PN-AAT-829 42219

FARM LEVEL TESTING OF CROPPING SYSTEMS - AN ECONOMIC ANALYSIS OF THE MULTIPLE CROPPING PROJECT EXPERIENCE

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Agricultural Economics Research Report No. 2
The Multiple Cropping Project
Faculty of Agriculture
Chiang Mai University
1978

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Agriculture is the predominant sector in most low income countries' economies in terms of contribution to the Gross National Product and percent of labor force employed. Data also suggests there are substantial per capita income disparities among farm and non-farm people.

One primary means to increase real economic growth in economies with large agricultural sectors is the development of new technology that can be adopted by small farmers. Under certain conditions this new technology can also reduce the income disparities between farm and non-farm people. The generation of new technology that will be adopted by farmers is a complex process requiring quality research and extension programs operating within a policy framework that is conducive to development.

The example of testing the economic performance of crop technology as managed by farmers to be used in this presentation is taken from an applied cropping system research program oriented to lowland irrigated areas in Northern Thailand - the Multiple Cropping Project at Chiang Mai University (MCP). The objectives of this presentation are to: outline a proposed framework for operation of applied cropping system research programs, discuss the process and content of one method of farm level testing of new technology, and explain the economic results obtained from this farm level testing.

Steps Recommended for an Applied Cropping System Research Program

Even a brief look at the current literature on cropping systems programs reveals a common agreement on the process that ought to be undertaken to develop improved adoptable cropping systems for farmers. The names attached to the individual steps and the specific aspects assigned to certain steps often vary, but the concepts are amazingly similar among the reports given of various programs. The general rationale for this recommended process is that cropping systems that are developed based on the environment the farmers

must function within are more likely to be adopted. In addition, to make a positive break from traditional cropping systems requires informed, tested changes be introduced to minimize possible undesirable consequences.

Analysis of farmers' situations and actions - step 1

This step involves the inventory and analysis of factors that influence what farmers do and how and why they do it. This activity may also be used to develop base line data from which technology induced changes that occur can be measured. The results of this analysis are used to define what lines of research might be more advantageous to pursue in terms of the ability and inclination of the farmer to adopt new technology.

Design of technology - step 2

As the farmer's working environment is analyzed and what he does and how and why he does it becomes better understood, new cropping system technology design can begin. Component elements of crop technology are developed and/or assembled, tested and combined into potential cropping systems that reflect the synthesis of information gathered in the previous step. These cropping systems being designed are to reflect the determinants (conditions difficult to change) of the environment while incorporating changes that can be adopted to develop technology that holds promise of demonstrating superior performance over traditional systems.

On-farm testing and evaluation - step 3

This third step involves taking systems judged to be feasible and productive to farm plots for further testing and evaluation. Since the previous step is usually accomplished in experimentally controlled conditions, the results of the design stage need to be verified and expanded using farmers' fields, reactions, and sometimes their management. The literature reflects some divergence in the specific objectives of this step. In some cases, farmers are asked to manage specified cropping systems and these results are compared to their traditional systems. In other examples, on-farm testing is divided

into component trials closely guided by researchers and subsequent farmer managed trials based on the results of the on-farm component research trials. Measures to determine the constraints experienced by the farmers and initial impressions of the impact of adoption on the farm and village are also usually made in this step. Some programs include analysis of these consequences on more aggregated levels also. Initial analyses may also be made at this stage on the types of programs that need to be developed by enabling institutions to insure that the requirements for the adoption of the new technology are met.

Extension and evaluation - step 4

As cropping systems are tested and shown to be compatible with the farmer's situation as well as substantially more profitable and/or stable than the tranditional systems, they may be extended over wider areas. The program leadership for this step is usually with extension agencies although the research program has a vital role to play. More complete studies can be made on the constraints to and consequences of the adoption of the new technology during this phase.

