizes from smallest to largest was expressed in percent as 45, 66 and 78 respectively. These efficiency numbers implied that given an equal amount of labor input and a unit of land, the larger farms

Table 28. Physical efficiency in corn production based on labor as a variable factor input by size of farms, Nakonrajasima, 1959 - 1960.

Items	Size of farms			All
	small	medium	large	
Number of farms	13	18	6	37
Rai of corn grown (avg.)	10	31	160	45
Yield per rai	12.9	20.4	27.4	18.9
Mandays per rai	28.49	30.99	34.93	30.71
Efficiency (percent)	45.21	65.92	78.36	61.51

could produce more physical output of corn than the smaller farms. Therefore the larger farms were more efficient physically in regards to labor than the smaller farms in producing corn. However, the physical efficiency may or may not be compatible with economic efficiency. Economic efficiency should be discussed in terms of income of the farmers, which is the subject matter of Chapter VI.

CHAPTER V

COST OF PRODUCTION

The costs referred to in this chapter are cash outlays incurred in the production of crops. They consist of explicit payments which were made outright by the farmers. The other costs, such as unpaid family labor, depreciation and interest on investment are implicit and are not considered in this study. Thus, three major categories of cost are found in corn production: cost of growing corn, cost of selling corn and cost of producing interplanted crops during the period of growing corn.

Cost of Growing Corn:

Costs of growing corn were composed of all cash costs taking place in the process of clearing land through the processes of picking and drying corn in the harvest period. These costs consisted of seed expense, wages to hired labor, land charges, maintenance of equipment and miscellaneous which was any unclassified cost. During the crop year, some farmers had rented land to grow corn and paid a cash rental. For the sake of simplicity in analysis and comparability of treatment, this land rent was adjusted and assigned to every farm as a land charge. To this extent the

land charge is an imputed cost.

It is shown in Table 29 that wage expense for hired labor accounted for the greatest share of the cost of producing corn. The three farm size groups from smallest to largest paid an average of 702 baht, 2, 199 baht and 10, 300 baht per farm for wages. Wages paid by the farmers comprised 62, 60 and 66 percent of the total production cost respectively. The average labor expense paid by all farms was 3753 baht, which represented 62 percent of the total costs. The importance of wages can be understood when it is realized that farm mechanization was hardly practiced. Also the wage expense reported included room and board for hired workers when provided by the farmer.

Seed expenses per farm for the three groups of farms were 35 baht, 142 baht and 519 baht respectively. They comprised only 3, 4 and 3 percent of the total cost of production respectively. The average expense of seed for all farms was 195 baht or equivalent to 3 percent of the total cost of producing corn.

Land charges varied with the size of farm. The small, medium and large size farms had land charges of 350 baht, 710 baht and 1800 baht per farm respectively. These land charges represented 31, 19 and 12 percent of the total cost of producing corn respectively. The average land charge for all farms was 760 baht or 12

Table 29. Expenses incurred in growing corn per farm by size of farm Nakonrajasima, 1959 - 1960.

Expenses	Size of farms: small		medium		large		All	
	Baht	Percent	Baht	Percent	Baht	Percent	Baht	Percent
Seed	35.37	3.2	142.19	3.9	518.80	3.3	195.17	3.2
Hired Labor	702.50	62.5	2199.14	60.1	10300.00	66.4	3753.23	61.7
Land Charge	350.00	31.1	710.00	19.4	1800.00	11.6	760.27	12.5
Maintenance of Equipment	36.20	3.2	17.00	0.5	48.33	0.3	34.27	0.6
Miscellaneous	---	---	587.50	16.1	2850.00	18.4	1341.67	22.0
Total	1124.07	100.0	3655.83	100.0	15517.13	100.0	6084.61	100.0

percent of all costs.

Maintenance of equipment was relatively small. It was concerned only with the equipment used in producing corn which included primarily water buffaloes and wooden ploughs. The small, medium and large farm paid 36 baht, 17 baht and 48 baht respectively for machinery and equipment repairs. This expense was found to be about 3 percent of the total cost of producing corn for the small farms but less than one percent for the medium and large farm sizes. The average expense of maintaining equipment for all farms was 34 baht and accounted for less than one percent of all costs of producing corn.

Miscellaneous was the last item of expense incurred in producing corn. Only the medium and large size farms reported having any unclassified expenses. They were 587 baht and 2850 baht and represented 16 and 18 percent of the total cost of producing corn respectively.

The total cost of producing corn per farm for the three size groups of farms from smallest to largest was found to be 1124 baht, 3656 baht and 15517 baht respectively. The average total cost of producing corn was 6085 baht per farm. The ratio of the costs for the small farms to the medium size farms was about one-third while that of the medium farms to the large farms was one-fourth.

The cost of growing corn on the basis of per rai and per tang was averaged for each element and shown in Table 30. It indicated that the average cost per tang varied inversely with the size of farm. That is, 10, 6 and 5 baht were found to be the average costs per tang for the three farm sizes from smallest to largest respectively. This relationship was understandable when the yield of corn varied directly with the size of farms as discussed in past sections of this thesis. But the average cost per rai fluctuated somewhat. The largest and smallest average costs per rai were found on the large and medium farm sizes respectively. The small, medium and large farm sizes incurred costs of 110, 105 and 120 baht per rai respectively. Considering different items of cost, wages to hired labor and land charge of the small and large farm size groups were comparatively larger than that of the medium farm size group. Consequently, these two major items of cost made the average cost of producing corn per rai fluctuate among the three size groups.

Costs of Selling Corn:

Costs associated with selling corn were the final items of expense incurred in corn production. These costs were made up of expense in shelling corn, packaging, transportation and hired

Table 30. Cost per unit in growing corn by size of farms, Nakonrajasima, 1959 - 1960.

Item	Size of farms: small		medium		large		All	
	per tang	per rai	per tang	per rai	per tang	per rai	per tang	per rai
	Baht	Baht	Baht	Baht	Baht	Baht	Baht	Baht
Seed	0.25	3.08	0.34	5.39	0.14	2.95	0.17	3.39
Hired Labor	8.14	72.99	3.79	71.46	3.99	85.83	4.01	80.21
Land Charge	1.40	30.00	0.85	12.46	0.52	20.00	0.99	19.84
Maintenance of Equipment	0.35	3.02	0.07	0.49	0.01	0.35	0.03	0.66
Miscellaneous	---	---	0.61	14.97	0.82	11.40	0.75	12.25
Total	10.14	109.69	5.66	104.77	5.48	120.53	5.95	116.35

workers required to carry corn. These costs were also variable and changed directly with the amount of corn sold per farm.

The transportation expense for the shipment of corn comprised the greatest share in the total cost of selling corn for the large farm sizes. They were 118 and 1855 baht per farm and represented 47 and 38 percent of the total selling cost respectively, Table 31. As for the medium size group of farms, the shelling expense represented the greatest cost reported while the transportation expense was next to the largest single item of expense. The shelling and transportation expenses for the medium size group of farms were 299 and 267 baht and represented 39 and 35 percent of the total selling cost respectively. The shelling expense was 78 and 1462 baht per farm for the small and large size group of farms respectively and represented 31 and 30 percent of the total selling cost.

Packaging expense largely was for the container in which the corn was placed such as a gunny bag. The small, medium and large farms reported the expense of 30, 170 and 1250 baht per farm respectively.

The wages for hired workers to carry corn were the last and least amount of expense in the selling function incurred by all farm sizes. They were reported as 25, 36, and 250 baht per farm, and constituted 10, 5 and 5 percent of the total selling cost

Table 31. Expenses of selling corn per farm by size of farms, Nakonrajasima, 1959 - 1960.