Relationship among the steps

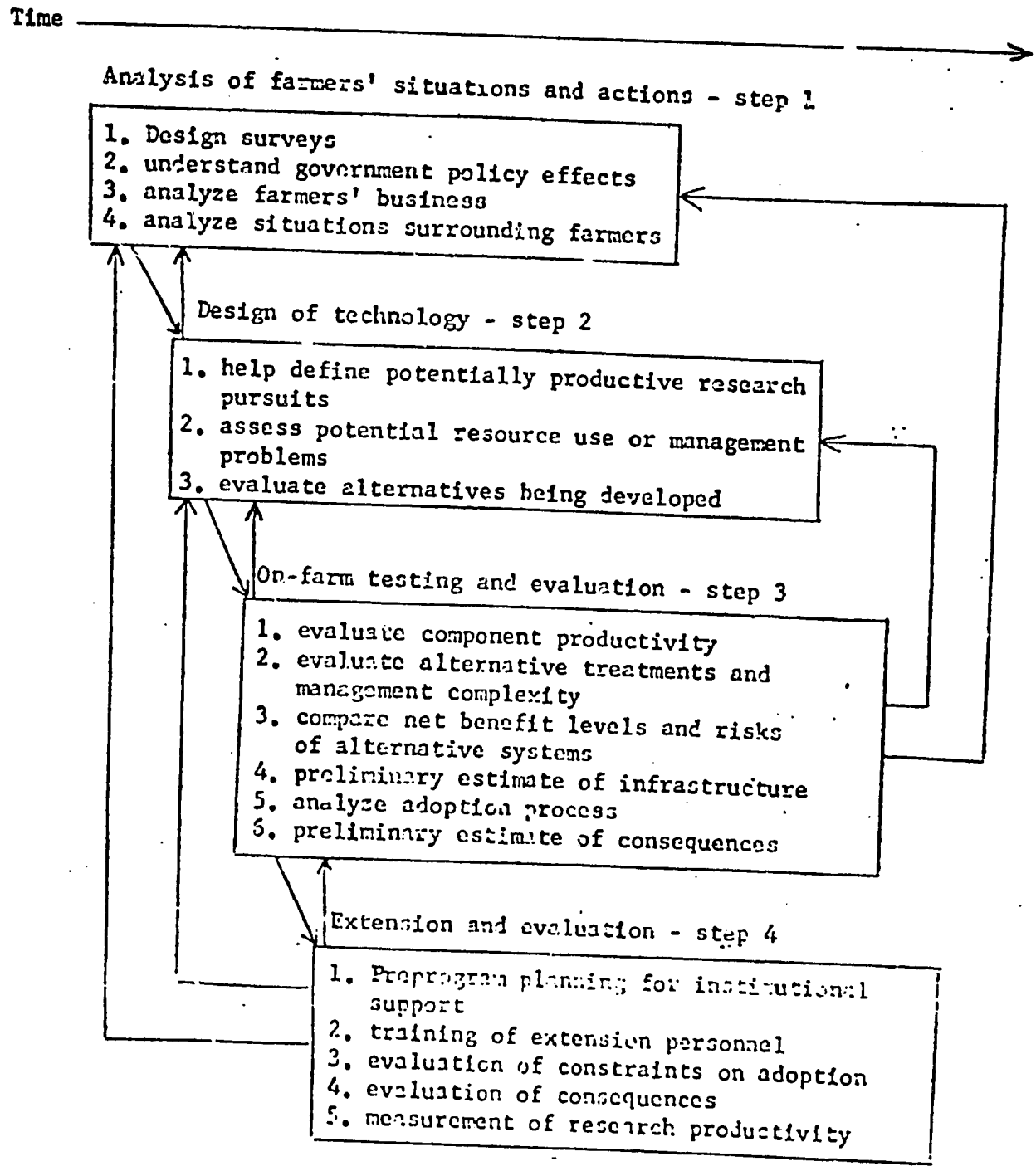
This process is not purely sequential nor does it always flow in one direction. The steps:

(1) overlap in that more than one should be undertaken at one time;

(2) interact in an iterative way such that results in one step may require going back to redo parts of previous steps.

An example of this interaction would be the situation where farm level testing showed the farmer could not manage the new cropping system properly because of commitments he had to other farm or nonfarm enterprises. This might entail further analysis of his environment (step 1) and redesign of new systems (step 2). See figure 1 for a summary of these steps.

Figure 1. Cropping System Research Program Process and General Contributions of Social Scientists[1/]



1/ These steps overlap in time and results in later steps may require going back to previous steps for further analysis.

Farm Level Testing Objectives

As previously stated, this paper is oriented toward an economic returns analysis of the farm level testing of new cropping systems. Further work on the factors associated with increased adoption of these systems, possible aggregate effects of more intensive cropping, and requirements these new systems may place on the institutions serving farmers is being done but will not be reported here. Besides these objectives, this farm testing step is utilized by the MCP as a way:

- to test cropping systems' performance under farmer management and compare this with traditional systems,
- to identify farmer problems with respect to cropping activities that require further research,
- to learn more about the farmers' situations and actions,
- to gain onfarm experience crucial to becoming effective trainers of personnel involved in wider technology diffusion.

The primary objectives in the village program step are testing and evaluation, in a broad sense, not the extension of technology. Therefore, the emphasis is on learning and analysis rather than extending packages of tested technology. In this case, the experience is not to be viewed as success or failure in terms of increased incomes of farmers, but the results are to be obtained to be considered in future research and development efforts.

Background Information the Farm Level Testing Step

Three villages in Chiang Mai province were chosen by the project for the farm level testing activities - Ban Han Kaew, Mue 1 Tambon Han Kaew, Amphur Hang Dong; Ban Mae Kung and Ban San Klang Nua, Tambon San Klang, Amphur Sanpatong. For the remainder of this report, these areas will be designated as Ban Han Kaew and Ban Mae Kung. The criteria used in selecting

these sites included adequate water availability, soil types representative of the Chiang Mai basin, a location which was close enough so that daily contact could be made by faculty (many of whom carried full teaching loads) and far enough so the impact of the Chiang Mai metropolitan area was not dominant.

A complete household census was taken to better understand family and population characteristics, economic conditions, agricultural production, and other variables useful for further intensive studies on cropping system adoption and consequences on the villages. Some of the relevant information gained from this survey for the farm testing activity included major and minor occupation categories, land use and tenure classes, cropping patterns and practices, non-farm incomes, and attitudes towards the MCP and new ideas in general. Slight over 70 percent of the individuals over 11 years of age indicated their major occupation was farming while 20 percent reported major occupations other than farming. Twenty five percent of the individuals said they had minor occupations which were not farming. Eighty-six percent of the households owned some land while 14 percent owned none. Forty-eight percent rented land. The mean and median for land used per household was 1.2 and 1 hectares respectively. The average and median land owned per household was 0.8 and 0.5 hectares respectively. The complete land size distribution by control category is given in Table 1.

Table 1. Land Size Distribution by Control Category

Land Size * (hectares)	Total Land Used	Land Owned	Land Rented
	(--------Percent of households--------)		
0	1.0	14.0	52.3
0 - 0.17	11.5	22.6	5.8
0.18 - 0.5	14.5	17.0	11.8
0.6 - 1.0	26.4	21.4	14.2
1.1 - 1.5	22.2	12.2	8.6
1.67 - 2.3	14.6	5.8	6.0
2.5 - 3.2	5.1	2.6	1.2
3.3 - 4.8	2.5	2.2	0
5 and above	2.1	1.8	0
		hectare per household	
Mean *	1.2	0.8	0.4
Median *	1.0	0.5	0

* rounded from rai figures

The common cropping patterns were glutinous rice in the wet season followed by either non-glutinous rice, tobacco, soybeans, chili, or peanuts. The average income was about 13,500 baht per year per household with 17-20 percent coming from nonfarm sources. About half of the farmers in these villages indicated they had tried new ideas in their farm business during the past cropping system. Near the beginning of the project the farmers were about equally divided as to whether they thought the new systems of the MCP could be successful for them. Therefore, the farm testing step of the MCP was done among farmers that had some nonfarm opportunities, had small farms, were used to growing two crops a year, and were about equally divided as to whether the new ideas would be useful to them.

During the time the baseline survey was being done, the project started the participant selection process by arranging a meeting through the village headmen with the farmers. The objective of the program was discussed with the farmers and certain cropping system alternatives were introduced. The farmers and project personnel jointly determined the systems to be tested. The criteria used for suggesting systems were; farmer's interest, economic performance in the experimental plots, and confidence possessed by the MCP staff on the technical feasibility of the systems when operated by farmers. In the first year of the program (1975/76), participants were selected that; wanted to grow a system the staff felt confident in, would devote at least 0.5 rai of land to testing the systems, were not too difficult to reach, and had reasonably good access to water throughout the year. In the second year, the criteria were expanded to include a wide distribution of the amount of land farmed per participant, income received, soil types, and age differences. In the second year, the land farmed per participant was about the same as the whole village, but participants had about 15 percent lower incomes than the average for the villages.

The participants grew the agreed upon systems under the supervision of the MCP staff. These observations are called T_2. The farmers had to provide all the inputs and market their products. The Project did loan farmers certain supply items if they were not available on the market but the loans were collected after each crop was harvested. If the farmers were concerned about yields or prices of certain crops, guarantees were made. However, this was not a common problem. Detailed input and output records were kept on each crop within the systems by local enumerators trained by the Project. These records were summarized and analyzed by the staff at the MCP office.

Records were also kept on non-participants to use as a basis for comparison with the new systems being tested. These observations are called T_1. Several nonparticipants were randomly selected to represent the traditional cropping systems performances.

Discussion of Results

Results are first given by individual crops which were included in the farm testing program. The outcomes of the MCP supervized participants are compared, when possible, to results achieved by farmers growing the crop but not working under the Project's supervision. Then, the systems grown by the participants are compared to traditional systems. The new systems for which there are adequate observations are as given in table 2.

Table 2. Cropping Systems Tested or Observed in the MCP Village Program in 1975 and 1976

System*			Remarks
Rice	Peanut	Tomato	MCP supervized - grown in both years.
Rice	Tobacco	Peanut	" - grown only in 1976/77 yea
Rice	Garlic	Sweet corn	" - " " " " "
Rice	Tomato	Rice	" - grown only in 1975/76 yea
Rice	Soybean	Ch. Cabbage	"
Rice	Tobacco		Traditional system
Rice	Soybean		"
Rice	Chili pepper		"

* The first crop listed is grown between mid July through mid November - rainy season. The second crop is generally planted in late November or early December and harvested in March or April - cool dry season. the third crop is usually planted in April or May and harvested in June or July - hot dry season.

Rice

The rainy season crop in each system whether traditional or new was rice. Chart 1 shows the categories of cost of production in baht per rai for each of three sets of observations. T_1 is used to denote rice grown by farmers on plots not in the testing program of the MCP. This is used to represent the traditional performance of farmers' rainy season rice crop. Actually these data may be somewhat biased since some of it was collected on plots of participants in 1975/76 cropping year that were seperated from the plots these participants devoted to the testing program. It was observed that some of these participants would adopt certain practices recommended by MCP on these non-testing plots. Therefore, the yields and net incomes of these observations may be upwards biased compared

to traditional performance. The set of observations labeled $1T_2$ are the results from the farmers' plots that were in the testing program for both 1975/76 and 1976/77 cropping years. The $2T_2$ observations represent data collected on rice production in the rainy season of 1976 only for the participants in the program.

As shown in chart 1, the labor cost per rai were essentially the same for the traditional (495 baht per rai) and new methods of producing rice (460 and 450 baht/rai). The major differences in cost were reflected in the supply category were MCP recommendations for fertilizer and insecticide use cost the farmers about 200 baht per rai compared with only 36 baht per rai supply costs for traditional methods. Equipment costs were higher for the observations on traditional practices than for the T_2 practices primarly due to higher percentage use of small two wheeled tractors in T_1 plots.

The total average cost of production per rai was 818, 925, and 896 baht per rai for T_1, $1T_2$ and $2T_2$ observations respectively. Labor costs accounted for the largest proportion of total costs for both sets of practices - 61 percent for traditional methods and 50 percent for the recommended practices. Supply costs were 22 percent of the total for the recommended methods and only 4.4 percent for the traditional practices. Equipment and land costs were about the same percentage for both.