Expenses	Size of farms: small		medium		large		All	
	Baht	Percent	Baht	Percent	Baht	Percent	Baht	Percent
Shelling	78.40	31.2	299.14	38.7	1462.12	30.3	463.01	33.1
Packaging	30.00	11.9	170.00	22.0	1250.00	26.0	483.33	34.6
Transport	117.75	46.9	266.86	34.6	1855.00	38.5	383.53	27.4
Wages for carrying	25.00	10.0	36.00	4.7	250.00	5.2	68.00	4.9
Total	251.15	100.00	772.00	100.0	4817.12	100.0	1397.87	100.0

respectively. Consequently, the total selling costs per farm were 251, 772, and 4817 baht respectively. They varied directly with the size of farms and the amount of corn produced and sold.

The costs of selling corn were averaged on a per tang and per rai basis as shown in Table 32. The average total selling cost per tang of corn for the three groups of farms from smallest to largest was 2.40, 1.93 and 1.95 baht respectively. The medium and large farm sizes incurred approximately the same amount of cost. Therefore, while there was a tendency for the average total cost per tang to vary inversely with the size of farm, the relationship was not precise. In other words, the larger farms with larger volume benefited somewhat by economy of scale but not greatly. However, the average total selling cost per rai varied directly with the size of farms. That is, 25, 29 and 34 baht were found to be the average total selling cost per rai for the three farm sizes from smallest to largest respectively. The average total selling costs per tang and per rai for all farms were 1.92 and 25 baht respectively.

The total cost per unit of corn production was summarized from Tables 30, 32 and is presented in Table 33. The average total cost per tang was 12.54, 7.54 and 7.43 baht for the three farm sizes from smallest to largest respectively. The inverse

Table 32. Costs per unit in selling corn classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Costs	Size of farms							
	small		medium		large		All	
	per tang	per rai	per tang	per rai	per tang	per rai	per tang	per rai
	Baht	Baht	Baht	Baht	Baht	Baht	Baht	Baht
Shelling	0.63	6.15	0.56	10.46	0.67	11.70	0.61	13.15
Packaging	1.00	6.00	0.65	7.39	0.62	12.50	0.63	1.13
Transport	0.63	10.47	0.66	9.48	0.54	7.42	0.58	8.28
Wages for Carrying	0.14	2.17	0.06	1.48	0.12	2.50	0.10	2.08
Total	2.40	24.79	1.93	28.81	1.95	34.12	1.92	24.64

Table 33. Total costs per unit of corn production by size of farms, Nakonrajasima, 1959-1960.

Costs	Size of farms: small		medium		large		All	
	per tang	per rai	per tang	per rai	per tang	per rai	per tang	per rai
Average Producing cost	฿10.14	฿109.69	฿ 5.61	฿104.77	฿ 5.48	฿120.53	฿ 5.94	฿116.35
Percent	80.9	81.6	74.4	78.4	73.8	77.9	75.6	82.5
Average selling cost	฿ 2.40	฿ 24.79	฿ 1.93	฿ 28.81	฿ 1.95	฿ 34.12	฿ 1.92	฿ 24.64
Percent	19.1	18.4	25.6	21.6	26.2	22.1	24.4	17.5
Total Baht	12.54	134.48	7.54	133.58	7.43	154.65	7.86	140.99
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

relationship to the size of farms is partly explained by the fact that the larger farms obtained larger yields than the smaller farms. However, the average total cost per rai fluctuated slightly. The medium size farms incurred the least cost per rai while the large farms incurred the greatest cost per rai. The average total costs per rai for the three sizes of farms from smallest to largest was 135, 134 and 155 baht respectively. The small and medium farm size groups had comparatively the same cost per rai. Therefore, if based on least cost per rai alone, the medium farm size seemed to be the appropriate size for producing corn. However, the economic optimum enterprise can not be based on the least cost per unit of land area alone because the least cost per unit of land area does not necessarily result in greatest return. This will be discussed in the next chapters.

Five different prices per tang of corn sold by farmers were reported as 9.00, 10.00, 11.00, 12.00 and 13.00 baht. These prices were set by corn traders based on the quality of corn. Therefore the group of small farms could not earn a net income unless the maximum price of corn was paid to them. In contrast, the medium and large farm size groups could make a net income even though the minimum price of corn was paid to them.

Based on the average total cost per tang of corn, it could be concluded that the managerial efficiency of the smaller farms was lower than the larger farms. This average total cost was operating cost or variable cost only, except for the land charge. If the price paid to the farmer does not at least cover this operating cost, it will not be possible for the farm business to survive very long. Undoubtedly, the small farm group needs to improve yield of corn without materially increasing per rai costs which will lessen the average cost per tang.

Costs of Producing Interplanted Crops:

Six kinds of interplanted crops were reported being grown by farmers during the period of growing corn. They were ground nut, castor bean, soya bean, job's tear, chily, and custard apples. The added crops were generally grown in order to use farm resources more completely and/or to distribute risk through scattering use of farm resources. Any crop used to meet the former purpose is called multiple enterprise in the literature and the latter is called diversified (1, p. 155). What the real aim was in growing the six crops in addition to corn was not known. However, it would be safe to presume that the farmers who participated in the study desired to fulfill both purposes.

It was assumed that two crops growing on the land at the same time should add income to the farm. Therefore care had to be exercised in the course of analysis so that the importance of corn as a primary crop studied would not be overlooked. Accordingly, the analysis reported in this section was confined to that which was deemed necessary.

Only 18 farms reported growing interplanted crops with corn, Table 34. Of this number, four, ten and four farms belonged to the three farm size groups from smallest to largest respectively. There were only three items of expenses reported, namely: seed, wages, and transportation. The group of small farms, on the average, reported more seed expense than the larger farms. That is, 430.00 baht, 98.55 baht and 111.40 baht were reported as seed expenses per farm by the three farm size groups from smallest to largest respectively. The wage expenses were not comparatively large and were paid for every process of production from planting through harvesting. These processes were performed nearly the same time as those associated with corn production. Therefore some workers were inevitably employed at the same time to do such work on both corn and interplanted crops. It is probable that some wage items overlapped each other, but it was not possible to segregate them

Table 34. Costs per farm of producing interplanted crops with corn classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Items*	Size of farms: small		medium		large		All	
Total number of farms	13		18		6		37	
Number of farms reporting inter-planted crops	4		10		4		18	
Percent of farms reporting inter-planted crops	31		55		67		49	
	Baht	Percent	Baht	Percent	Baht	Percent	Baht	Percent
Seed	430.00	51.5	98.55	15.2	111.40	14.9	144.00	20.5
Wages to hired labor	370.00	44.3	497.00	76.6	604.80	80.6	516.00	73.3
Transport	35.00	4.2	53.20	8.2	34.00	4.5	43.80	6.2
Total	835.00	100.0	648.75	100.0	756.20	100.0	703.80	100.0

* All calculations are based on number of farms reporting.

when detailed records of labor expense and use were not kept. The wages paid to hired workers employed on interplanted crops averaged 370.00, 497.00 and 605.80 baht for those farms in the three size groups from smallest to largest respectively.

The last item of expense was for transportating the crops when being shipped to market. The transport cost averaged only 35.00, 53.20, and 8.20 baht per farm. The total cost of producing interplanted crops by farms in the three size groups from smallest to largest averaged 835.00, 648.75 and 750.70 baht respectively. The small farms averaged more cash outlay per farm than the larger farms.