Since farmers are also interested in cash costs, these are presented in chart 1 as well. The new methods used slightly over twice as much cash per rai as the traditional practices in growing rice. This is an important consideration for farmers that have little cash reserves to protect them from disastrous results such as crop failures.

The average yields of the three samples are given in chart 2. In the plots where farmers were advised by the MCP staff, yields were 22 percent and 34 percent higher than the T_1 plots.

With this information it is possible to calculate the cost of producing a kilogram of rice which is an important variable for setting policy on price supports or guarantees. Chart 3 presents this information. If one assumes paddy can be sold at 1.9 baht per kilogram, farmer using traditional methods on the average make a profit of about 65 satang per kilogram, paying themselves about 2.5 baht per hour and 200 baht per rai for using the land for 3-4 months. Since the T_2 methods increased the yield proportionately more than the costs of production as compared to T_1, the cost of producing a kilogram of rice was lower. This is one measure of productive technology; whether its application results in lower costs per unit of output and the T_2 methods on the average seem to pass this test.

These kinds of calculations are difficult to make correctly since the major production costs are labor and land (85 percent of the total for traditional practices). The prices to charge for these resources are largely noncash opportunity costs and can be quite different depending on the assumptions one makes. Therefore, the appropriate values for these variables are almost always argued among farmers and policy makers in setting guaranteed prices for agricultural commodities.

Chart 4 contains the comparison of net returns among T_1, $1T_2$ and $2T_2$ observations. Considering all costs, the 1976 rainy season rice grown under MCP staff supervision resulted in 55 percent higher average net returns per rai than did the rice grown by farmers without the Project's advice. However, if no labor or land costs are included, the average returns per rai for MCP supervized plots was only 21 percent higher.

The discussion thus far has been based on the averages for the observations However, farmers know that averages mask much valuable information about what the performance of the different methods of growing rice is. They are also interested in how variable the results might be, how often they might expect to lose money, and what amount they might lose if they do incurr a loss. We know farmers usually prefer methods that give higher means and smaller variance of results along with a low probability of losing money and a small expected loss. If they have a choice of methods that have equal means, they would want the one with a low variance. Therefore, the distribution of the net returns for each set of observations is also important. Chart 5 shows the frequency distributions of net returns for T_1, $1T_2$, and $2T_2$ observations. As was shown in chart 4, the means of the distributions are 430, 561, and 710 baht per rai respectively. The estimates of the standard deviation of the distribution for $1T_2$ indicates it has a larger variance than do the other two distributions. Statistical tests show that the average net returns per rai are significantly higher for the MCP supervised plots than for farmers plots. Moreover, the variance of the T_1 observation was significantly greater than the variance of $2T_2$ treatments. This indicates that the practices used in $2T_2$ plots not only yield higher net returns on the average, but also are less variable. This is another important characteristic that new technology must possess to be more acceptable to farmers, that is, to have higher net returns on the average as well as lower variance than the traditional practices.

Chart 6 presents a more-than-cumulative frequency distribution for each of three sets of distributions. These curves show the probability of obtaining more than the given net returns. For example, the probability of obtaining more than 400 baht per rai using T_1 practices is 50 percent, using

$1T_2$ methods it is 73 percent, and for $2T_2$ practices it is 83 percent. Looking at the figure in another way, it indicates tha ere is a 50 percent probability of achieving at least 400 baht per rai or more for T_1, 615 baht per rai or more for $1T_2$ and 720 baht per rai or more for $2T_2$.

Another interesting piece of information relates to the probability of losing money for each of the three sets of observations. This can be calculated by substracting the probability level at zero net returns from 100. For T_1, the probability of losing money is 18 percent. For $1T_2$ and $2T_2$ it is 11 percent and 0 percent respectively. Again, this indicates that farmers will be interested in the set of practices used in the $2T_2$ plots.

Farmers are not only interested in how often they might lose money, but how much they might lose if they do not cover their expenses. This is called the expected value of loss. For T_1 observations, the expected value of loss is about 190 baht per rai. For $1T_2$ observations it was 250 baht per rai.

The $2T_2$ observations have a higher probability of achieving more than any given net returns per rai than do the T_1 observations. This is called stochastic dominance. $1T_2$ is not stochastically dominant over T_1 nor is $2T_2$ over $1T_2$ since the curves cross each other at certain net return levels. For example, the probability of achieving over 400 baht per rai is less with $1T_2$ than T_1 and the probability of achieving over 1100 baht per rai is greater with $1T_2$ than $2T_2$. An inspection of the frequency and cumulative distribution functions for $1T_2$ and $2T_2$ indicates the MCP staff probably learned something about growing rice at the farm level between 1975 and 1976.

Many farmers and laborers may view the opportunity to work off the farm as an alternative to consider particularly in the dry seasons of the year. Research is just beginning in the MCP on the probability of obtaining

nonfarm work and the wages that are paid for that work. This opportunity cost for labor in nonfarm work is not known at this time. However, returns to labor in cropping activities must compete with these nonfarm wages and probabilities of employment. For the T_1 observations, labor returns were about 30 baht per day while they were approximately 35 and 40 baht per day for the $1T_2$ and $2T_2$ observations. Again, these calculations are rough estimates and must be viewed with some care because of the difficulty of estimating land costs and consequences of not producing the staple food of rice. However, it does appear that the new technology of producing rice allows farmers to earn higher wages than he might achieve in nonfarm work if he could find employment.