An attempt was made to compare the input costs per rai on farms practicing interplanting to those farms producing corn only. The results are shown in Table 35. It was revealed that the additional cost per rai incurred when producing the interplanted crops varied inversely with the size of farms. The additional costs per rai for the three size groups of farms were 57.71, 16.41 and 11.16 baht respectively. Thus, the total costs per rai, cost of producing corn plus cost of interplanted crops, were 122.24, 130.85 and 119.02 baht respectively for the three farm size groups from smallest to largest. The costs of production per rai for the farms producing corn only were 63.89, 93.80 and

Table 35. Comparison of input costs per rai on farms with and without interplanted crops classified by size of farms growing corn. Nakonrajasima, 1959 - 1960.

Items	Size of farms			All
	small	medium	large	
	Baht	Baht	Baht	Baht
Farms with Interplanted Crops:				
Cost of producing corn only	64.53	114.44	107.86	108.73
Additional cost of producing inter-planted crops	57.71	16.41	11.16	15.99
Total Cost per rai	122.24	130.85	119.02	124.72
Farms without Interplanted Crops:				
Cost of producing corn	63.89	93.80	107.53	99.68

107.53 baht respectively. It is indicated positively that the farms producing interplanted crops with corn spent more than the farms producing corn only. Within the small farm size group, the costs per rai on farms with interplanted crops were nearly twice the costs per rai on farms producing corn only. As for the medium farm size group, the costs per rai on farms with corn only were slightly less than three-fourths the cost per rai on farms with interplanted crops. In the large farm size group, the costs for producing corn only were only 90 percent of the costs for producing corn and interplanted crops. The purpose of presenting this cost discussion here was to enable the information to be used in comparing returns of the farms with and without interplanted crops in the next chapter.

CHAPTER VI

INCOME OF FARMERS

The past three chapters have dealt with the factor inputs and their functions which brought forth the value of output discussed in this chapter. The output treated in economic terms, money income, was a function of volume of product sold and its value per unit. Therefore this chapter is concerned with the disposal of corn produced, money income or its equivalent obtained and also income from interplanted crops.

Disposal of Corn Produced:

The main purpose of producing corn certainly was for sale. However, corn produced was used for other purposes also but in relatively small amounts. From Table 36, the volume of product sold from the three farm size groups from smallest to largest was 141.92, 445.28 and 3224.50 tangs per farm respectively. The volume of sales corresponded directly with the size of farms. The average amount of corn sold by all farms was 789.38 tangs.

Operators of three small farms, two medium size farms and one large farm reported using an average of 2.67, 10.00 and 4.00 tangs of corn per farm respectively for home consumption.

Table 36. Disposal of corn per farm classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Use *	Size of farms			All
	small	medium	large	
	tangs			tangs
Sold	141.92	445.28	3224.50	789.38
Number of farms reporting	13	18	6	37
Home consumption	2.67	10.00	4.00	5.33
Number of farms reporting	3	2	1	6
Seed	5.00	7.69	50.67	14.61
Number of farms reporting	11	16	6	33
Payment of debt	40.00	733.33	100.00	668.00
Number of farms reporting	1	3	1	5
Total per farm	149.92	581.00	3442.50	8935.67

* All calculations are based on number of farms reporting.

Farmers also put aside an amount of corn as seed for the next crop year. Operators of eleven, sixteen and six farms in the small, medium and large groups respectively reported retaining 5.00, 7.69 and 50.67 tangs of corn per farm for seed for the next crop year. Five farmers had been indebt and retired their debt with an amount of corn. Of this number, one, three and one operators of the farm size groups from the smallest to largest used 40.00, 733.33 and 100.00 tangs per farm respectively for debt retirement. The volume sold from each size group was affected by this action, but the medium group was most seriously affected. Consequently, the cash received from corn sold by the medium size farm group was decreased in comparison to the other farm size groups.

Income From Corn Production:

All items of costs and returns reported were involved in the farm business only. However, the amount of corn used for other purposes in addition to sale are considered as returns to the farm business. These amounts of corn were converted into monetary value by multiplying the average price received for corn sold by each farm size group. This total value of corn used for purposes other than for sale plus the total cash received from corn sold became the total return or value of corn produced. Then the net

income, which constitutes a return to all family labor, including the farm operator, and a return on the operators equity capital other than land, can be derived by subtracting the total cost of corn production from the total value of corn produced. This amount of net income would be available for family living, debt reduction, to replace depreciable equipment and/or to be saved.

The total value of corn for other uses per farm increased as the size of farms increased. But the total value of corn per rai for other uses was largest for the medium size group of farms and smallest for the small size group of farms. The farms in the three size groups from smallest to largest reported the total value of corn for other uses as 9.91 baht per rai, 93.17 baht per farm; 37.87 baht per rai, 1508.91 baht per farm; and 26.71 baht per rai, 2452.00 baht per farm respectively, Table 37.

The total cash received from corn sold per rai and per farm increased as the size of farms increased. The farms in the small size group had total cash receipts which averaged 146.83 baht per rai and 1524.77 baht per farm. The farms in the medium size group indicated total cash receipts averaging 151.18 baht per rai and 4653.03 baht per farm. The farms in the large size group obtained total cash receipts averaging 227.05 baht per rai and 36327.42 baht per farm. The average cash receipts for all farms

Table 37. Total value of corn produced and net income from corn by size of farms, Nakonrajasima, 1959 - 1960.

Items	Size of farms						All	
	small		medium		large			
	per rai	per farm	per rai	per farm	per rai	per farm	per rai	per farm
	Baht							
Total value of corn for other uses	9.91	93.17	37.87	1508.91	26.71	2452.00	26.37	1185.26
Cash receipts from corn sold	146.83	1524.77	151.18	4653.03	227.05	36327.42	194.99	8690.30
Total value of corn produced	156.74	1617.94	189.05	6161.94	253.76	38779.42	221.36	9875.56
Costs of producing corn	134.48	1375.22	133.58	4427.83	154.65	20334.25	140.94	7482.48
Net income from corn	22.26	242.72	55.47	1734.11	99.11	18445.17	80.42	2393.08

was 194.99 baht per rai and 8690.30 baht per farm. Finally the total value of corn produced obtained by adding the value of corn used for other purposes to the cash received from the corn sold also is presented in Table 37. In addition, the total farm expenses incurred in producing corn or the total cost of production derived from Tables 29, 31, 33 of the last chapter are shown together with the total value of corn produced. The net income from corn production, both per rai and per farm, indicated a direct relationship to the size of farms. The farms in the small size group had net income from corn averaging 22.26 baht per rai and 242.72 baht per farm. The farms in the medium size group earned net incomes which averaged 55.47 baht per rai and 1734.11 baht per farm. The farms in the large size group earned the greatest net income averaging 99.11 baht per rai and 18445.77 baht per farm. The average net income from corn for all farms was 80.42 baht per rai and 2393.08 baht per farm.

It was interesting to note that the small farm size group having the largest cost of production per tang of corn obtained an amount of net income per rai and per farm. One contributing factor was that the average price paid for corn to farmers in the small size group was higher than the prices received by farmers in the medium size group but smaller than the average price

received by the farmers in the large farm size group. That is, 10.75, 10.50 and 11.25 baht were reported as the average prices received per tang for corn sold by farmers in the three farm size groups from smallest to largest respectively. Therefore, to measure economic efficiency of corn production one needs to consider not only the average cost per rai and yield but also the price received. However, in this situation, the larger farms could obtain greater economic efficiency than the smaller farms in producing corn. Economies of scale are evident from the analysis of information obtained from the corn farmers in Northeastern Thailand.