Another consideration is the cost of capital a farmer may have to pay as related to the returns he achieves from investing more capital. The cost of capital must include the interest rate a farmer must pay, other costs involved in getting the loan, and a risk premium he feels is necessary to protect himself from results he achieves being different from the results he observes in the MCP supervised plots. From our research on credit, we have found that the interest rate charged by the bank is 12 percent per year and by noninstitutional sources about 40 percent per year. However, to get loans for a short term a farmer must either have property collateral or be a part of a group. The real cost of credit then must reflect the money and time spent meeting these conditions as well as the interest rate charged. Suppose the real cost of credit for four months is 4 percent for the loan interest, 3 percent for traveling to and from the bank and a risk premium of 20 percent giving a total of 27 percent. Can the farmer pay this interest rate for cash for four months by increasing his cash expenditures from T_1 to $2T_2$ levels? The average results show that the marginal net rate of

returns from doing this are greater than 27 percent for the four month period. This results indicates that credit can be profitably used by farmers in moving from T_1 methods to $2T_2$ practices. Credit provision then becomes an important factor in technology adoption.

Peanuts

The peanut crop was grown in the cool dry season by 15 farmers supervised by the MCP staff in 1975 and 1976. Since there were not enough observations on traditional peanut cultivation in the villages of the MCP program, twenty five farmers growing peanuts under irrigation in the Chiang Mai valley were interviewed by MCP personnel and used as the T_1 sample. Chart 7 gives the cost of producing a rai of peanuts for both T_1 and T_2 observations. Labor costs accounted for 65 and 50 percent of the total costs for T_1 and T_2 respectively. The supply costs were significantly higher for the T_2 methods while equipment costs were almost the same. Due to higher labor costs, the total cost of production per rai for T_1 practices was about 18 percent higher than for T_2. However, if only supply and equipment costs are considered by farmers, it was only 18 percent cheaper to produce peanuts using the practices of the T_1 group. Therefore, the practices recommended by the MCP did not require substantial increases in cash costs.

The average yields of the two samples are shown in chart 8. There was no significant difference in the yields between the two groups of observations.

Average net returns achieved by the farmers in T_1 and T_2 groups are given in chart 9. Considering costs of labor, supplies and equipment (not land), the returns for the farmers supervised by the MCP were 191 percent higher than T_1 farmers. However, if labor costs are not considered, the net returns per rai for peanuts are essentially the same for T_1 and T_2 alternatives.

The frequency distributions of net returns for peanuts are given in chart 10 for T_1 and T_2. As noted previously, the average net return per rai is much higher for T_2 than T_1, but because the variances of the net return distributions are so high, there was not a statistical difference between the averages. There is obviously no difference in variances either. These wide distributions of net returns are a direct reflection of the extreme variability in yields and costs of production of peanuts. This is one indication that peanut varieties are not well adapted for this area. Farmers do not have a wide selection of peanut variaties to choose from for planting in different soil and/or water conditions. Breeding programs to develop more adaptable varieties of peanuts are needed.

Chart 11 presents a more-than-cumulative frequency distribution for both T_1 and T_2 farmers. The T_2 curve is not quite stochastically dominant, but is nearly so. The probability of receiving less than zero net returns (counting labor costs) is 27 percent for T_2 and 54 percent for T_1. Therefore, the new technology of T_2 seems to be less risky than traditional practices counting labor costs. The expected value of loss, however, is greater for T_2 compared to T_1-310 baht per rai and 256 baht per rai respectively. This indicates that the probability of losing money is less with the new technology, but if a loss is incurred, it would be larger than the expected loss using traditional practices.

The farmers paid tehmselves on the average about 23 baht per day for their labor in this second crop of peanuts. This indicates that as nonfarm job opportunities become more available and labor opportunity costs increase, farmers might prefer to work off the farm rather than grow peanuts. Farmers are not likely to be willing to borrow money and risk losing cash on the T_2

methods of producing peanuts since there was no significant difference in the mean net incomes. More observations on this point need to be made to see if the variances of the T_1 and T_2 samples are representative of the population.

Tobacco

Research on tobacco is relatively new to the MCP but it was included in the farm testing systems since it was a popular crop with farmers. Farmers generally care for tobacco well and utilize fertilizer and other recommendaed practices. The expectation of the project staff was that the farmer supervised plots would probably not be significantly better than the farmers plots that were not supervised. Chart 12 shows the production costs for tobacco on T_1 and T_2 plots. There were only seven observations in the two village areas for each. Labor costs were much higher on the T_1 plots and accounted for 47 percent of the total cost of production compared to 37 percent for T_2 farmers. However, supply and equipment costs per rai were higher for farmers plots in the T_2 sample than for the T_1 fields. The total costs of producing tobacco was almost the same for both samples. Not counting labor and land costs, the cost of producing a rai of tobacco was about 21 percent higher for the T_2 practices.

The average yield achieved in the T_1 sample was about 15 percent higher than the T_2 sample as shown in chart 13.

Average net returns counting all costs of production were almost equal between the two groups. However, by not counting labor or land costs, the net returns per rai for the T_1 sample was about 17 percent higher than the T_2 group. The small number of observations does not allow one to make meaningful tests regarding the statistical significance between the samples. If the MCP is to generate substantially more profitable technology for tobacco than farmers already have access to, more research will be required.