Income From Interplanted Crops:

Interplanted crops provided the farmers who grew them with considerable additional income. Four farmers in the small size group had an average return per rai of 242.36 baht, from interplanted crops, Table 38. Ten farmers in the medium farm size group obtained returns averaging 92.94 baht per rai from interplanted crops. The other four farmers in the large size group earned an average return of 64.84 baht per rai. This indicated an inverse relationship between size of farms and income from interplanted crops. But the returns from corn on the same farms

Table 38. Comparison of costs and returns per rai of farms with and without interplanted crops classified by size of farms growing corn, Nakonrajasima, 1959 - 1960.

	Size of farms			
	small	medium	large	All
Farms with interplanted crops (No.)	4	10	4	18
Returns from interplanted crops	฿ 242.34	฿ 92.94	฿ 64.84	฿ 87.04
Returns from corn	69.22	224.80	311.24	258.45
Total returns	311.54	317.74	376.08	345.49
Total costs	122.24	130.85	119.02	124.72
Net returns	189.30	186.89	257.06	221.07
Farms without interplanted crops (No.)	9	8	2	19
Returns from corn	฿ 185.18	฿172.34	฿ 206.30	฿ 195.89
Total costs	63.89	93.80	107.53	99.68
Net returns	121.29	78.54	98.77	96.21

indicated a direct relationship with size of farms. This relationship is shown in Table 38 also. This evidence indicated operators of the larger farms became more specialized in producing corn in relation to operators of the smaller farms. The net returns per rai based on the returns from both corn and interplanted crops for the three farm size groups from smallest to largest was 189.30, 186.89 and 257.06 baht respectively.

The returns to farmers producing corn only are shown in Table 38. Nine farmers in the small size group producing corn only obtained net returns of 121.29 baht per rai. Eight farmers in the medium size group had net returns of 78.54 baht per rai. Two farmers in the large size group earned 98.77 baht as net returns per rai.

It is evident from data presented that the farms with interplanted crops earned larger returns per rai than the farms without interplanted crops. Therefore, with other factors remaining relatively unchanged, there is reason to believe the income of farm families growing corn in Nakonrajasima could be increased by growing some interplanted crops. The interplanted crops could be good alternative sources of income if the major crop, corn, is damaged. In fact, it appears from Table 38 that during the period of this study gross income per rai from interplanted crops on the

small farms greatly exceeded the gross income from corn. This was not true for the farms in the medium and large size groups, however.

CHAPTER VII

CONCLUSION

This chapter deals with a discussion of the results obtained from a statistical analysis to measure the extent to which factor inputs affected the income on farms growing corn. The best size of farm also is suggested and discussed.

In the analyses already presented, farm income was found to be the outcome of the interaction of the services of the following factors: size of farm, yield of corn per rai, labor and equipment used. Since the equipment used was simple and similar for all farms, it was reasonable to assume this factor to be constant. It was therefore eliminated from the statistical analysis. The labor factor in the form of wages per rai (baht) was employed in the analysis. Therefore the relevant independent variables were size of farm (rai), yield of corn per rai (tang), and wages per rai (baht) while the gross returns per rai from corn (baht) was the dependent variable. The method of multiple correlation was employed for the purpose and was adopted from the text of Federick C. Mill (6, p. 612 - 627). But the method of solving the simultaneous equations was based on the Crout method as

discussed in the class of Agricultural Production Economics. Due to incomplete information about the wages paid to hired labor by five small farms, thirty-two farms was the size of sample for this analysis.

X_1, X_2, X_3, and X_4 were the symbols representing the gross returns per rai, size of farm, yield of corn and wages per rai respectively. Because of three independent variables, three simultaneous equations had to be used for the solution of the regression coefficients required to obtain the coefficient of multiple correlation. The three equations were:

$$P_{12} = S_2^2 b_{12.34} + P_{23} b_{13.24} + P_{24} b_{14.23} \quad (1)$$

$$P_{13} = P_{23} b_{12.34} + S_3^2 b_{13.24} + P_{34} b_{14.23} \quad (2)$$

$$P_{14} = P_{24} b_{12.34} + P_{34} b_{13.24} + S_2^2 b_{14.23} \quad (3)$$

whereas - P_{12} = the mean product of X_1 and X_2,

P_{13} = the mean product of X_1 and X_3,

P_{14} = the mean product of X_1 and X_4,

$b_{12.34}$ = the regression coefficient of X_1 on X_2,

$b_{13.24}$ = the regression coefficient of X_1 on X_3,

$b_{14.23}$ = the regression coefficient of X_1 on X_4,

S_1^2 = the variance of X_1,

S_2^2 = the variance of X_2,

S_3^2 = the variance of X_3,

S_4^2 = the variance of X_4.

The formula used to obtain the coefficient of multiple correlation was

$$R^2_{1.234} = \frac{b_{12.34}P_{12} + b_{13.24}P_{13} + b_{14.23}P_{14}}{S_1^2},$$

when $R_{1.234}^2$ was the coefficient of determination whose square root became the coefficient of multiple correlation.

Also the partial correlation coefficients were determined and their symbols were r_{12}, r_{13}, and r_{14} for X_1 to X_2, X_1 to X_3, and X_1 to X_4 respectively.

The details of calculation are shown in Appendix Tables 25, 26.

The Result:

The computed R was equal to 0.984 which indicated that there was a high degree of correlation between the income per rai and the

three factors - size of farm, the yield of corn per rai and the wages of labor used. The coefficient of determination was 0.968. This value implied that nearly 97 percent of the variation in income of farmers growing corn was accounted for by the mentioned factors. In other words, about 97 percent of the variability in income was associated with the three factors. Only 3 percent of the variability in income could not be explained by the three factors. This unaccounted-for variability might be due to errors in the data obtained, small size of sample and other factors not included in the analysis.

To consider the partial correlation coefficients separately, it appeared that r_{12}(size of farm), r_{13}(yield of corn) and r_{14}(wages per rai), were equal to 0.145, 0.925 and 0.345 respectively. This empirical evidence suggested farm income per rai was slightly affected by the size of farm and wages per rai. But the income was highly related to the yield of corn per rai. That is, as the yield increased the income increased.

Besides agronomic rearrangements, the yield of corn in the Province of Nakonrajasima certainly can be increased by the application of inorganic fertilizer or other types of fertilizer such as animal dung or composted plant material. However, it is realized the marginal increment of value must offset the marginal

cost incurred. The use of fertilizer should be needed when the soils of the area are naturally relatively low in fertility. The more years the soils have been exploited the more fertility the soils need to have added to grow satisfactory yields of crops.

The Economic Optimum Enterprise:

A meaningful criterion used to identify the economic optimum enterprise or which is the best size of farms for producing corn is the least cost per unit of monetary gain. This permits one to conceive together the managerial ability and the economic efficiency associated with farms growing corn.

Among the three farm size groups, to obtain 100 bahts of gross return per rai from producing corn, the farms in the small, medium and large size groups had to invest 86, 71 and 61 bahts respectively. Based on this empirical evidence, the large farm size group was the most efficient because of the least cost incurred to earn 100 bahts of gross return. The medium farm size group was the second most efficient. The small farm size group was less efficient in comparison with the former two farm sizes. This was largely because of lower yields obtained by this farm size group. However, there probably was a great opportunity for all three size groups to earn larger incomes through

increasing yield of corn by the application of fertilizers. The experiment station in the northeast region obtained a substantial increase in yield of corn with fertilizer. It was believed this increment would be more than enough to offset the cost of the fertilizer. The economic data for the response of corn yield to fertilizer could be had and used to indicate to what extent fertilizers should be applied. This is really the task and burden of the agricultural economists and extension workers in the region to determine and convey such information to the farmers of the region. Furthermore, the land could be used more intensively by introducing multiple crops of legume varieties such as soya beans, castor beans and ground nuts, which would contribute some nitrogen plant nutrient to corn in addition to increasing the gross returns of the farms.