Garlic

Garlic was planted after sweet corn in the second year of the farm testing program by six participating farmers. While this crop is not particularly common among farmers in the testing villages, it is an important cash crop in the Chiang Mai valley. The MCP staff had been doing research on garlic trying to better understand disease problems and proper bedding practices. When satisfactory answers were found to these problems, the crop was given to farmers as an option for the cool season in 1976/77.

Chart 15 gives the costs of production for the six sample points observed. Supply costs are the predominant category accounting for over 70 percent of the total cost of production not counting land costs. The average yield was satisfactory at 1,389 kilograms per rai. However, the price obtained was only 2.66 baht per kilogram compared to 5.83 baht for the year before. Therefore, the net returns were lower than might be expected at 648 baht per rai not counting land costs and 1134 baht per rai not costing land and labor. This data is shown in chart 16.

Thirty three observations were made on farmers growing garlic in the Chiang Mai valley in the 1975/76 cool season by the research staff in the MCP. These were to be used, among other things, for comparison with the supervised farmers in the testing program. However, the variances of net incomes were so large that the sample was of little use for comparison purposes. Even the six observations of the farmers working with the Project were widely spread. The coefficients of variation were 96.32 and 1.46 for the large sample and farmer participant sample respectively. This indicates that the standard deviations were 9,632 percent of the mean for the Chiang Mai valley sample and 146 percent of the mean for the MCP farm testing group.

Since the mean of the 33 observations was only 2.00 baht per rai, the coefficient of variation could be potentially large and it was. The range was from -2,905 baht per rai loss to 4,030 baht per rai profit. The farmers participating with the MCP had net incomes ranging from -919 baht per rai loss to 1,735 baht per rai profit. Besides the disease problems and costs and yield variances, garlic prices can change significantly from year to year as well. All of this indicates that garlic is a very risky crop. That it continues to be grown in large areas means that farmers are willing to handle those risks in some way for the potential of a large gain. Research to reduce these large variations would be quite valuable for this region. Recording data on garlic growing over time is particularly important to see if these two years were for some reason not representative.

Tomatoes - Cool dry season

The cool dry season is the usual time for growing tomatoes in the Chiang Mai valley. Since research at the experimental plots showed that this crop offered good potential in terms of net incomes, it was included in the farm testing program. Chart 17 illustrates the average cost of producing a rai of tomatoes experienced by five farmers in Mae Kung during the 1975/76 cool season Labor and supply costs combined made up 80 percent of the production costs.

The average yield obtained was 1,426 kilograms per rai which was sold at an average price of 1.6 baht per kg. However, the range in yield and prices experienced by the farmers supervised by the MCP staff was wide. Yields varied from 672 to 2633 kg per rai. Prices obtained ranged from 0.67 to 2.63 baht per kg. The main strategy for growing tomatoes in this season is to plant and harvest them as soon as possible to avoid the large decline in prices that occur as the main crop is being sold. This is one advantage to having a

shorter duration rice variety before tomatoes and being able to prepare the land quickly for tomato production.

Chart 18 gives the average net returns per rai calculated two ways. This crop holds potential for further extension if farmers can manage disease problems and plant early. However, the risks are relatively great considering the high cash costs involved and the market and disease problems. If these net returns are representative of the experience farmers would obtain, they could easily borrow the money to pay for the supply costs, interest rate and a high risk premium.

Soybeans

Soybeans is one of the main crops in lowland irrigated areas of Northern Thailand. There were a total of 21 plots of soybeans grown by farmers under the supervision of the MCP staff in the two cool seasons of 1976 and 1977. Farmers' traditional practice for growing this crop is to plant in the rice stubble with little land preparation. Since we were not certain of the value of making beds for soybeans, two seperate sets of MCP supervised practices were done consisting of planting in rice stubble with improved methods and bedding with improved methods. These are called $1T_2$ and $2T_2$ respectively. Forty observations were taken in the Chiang Mai valley to determine traditional cultivation results for soybeans - T_1. Chart 19 gives the cost of production for these three methods in baht per rai. Labor costs do not seem to be greatly different although equipment and supply costs were greater for the bedded method - $2T_2$. The total costs of production, not [illegible] land costs, were about [illegible] percent less for traditional practices than for the $2T_2$ observations. However, the improved non-bedding methods were only 20 percent more expensive. If labor costs are not considered, both $1T_2$ and $2T_2$

farmers incurred substantially higher costs. Traditionally soybeans are quite inexpensive to grow in terms of cash costs.

The yields of the three sets of observations are given in chart 20. The non-bedding improved practices yield was over 40 percent higher than traditional yields. The average price received was 81.41 baht per tang. Net returns per rai including all costs except land were highest for the $1T_2$ observations - 62 percent more than T_1 and over twice the $2T_2$ practices. It appears that bedding for soybean production is not profitable when analyzing the crop in isolation of the system in which it is placed. However, if a crop following soybeans requires beds of the same size and shape, all of the costs of bedding for soybeans should not be charged to one crop only. Research is in progress at the experimental plots to ascertain how land preparation and other practices interact throughout the system. Net returns per rai considering only cash costs are again substantially higher for the non-bedded improved practices as compared to the other two sets of observations.

The frequency distributions of net returns are shown in chart 22. The means are significantly different between T_1 and $1T_2$ observations at the 4 percent level of significance. Obviously, the $2T_2$ methods are not appealing to farmers since the mean is lower than the other alternatives and the variance is not smaller.

Chart 23 gives the cumulative frequency distributions of the observations. The $1T_2$ curve is nearly stochastically dominant except above 900 baht per rai levels. The probability of losing money is about 25 percent for the T_1 observations while no losses were observed in the $1T_2$ group. Additional observations are required to make more meaningful conclusions

regarding traditional non-bedding methods versus MCP recommended non-bedding practices.

The additional requirement of cash for $1T_2$ methods is about 170 baht per rai higher than for T_1 practices. Could farmers borrow this additional money and pay for the interest rate charged by the bank and a risk premium of 20 percent? If these observations are representative of what would happen, the answer would be yes. Again, credit provision for the new technology for soybean production would be important.

Both T_1 and $1T_2$ observations indicate soybean production pays farmers competitive wages for their work. However, if farmers have the opportunity to earn more than 30 baht per day, they might not choose to grow soybeans in the traditional way since the returns to labor were only 32 baht per day.

The $1T_2$ methods of growing soybeans appear to possess potential for further extension to farmers. More farmer managed $1T_2$ observations should be made to validate this potential.

Tomatoes - Hot dry season

Tomatoes were included in the cropping systems during the hot dry season to take advantage of the higher prices usually prevailing at harvest time. In order to successfully grow tomatoes during this time, a new variety was developed at the experimental plots from material received from AVRDC in the Republic of China. As can be seen from chart 24, the cost of producing a rai of tomatoes was somewhat higher compared to most other crops. Labor accounted for slightly over ½ of the total costs with supply costs being about 30 percent. Cash costs were also substantial in comparison to many other crops.

The average yield of 910 kilograms per rai achieved by the eight farmers testing hot season tomatoes was quite good considering the lack of familiarity with the crop during this time. The average price received in the open market was 4.8 baht per kilogram - about 4-5 times the average price during the main producing season.

Net returns from this crop were substantial as shown in chart 25. While only eight observations are too few from which to make firm conclusions, some tentative points can be discussed. First, the experience of the project was that good quality disease free seedlings will be difficult to produce and distribute on a wide scale for quite some time. Secondly, this crop is relatively risky in terms of yield and within year prices. These values for the eight observations are given in table 3. If farmers can learn to identify and manage disease problems and obtain good quality seedlings of the new variety, hot season tomatoes can contribute substantially to their dry season income. More observations are being made on this crop's performance this year and it will be grown next year in the farm testing program also. In addition, research is being done on the expected price declines that might be accompanied by the increased production of tomatoes as well as other fresh vegetables.

Table 3 Hot Dry Season Tomatoes

Observation	Yield per rai (kg)	Price (bht/Kg)	Net return per rai all costs (Baht)
MK 4	589.79	5.91	1,950.96
MK 1	33.96	6.00	- 839.66
HK 1	1,345.76	3.11	3,102.95
MK 8	666.66	5.23	1,847.47
HK 4	1,371.91	4.48	4,796.74
HK 4-2	817.96	4.44	2,651.56
MK 8-2	1,110.20	2.33	1,514.87
MK 23	1,345.24	6.88	7,294.13
upper - lower	1,371.91 - 33.96	6.88 - 2.33	7,294.13 - -839.66

Peanuts - hot dry season

The peanuts grown by farmer participants in the 3rd season followed a tobacco crop. Chart 26 gives the break down of the average production costs per rai for the seven observations. Labor accounted for 65 percent of the cost with supplies and equipment contributing 11 and 4 percent respectively. The average yield achieved was 27.13 tang per rai of unshelled peanuts.

Chart 27 presents the average net returns for the sample. Counting all costs, the net return was only 57 baht per rai. If only supply and equipment costs are considered, the net return per rai was 801 baht. This indicates that peanuts grown in this hot dry season can provide farmers with returns that pay him about 2.5 baht per hour and cover his other costs of production with little left over. However, if he has no alternative for his labor that pays more than 15-20 baht per day, it is economically advantageous to grow peanuts. Since labor constitutes such a large percentage of these production costs, it is important to know what the opportunity costs are for a farmer and how he values having some leisure time during this hot season. Farmers would not, on the average, be willing to borrow money for growing peanuts since the net returns are too low to cover the real interest rates and risk premiums they would place on not wanting to lose the money.

Sweet corn

Sweet corn was grown in the hot dry season and followed garlic on six farmers' plots that were supervised by the MCP staff. This crop was not familiar to the farmers and is not widely grown in areas around these villages so no farmer traditional observations were obtained with which results could be compared. Chart 28 illustrates the cost categories incurred by the farmers.

Again, labor costs are dominant and constitute 61 percent of the total. Total costs were 848 baht per rai while the out of pocket costs were only 217 baht per rai.

The net returns per rai were reasonably good considering the lack of experience of the farmers in growing the crop. The average yield was 2,837 kilograms per rai which was sold on the market for about 0.4 baht per kilogram. There were some marketing problems with product quality for two farmers. While the production technology for sweet corn appears to be good, the major problem involves the market for the new variety used. While the food processing firm in Lamphoon will buy the sweet corn, the acceptability on the fresh market is still somewhat uncertain. However, sweet corn does appear to offer promise as a good cropping alternative for the hot dry season. More data is needed to analyze the variance in yields, net returns and market acceptability.