While the small farm size group generally was found to be least efficient in the production of corn, it is recognized that four small farms effectively combined interplanted crop with corn. The operators of these four small farms had to invest on the average only 39 bahts per 100 bahts of gross return, which was less than the operators of the large size group of farm invested to obtain 100 bahts gross from corn. From the limited data, one would suspect that the small farm size group might concentrate more

heavily on the production of interplanted crops for improved efficiency and increased income. The four small farms growing interplanted crops, produce greater gross and net income per rai from the interplanted crops than the other farmers in the small size group produced from corn only. The returns from corn was an extra bonus to those farmers of the small units that combined interplanted crops with corn.

Four farmers within the large farm size group also effectively combined interplanted crops with corn. With an average gross return per rai of 376.08 bahts from corn and interplanted crops and an average combined input cost of 119.02 bahts per rai, this group obtained 100 bahts of gross income with an input factor of 32 bahts. So one must conclude again that the larger farms are more efficient from an economic point of view. However, the thinness of data does not permit any definite conclusion to be drawn.

Ten farmers in the medium farm size group combined interplanted crops with corn. The average value of input was 41 bahts per 100 bahts of gross return. They were less efficient than either of the other two size groups, but no significance can be attached to the difference of 2 points in the ratio of inputs to outputs between the small farm size group and the medium farm size group.

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APPENDIX

Table 1. Correlation of the number of workable numbers within a family to size of farms growing corn. Nakonrajasima, 1959 - 1960.

Size of family Number	Average workable members per family Number (X)	Average size of farm rai (Y)
3	2.00	20.33
4	2.50	29.67
5	2.00	29.17
6	2.33	44.44
7	3.83	23.83
8	4.25	50.50
9	5.00	10.00
10	3.00	80.00
11	7.00	400.00

$n = 9$

$\sum X = 31.91$

$\sum Y = 687.94$

$\sum X^2 = 135.4103$

$\sum Y^2 = 173737.5392$

$(\sum X)^2 = 1018.2481$

$(\sum Y)^2 = 473261.4436$

$\frac{(\sum X)^2}{n} = 113.1386$

$\frac{(\sum Y)^2}{n} = 52584.6048$

$(\sum X)(\sum Y) = 21952.1654$

$\frac{(\sum X)(\sum Y)}{n} = 2439.1295$

$\sum XY = 3672.6141$

$\sum XY - \frac{(\sum X)(\sum Y)}{n} = 1233.4846$

$SP = 1233.4846$

$\sum X^2 - \frac{(\sum X)^2}{n} = 22.2717$

$SS_X = 22.2717$

$\sum Y^2 - \frac{(\sum Y)^2}{n} = 121152.9344$

$SS_Y = 121152.9344$

$$r = \sqrt{\frac{SP}{SS_X \cdot SS_Y}}$$

$$= \frac{35.13}{1642.8904}$$

$$= .0214$$

Table 2. Amount of corn seed used per rai by size of farms, Nakonrajasima, 1959-1960.

Small		Medium		Large	
Size rai	Seed used per rai Kg	Size rai	Seed used per rai Kg	Size rai	Seed used per rai Kg
3	3.00	18	3.00	70	2.50
5	1.80	20	4.00	80	2.00
7	2.50	20	2.00	80	1.90
7	2.50	20	4.00	100	3.00
8	1.00	20	3.00	230	3.00
10	3.20	20	3.20	400	3.40
10	1.60	20	3.00		
10	5.40	20	2.40		
15	3.00	20	1.50		
15	3.20	23	3.00		
15	3.00	30	2.00		
15	0.50	30	4.00		
15	3.00	30	4.00		
		36	3.00		
		50	1.10		
		57	6.00		
		60	6.50		
		60	4.00		

Table 3. Analysis of variance for seed used per rai for three farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Medium	Large	All
T	33.70	59.70	15.80	$G = 109.20$
n	13	18	6	$\sum n = 37$
$\bar{Y}$	2.75	3.32	2.63	$\bar{\bar{Y}} = 2.95$
$\frac{T^2}{n}$	87.3608	198.005	41.6067	$\sum\left(\frac{T^2}{n}\right) = 326.9725$

$\frac{G^2}{n} = 322.2876$ $\quad \sum\left(\frac{T^2}{n}\right) = 326.9725$ $\quad \sum Y^2 = 379.3200$

Analysis of variance

Sources of variation	SS	D. F.	MS	F
Among farm sizes	4.6849	2	2.3424	1.5214
Within farm size	52.3475	34	1.5396	
Total	57.0324	36		

At 5%, F - value $>$ value between 3.3138 and 3.2317.

Table 4. Mandays used in clearing land for corn, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
3	18	4	72	24.00	18	43	10	430	23.89	70	30	20	600	8.57
5	17	2	34	6.80	20	38	14	532	26.60	80	63	102	642	8.02
7	15	5	75	10.71	20	8	9	72	3.60	80	58	18	928	11.60
7	9	13	117	16.71	20	10	4	40	2.00	100	90	13	1170	11.70
8	28	3	84	10.50	20	30	13	390	19.50	230	76	70	5320	23.13
10	30	8	240	24.00	20	30	6	180	9.00	400	85	83	7055	17.64
10	3	2	6	.60	20	15	6	90	4.50					
10	10	9	90	9.00	20	10	8	80	4.00					
15	35	3	105	7.00	23	28	4	112	4.87					
15	32	2	64	4.27	30	10	13	130	4.33					
15	25	21	525	35.00	30	19	7	133	4.43					
15	28	9	252	16.80	30	24	5	120	4.00					
15	20	12	240	16.00	36	20	14	280	7.78					
					50	34	15	510	10.20					
					57	70	4	280	4.91					
					60	29	7	203	3.38					
					60	62	6	372	6.20					
135	270	93	1904	181.39	534	480	145	3954	143.19	960	402	310	15715	80.66

(1) Size of farm (rai)
(2) Days worked per farm
(3) Number of workers per farm
(4) Total mandays worked per farm
(5) Mandays per rai (col. 4 ÷ col, 1)

Table 5. Analysis of variance for mandays used in clearing land for three farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Medium	Large	All
T	181.39	143.20	80.66	G = 405.25
n	13	17	6	$\sum n$ = 36
$\bar{Y}$	13.95	8.42	13.44	$\bar{\bar{Y}}$ = 11.27
$\frac{T^2}{n}$	2530.9486	1206.2494	1084.3393	$\sum\left(\frac{T^2}{n}\right)$ = 4821.5373

$\frac{G^2}{n}$ = 4561.8767 $\quad \sum\left(\frac{T^2}{n}\right)$ = 4821.5373 $\quad \sum Y^2$ = 5723.6348

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	259.6606	2	129.8303	4.7494 *
Within farm size	902.0975	33	27.3363	
Total	1161.7581	35		

At 5%, F-value $>$ value between 3.3158 and 3.2317.

At 1%, F-value $>$ value between 5.3904 and 5.1785.

Table 6. Analysis of variance for mandays used in clearing land for corn for two farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Large	All
T	181.39	80.66	G = 262.05
n	13	6	$\sum n$ = 19
$\bar{Y}$	13.95	13.44	$\bar{\bar{Y}}$ = 13.79
$\frac{T^2}{n}$	2530.9486	1084.3393	$\sum\left(\frac{T^2}{n}\right)$ = 3615.2879

$\frac{G^2}{\bar{n}}$ = 3614.2212 $\quad \sum\left(\frac{T^2}{n}\right)$ = 3615.2879 $\quad \sum Y^2$ = 4869.6329

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	1.0667	1	1.0667	.0145
Within farm size	1254.3450	17	73.7850	
Total	1254.4117	18		

At 5%, F-value $>$ 4.4513.

Table 7. Mandays used in ploughing land for corn by size of farms, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
5	15	1	15	3.00	20	1	4	4	.20	70	14	1	14	.20
15	1	1	1	:06	20	2	2	4	.20	230	36	1	36	.16
					20	2	1	2	.10					
					20	2	2	4	.20					
					23	8	1	8	.29					
					30	5	1	5	.17					
20	16	2	16	3.06	173	25	11	27	1.16	300	50	2	50	.36

(1) Size of farm (rai)
(2) Days worked per farm
(3) Number of workers per farm
(4) Total mandays worked per farm
(5) Mandays per rai (Col. 4 ÷ Col. 1)

Table 8. Analysis of variance for mandays used in ploughing land for corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Medium	Large	All
T	3.06	1.16	.36	G = 4.58
n	2	6	2	$\sum n$ = 10
$\bar{Y}$	1.03	.19	.18	$\bar{\bar{Y}}$ = .46
$\frac{T^2}{n}$	4.6818	.2243	.0648	$\sum\left(\frac{T^2}{n}\right)$ = 4.9709

$\frac{G^2}{n}$ = 2.0976 $\quad \sum\left(\frac{T^2}{n}\right)$ = 4.9707 $\quad \sum Y^2$ = 9.3122

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	2.8733	2	1.4366	.2316
Within farm size	4.3413	7	.6202	
Total	7.2146	9		

At 5%, F-value $>$ 4.7374

Table 9. Mandays used in planting corn by size of farms, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
3	4	4	16	5.33	18	3	22	66	3.67	70	15	9	135	1.93
5	2	7	14	2.80	20	3	20	60	3.00	80	10	52	520	6.50
7	2	10	20	2.86	20	3	4	12	.60	80	16	18	288	3.60
7	1	3	3	.43	20	2	4	8	.40	100	45	13	585	5.85
8	5	3	15	1.87	20	2	13	26	1.30	230	18	250	4500	19.56
10	3	3	9	.90	20	4	14	56	2.80	400	30	87	2160	5.40
10	2	2	4	.40	20	2	24	48	2.40					
10	6	9	54	5.40	20	10	6	60	3.00					
15	4	3	12	.80	20	5	7	35	1.75					
15	12	2	24	1.60	23	8	7	56	2.43					
15	2	19	38	2.53	30	8	13	104	3.47					
15	5	9	45	3.00	30	10	7	70	2.33					
15	10	2	20	1.33	30	4	16	64	2.13					
					36	10	14	140	3.89					
					50	22	15	330	6.60					
					57	30	4	120	2.10					
					60	3	20	60	1.00					
					60	45	52	2236	37.27					
135	58	76	274	29.25	554	174	262	3551	80.14	960	134	429	81888	42.84

(1) Size of farm (rai) (2) Days worked per farm (3) Number of workers per farm
(4) Total mandays worked per farm (5) Mandays per rai (Col. 4 ÷ Col. 1)

Table 10. Analysis of variance for mandays used in planting corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Description	Small	Medium	Large	All
T	29.25	80.14	42.84	G = 152.23
n	13	18	6	$\sum n_i$ = 37
$\bar{Y}$	2.25	4.45	7.14	$\bar{\bar{Y}}$ = 4.11
$\frac{T^2}{n}$	65.8125	356.8011	305.8776	$\sum\left(\frac{T^2}{n}\right)$ = 728.4912

$\frac{G^2}{n}$ = 626.3236 $\quad \sum\left(\frac{T^2}{n}\right)$ = 728.4912 $\quad \sum Y^2$ = 2134.9291

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	102.1676	2	51.0838	1.2349
Within farm size	1406.4379	34	41.3658	
Total	1508.6055	36		

At 5%, F value $>$ value between 3.3158 and 3.2317

Table 11. Mandays used in replanting corn by size of farms, Nakonrajasima, 1959-1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
5	4	2	8	1.60	20	6	9	54	2.70	70	3	1	3	.04
8	7	3	21	2.62	20	10	5	50	2.50	80	3	3	9	.11
15	2	3	6	.40	23	30	5	150	6.52	100	12	10	120	1.20
15	2	2	4	.27	30	7	2	14	.47					
15	3	9	27	1.80	30	4	5	20	.67					
					50	3	15	45	.90					
					60	5	6	30	.50					
58	18	19	66	6.69	233	65	47	363	14.26	250	18	10	132	1.32

(1) Size of farm (rai)
(2) Days worked per farm
(3) Number of workers per farm
(4) Total mandays worker per farm
(5) Mandays per rai (Col. 4 ÷ Col. 1)

Table 12. Analysis of variance for mandays used in replanting corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Medium	Large	All
T	6.69	14.26	1.35	G = 22.30
n	5	7	3	$\sum n$ = 15
$\bar{Y}$	1.36	2.04	.45	$\bar{\bar{Y}}$ = 1.49
$\frac{T^2}{n}$	8.9512	29.0497	.6075	$\sum\left(\frac{T^2}{n}\right)$ = 38.6084

$\frac{G^2}{n}$ = 33.1527 $\sum\left(\frac{T^2}{n}\right)$ = 38.6084 $\sum Y^2$ = 72.1312

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	5.4557	2	2.7278	0.9764
Within farm size	33.5225	12	2.7936	
Total	38.9785	14		

At 5%, F-value $>$ 3.8853

Table 13. Mandays used in thinning corn by size of farms, Nakonrajasima, 1959-1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
5	4	2	8	1.60	20	4	2	8	.40	70	3	3	9	.13
8	7	3	21	2.62	20	6	9	54	2.70	100	5	13	65	.65
10	1	3	3	.30	20	10	3	30	1.50					
15	2	3	6	.40	23	30	5	150	6.52					
15	2	2	4	.27	30	4	5	20	.67					
					60	5	6	30	.50					
55	16	13	42	5.19	173	59	30	292	12.29	170	8	16	74	.78

(1) Size of farm (rai)
(2) Days worked per farm
(3) Number of workers per farm
(4) Total mandays worked per farm
(5) Mandays per rai (Col. 4 ÷ Col. 1)

Table 14. Analysis of variance for mandays used in thinning corn for three farm sizes, Nakonrajasima, 1959-1960.

Description	Small	Medium	Large	All
T	5.19	12.29	0.78	G = 18.26
n	5	6	2	$\sum n$ = 13
$\bar{Y}$	1.04	2.05	0.39	$\bar{\bar{Y}}$ = 1.40
$\frac{T^2}{n}$	5.3872	25.1740	0.3042	$\sum\left(\frac{T^2}{n}\right)$ = 30.8654

$\frac{G^2}{n}$ = 25.6483 $\quad \sum\left(\frac{T^2}{n}\right)$ = 30.8654 $\quad \sum Y^2$ = 63.0960

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	5.2171	2	2.6085	0.8093
Within farm size	32.2306	10	3.2231	
Total	37.4477	12		

At 5%, F-value $>$ 4.1028

Table 15. Mandays used in cultivating corn by size of farms, Nakonrajasima, 1959-1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
3	8	4	32	10.67	18	30	11	330	18.33	70	10	3	30	.43
5	4	2	8	1.60	20	10	7	70	3.50	80	25	52	1300	16.25
7	4	27	108	15.43	20	7	14	98	4.90	80	26	6	156	1.95
7	1	10	10	1.43	20	10	4	40	2.00	100	20	13	260	2.60
8	7	3	21	2.62	20	2	13	26	1.30	230	30	50	1500	6.52
10	20	3	60	6.00	20	24	12	288	14.40	400	20	87	1640	4.10
10	8	2	16	1.60	20	6	9	54	2.70					
10	11	4	44	4.40	20	15	17	255	12.75					
15	5	3	8	0.53	20	10	5	50	2.50					
15	30	2	60	4.00	23	30	5	150	6.52					
15	7	19	133	8.87	30	36	8	288	9.60					
15	8	9	72	4.80	30	25	2	50	1.67					
15	15	2	30	2.00	30	4	5	20	0.67					
					36	30	19	570	15.83					
					50	41	15	615	12.30					
					57	25	4	100	1.75					
					60	29	7	203	3.38					
					60	70	42	2940	49.00					
135	128	90	602	63.95	554	404	259	6147	163.10	960	131	211	4886	31.85

(1) Size of farm (rai) (2) Days worked per farm (3) Number of workers per farm
(4) Total mandays worked per farm (5) Mandays per rai (Col. 4 ÷ Col 1)

Table 16. Analysis of variance for mandays used in cultivating corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Description	Small	Medium	Large	All
T	63.95	163.10	31.85	$G = 258.90$
n	13	18	6	$\sum n = 37$
$\bar{Y}$	4.92	9.06	5.31	$\bar{\bar{Y}} = 6.97$
$\frac{T^2}{n}$	376.3848	1477.8872	169.0704	$\sum\left(\frac{T^2}{n}\right) = 2023.3224$

$\frac{G^2}{n} = 1811.6003$ $\quad \sum\left(\frac{T^2}{n}\right) = 2023.3224$ $\quad \sum Y^2 = 4594.1266$

Analysis of variance

Sources of variation	SS	D. F.	MS	F
Among farm sizes	211.7221	2	105.8610	1.4001
Within farm size	2570.8042	34	75.6119	
Total	2782.5263	36		

At 5%, F-value $>$ value between 3.3158 and 3.2317

Table 17. Mandays used in picking corn by size of farms, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
2	3	4	12	6.00	18	5	31	155	8.61	70	32	22	704	10.06
4	5	2	10	2.50	20	7	2	14	.70	80	18	52	936	11.70
7	3	22	66	9.43	20	4	4	16	.80	80	14	18	252	3.15
7	2	3	6	.86	20	10	5	50	2.50	100	30	14	420	4.20
4	5	3	15	3.75	20	8	13	104	5.20	230	25	55	1375	5.98
10	12	3	36	3.60	20	6	8	48	2.40	200	30	87	2610	13.05
10	10	2	20	2.00	18	30	2	60	3.33					
10	6	9	54	5.40	20	15	10	150	7.50					
15	5	3	15	1.00	20	7	5	35	1.75					
15	22	2	44	2.93	18	18	4	72	4.00					
15	5	22	110	7.33	30	18	13	234	7.80					
15	4	7	28	1.87	30	33	11	363	12.10					
15	5	12	60	4.60	30	6	14	84	2.80					
					36	20	9	180	5.00					
					50	28	5	140	2.80					
					30	40	4	160	5.33					
					60	12	13	156	2.60					
					60	38	17	646	10.77					
129	87	94	476	51.27	510	308	170	2567	48.14	760	149	248	6297	48.14

(1) Size of farm (rai) (2) Days worked per farm (3) Number of workers per farm
(4) Total mandays worked per farm (5) Mandays per rai (Col. 4 ÷ Col. 1)

Table 18. Analysis of variance for mandays used in picking corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Description	Small	Medium	Large	All
T	51.27	85.99	48.14	G = 185.40
n	13	18	6	$\sum n$ = 37
$\bar{Y}$	3.94	4.78	8.02	$\bar{\bar{Y}}$ = 5.01
$\frac{T^2}{n}$	202.2010	410.7933	386.2433	$\sum\left(\frac{T^2}{n}\right)$ = 999.2376

$\frac{G^2}{n}$ = 929.0043 $\quad \sum\left(\frac{T^2}{n}\right)$ = 999.2376 $\quad \sum Y^2$ = 1351.5920

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	70.2333	2	35.1166	3.3885*
Within farm size	352.3544	34	10.3634	
Total	422.5877	36		

At 5%, F-value $>$ value between 3.3158 and 3.2317

At 1%, F-value $>$ value between 5.3904 and 5.1785

Table 19. Mandays used in drying corn per 100 tangs by size of farms, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
8	7	1	7	87.500	570	2	20	40	7.017	2280	10	12	120	5.263
30	3	2	6	20.000	430	4	2	8	0.186	1650	15	18	270	16.364
43	5	1	5	11.628	215	2	13	26	12.093					
95	4	3	12	12.632	229	2	2	4	0.175					
10	5	2	10	100.000	560	4	2	8	0.143					
300	10	3	30	10.000	1000	34	2	68	6.800					
116	7	4	28	24.138	1000	5	2	10	1.000					
344	5	3	15	4.360	1000	30	5	150	15.000					
500	23	2	46	9.200	84	2	2	4	4.762					
40	5	3	15	37.500										
200	8	2	16	8.000										
1686	82	26	190	324.958	5088	85	50	318	47.176	3930	25	30	390	21.627

(1) Amount of corn (tangs) (2) Days worked per farm (3) Number of workers per farm
(4) Total mandays worked per farm (5) Mandays per 100 tangs of corn (Col. 4 x100 ÷ Col. 1)

Table 20. Analysis of variance for mandays used in drying 100 tangs of corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Description	Small	Medium	Large	All
T	324.96	47.18	21.63	G = 393.77
n	11	9	2	$\sum n$ = 22
$\bar{Y}$	29.54	5.24	10.81	$\bar{\bar{Y}}$ = 17.90
$\frac{T^2}{n}$	9599.9092	247.3280	233.9284	$\sum\left(\frac{T^2}{n}\right)$ = 10081.1656

$\frac{G^2}{n}$ = 7047.9460 $\quad \sum\left(\frac{T^2}{n}\right)$ = 10081.1656 $\quad \sum Y^2$ = 21393.4109

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	3033.2196	2	1516.6098	2.5473
Within farm size	11312.2453	19	595.3813	
Total	14345.4649	21		

At 5%, F-value $>$ 3.5219

Table 21. Mandays used in storing 100 tangs of corn by size of farms, Nakonrajasima, 1959 - 1960.

Small					Medium					Large				
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
8	3	2	6	75.000	570	2	3	6	1.053	2800	2	22	44	1.571
30	5	1	5	16.667	430	4	1	4	9.302	2280	15	3	45	1.974
43	3	4	12	27.907	215	4	13	52	24.186	1650	4	3	12	0.727
95	3	3	9	9.474	229	12	2	24	10.480	2025	8	3	24	1.185
10	1	1	1	10.000	560	3	2	6	1.071	7000	25	55	1375	19.643
300	10	3	30	10.000	603	5	2	10	1.658					
116	5	4	20	17.241	262	5	3	15	5.725					
344	9	3	27	7.888	1000	5	4	35	3.500					
500	11	2	22	4.400	1000	3	2	6	0.600					
158	1	1	1	0.633	1000	5	5	25	2.500					
40	11	3	33	82.500	2031	12	13	156	7.681					
200	8	2	16	8.000	84	2	4	8	9.524					
1844	70	29	182	269.710	7984	62	57	347	77.270	15755	54	86	1500	25.090

(1) Amount of corn (tangs)
(2) Days worked per farm
(3) Number of workers per farm
(4) Total mandays worked per farm
(5) Mandays per 100 tangs of corn (Col. 4 x 100 ÷ Col. 1)

Table 22. Analysis of variance for mandays used in storing 100 tangs of corn for three farm sizes, Nakonrajasima, 1959 - 1960.

Description	Small	Medium	Large	All
T	269.71	77.27	25.09	G = 372.07
n	12	12	5	$\sum n$ = 29
$\bar{Y}$	22.48	6.44	5.05	$\bar{\bar{Y}}$ = 11.28
$\frac{T^2}{n}$	6061.9570	497.5544	125.9016	$\sum\left(\frac{T^2}{n}\right)$ = 6685.4130

$\frac{G^2}{n}$ = 4774.1713 $\quad \sum\left(\frac{T^2}{n}\right)$ = 6685.4130 $\quad \sum Y^2$ = 15602.6859

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	1911.2417	2	955.6208	2.7863
Within farm size	8917.2729	26	342.9720	
Total	10828.5146	28		

At 5%, F-value $>$ 3.3690

Table 23. Yield of corn per rai by size of farms growing corn, Nakonrajasima, 1959 - 1960.

Small	Medium	Large
Yield per rai (tangs)	Yield per rai (tangs)	Yield per rai (tangs)
4.00	31.67	40.00
7.50	21.50	28.50
6.15	5.75	20.62
13.57	19.80	20.25
2.50	10.75	30.43
30.00	11.45	24.50
10.50	31.11	
11.60	11.50	
22.93	30.15	
33.33	14.55	
10.53	10.85	
2.67	33.33	
13.33	33.33	
	18.86	
	20.00	
	27.90	
	33.85	
	1.40	

Table 24. Analysis of variance for yield of corn per rai for three farm sizes, Nakonrajasima, 1959 - 1960.

Descriptions	Small	Medium	Large	All
T	167.47	367.75	164.30	$G = 699.52$
n	13	18	6	$\sum n = 37$
$\bar{Y}$	12.88	20.43	27.38	$\bar{\bar{Y}} = 18.91$
$\frac{T^2}{n}$	2157.40	7513.34	4499.08	$\sum\left(\frac{T^2}{n}\right) = 14169.82$

$\frac{G^2}{n} = 13225.09$ $\quad \sum\left(\frac{T^2}{n}\right) = 14169.82$ $\quad \sum Y^2 = 17530.46$

Analysis of variance

Sources of variation	SS	D.F.	MS	F
Among farm sizes	944.73	2	472.365	4.77899*
Within farm size	3360.64	34	98.842	
Total	4305.37	36		

At 5%, F-value $>$ value between 3.3158 and 3.2317

At 1%, F-value $>$ value between 5.3904 and 5.1785

Table 25. Calculation of the coefficient of multiple correlation between gross returns per rai of corn as the dependent variable and size of farms, yield per rai and wages per rai.

X_1 (gross returns per rai)	X_2 (Size of farms)	X_3 (yield per rai)	X_4 (wages per rai)
33.91	3	4.00	66.67
71.50	5	7.50	10.80
73.36	7	6.14	103.71
140.25	7	13.57	67.14
138.70	10	11.60	80.00
69.13	15	10.53	74.67
28.03	15	2.67	10.00
153.86	15	13.33	133.33
379.34	18	31.67	172.22
210.75	20	21.50	60.00
59.07	20	5.75	36.00
198.15	20	19.80	46.00
128.62	20	10.75	250.00
120.22	20	11.45	15.00
335.25	20	31.11	80.00
126.43	20	11.50	72.00
256.58	20	30.15	125.00
136.50	23	14.55	21.00
86.45	30	10.85	16.00
346.80	30	33.33	133.00
384.50	30	33.33	100.00
188.71	36	18.86	83.33
200.07	50	20.00	16.00
132.64	57	27.90	94.60
348.75	60	33.85	16.67
15.37	60	1.40	108.33
539.35	70	40.00	150.00
316.68	80	28.50	50.00
216.75	80	20.62	100.00
222.81	100	20.25	10.00
364.89	230	30.43	147.39
115.10	400	24.50	62.50

Table 25 (continued)

$\sum X$	6138.52	1591	601.39	2511.36
$\frac{\sum X}{n} = C$	191.829	49.719	18.793	78.480
$\sum X^2$	1679576.766	262505.00	14877.291	203561.688
$\sum X_i X_j$		349187.66	154564.993	55761.386
			37709.39	228344.70
				52418.374
$\frac{\sum X^2}{n}$	52486.774	8203.281	464.915	9173.803
C^2	36798.365	2471.979	353.177	6159.110
$S^2 = \frac{\sum X^2}{n} - C^2$	15688.409	5731.302	111.738	3014.693
S	125.253	75.705	10.571	54.906
$S_i S_j$		9482.278	1324.049	6877.141
			800.277	4156.659
				580.411
$\frac{\sum (X_i X_j)}{n}$		10912.114	4830.156	17427.231
			1178.418	7135.772
				1638.074
$C_i C_j$		9537.546	3605.042	15054.740
			934.369	3901.947
				1474.875

Table 25 (continued)

$P_{ij} = \frac{\sum(X_i X_j)}{n} - C_i C_j$	1374.568	1225.114	2372.491
		244.049	3233.825
			163.199
$r = \frac{P_{ij}}{S_i S_j}$	.1450	.9253	.3450
		.3050	.7780
			.2812

Table 26. Method of solving simultaneous equations and calculation of the coefficient of multiple correlation.

$$P_{12} = S_2^2 b_{12.34} + P_{23} b_{13.24} + P_{24} b_{14.23}$$

$$P_{13} = P_{23} b_{12.34} + S_3^2 b_{13.24} + P_{34} b_{14.23}$$

$$P_{14} = P_{24} b_{12.34} + P_{34} b_{13.24} + S_4^2 b_{14.23}$$

$$1374.568 = 5731.302\ b_{12.34} + 244.049\ b_{13.24} + 3233.825\ b_{14.23}$$

$$1225.114 = 244.049\ b_{12.34} + 111.738\ b_{13.24} + 163.199\ b_{14.23}$$

$$2372.491 = 3233.825\ b_{12.34} + 163.199\ b_{13.24} + 3041.693\ b_{14.23}$$

table a.

5731.302	244.049	3233.825	1374.568	10583.744
244.049	111.738	163.199	1225.114	1744.100
3233.825	163.199	3014.693	2372.491	8784.208

table b.

5731.302	.043	.564	.239	1.846
244.049	101.342	.252	11.511	12.762
3233.825	25.438	1183.756	1.101	2.101

table c.

-.860	11.233	1.101
.140	12.233	2.101

Table 26 (continued)

$b_{12.34} = -0.860, \quad b_{13.24} = 11.233 \quad b_{14.23} = 1.101$

$$R^2_{1.234} = \frac{b_{12.34} P_{12} + b_{13.24} P_{13} + b_{14.23} P_{14}}{S_1^2}$$

$$= \frac{(-0.860)(1374.568) + (11.233)(1225.114) + (1.101)(2372.491)}{15688.409}$$

$$= \frac{15191.690}{15688.409}$$

$$= 0.968338$$

$$R = 0.98404$$