Comparison of Crops

The Project and farmers are not only interested in comparing traditional and newer ways of growing the same crop but also how crops compare with one another on several criteria. Table 4 shows the crop rank and values for seven criteria on profitability, input use, and risk factors. These data should be considered preliminary as some crops had limited observations.

Profitability criteria include net returns calculated by including all costs except land and all costs except land and labor. Tomatoes and tobacco were the most profitable crops by these criteria. Rice grown by farmers supervised by the MCP also ranked in the top third. Soybeans, garlic T_2, rice T_1 and sweet corn were in the middle of the ranking by net returns not including land costs. All peanut observations -T_2 and T_1- were among

Table 4 Crop Rank by Selected Criteria

Profitability				Input Use				Risk Factors					
Net Returns not counting land cost		Net Returns without land and labor cost		Cash Costs		Labor Use		Standard deviation of net return		Coefficient of Variation of net return		Probability of loss	
Crop	Net Return	Crop	Net Return	Crop	Cost	Crop	Cost	Crop	S.D.	Crop	C.V.	Crop	Prob.
	(฿/rai)		(฿/rai)		(฿/rai)		(฿/rai)						(%)
Tomato T_2 hot dry season	2093	Tomato T_2 hot dry season	3591	Garlic T_2	2524	Garlic T_1	1022	Tomato T_2 hot dry	2266	Garlic T_1	81900	Peanuts T_1	55
Tobacco T_1	1500	Tobacco T_1	2496	Garlic T_1	1607	Tobacco T_1	977	Tomato T_2 cool	1652	Peanuts T_1	441	Garlic T_2	33
Tobacco T_2	1410	Tobacco T_2	2127	Tobacco T_2	1123	Tobacco T_2	754	Garlic T_1	1639	Peanuts T_2	147	Sweet corn T_2	33
Tomato T_2 cool season	1156	Tomato T_2 cool season	1807	Tobacco T_1	928	Tobacco T_2 hot dry	699	Garlic T_2	946	Garlic T_2	146	Peanuts T_2	27
Rice T_2	900	Rice T_2	1357	Tomato T_2 hot dry	533	Tomato T_2 cool season	651	Tobacco T_2	935	Tomato T_2 cool	143	Tomato T_2 cool	20
Soybeans T_2	737	Garlic T_2	1134	Tomato T_2 cool season	466	Peanuts T_1	641	Tobacco T_1	728	Sweet corn T_2	125	Rice T_1	18
Garlic T_2	648	Rice T_1	1126	Peanuts T_2	421	Peanuts T_2 hot season	574	Sweet corn	563	Peanuts T_2 hot season	84	Garlic T_1	15
Rice T_1	620	Garlic T_1	1024	Peanuts T_1	346	Sweet corn T_2	515	Peanuts T_1	454	Tomato T_2 hot season	76	Tobacco T_2	14
Soybeans T_1	456	Soybeans T_2	1015	Sweet corn	277	Rice T_1	496	Peanuts T_2	440	Tobacco T_2	66	Tomato T_2 hot season	12.5
Sweet corn T_2	451	Sweet corn T_2	965	Soybean T_2	264	Garlic T_2	486	Rice T_1	326	Soybean T_1	66	Rice T_2	
Peanuts T_2	300	Peanuts hot dry	801	Rice T_2	254	Rice T_2	450	Soybeans T_1	302	Rice T_1	61	Tobacco T_1	
Peanuts T_2 hot dry season	277	Soybeans T_1	783	Peanuts hot season	138	Peanuts T_2	416	Rice T_2	272	Tobacco T_1	49	Soybeans T_1	0
Peanuts T_1	103	Peanuts T_1	746	Rice T_1	123	Soybeans T_1	326	Soybean T_2	226	Soybean T_2	31	Soybeans T_2	
Garlic T_1	2	Peanuts T_2	716	Soybeans T_1	110	Soybeans T_2	278	Peanuts hot dry	191	Rice T_2	30	Peanuts hot season	

the lowest average net returns. Garlic T_1 was ranked at the bottom in the first profitability criteria, but the observations on this crop were so variable, the average may be less meaningful. If one does not consider land and labor costs, garlic T_1 ranked 8th out of 14 crops. For this second profitability criteria, garlic is ranked higher and soybeans and peanuts are less attractive.

Input use is evaluated by cash costs and labor use criteria. Garlic, tobacco, and tomatoes have relatively high cash cost and labor requirements. These crops are much more expensive per rai to produce than rice, peanuts and soybeans. Peanuts are ranked in the middle third in terms of cash costs and labor use while rice and soybeans tend to have smaller cash and labor requirements.

Risk criteria include the standard deviation of net returns, coefficient of variation of net returns, and the observed probability of not covering labor, supply, and equipment costs. Additional relevant measures for risk would have been net returns over time to be combined with returns over space as reported in this paper. Data was obtained that gave time series information, but its validity was seriously questioned. More statistical work must be done to collect time series data on yields, costs, and returns for the major crops in northern Thailand. This kind of data would allow one to observe the influence of weather and yearly price changes on net income variation.

Tomatoes, garlic, and tobacco have the highest variances in net returns with peanuts, rice, and soybeans exhibiting substantially less variability. Variance is a measure of absolute variation so crops with higher net returns would tend to have higher variances. The coefficient of variation is a measure of the percent variation the standard deviation is of the mean.

This measure is difficult to interpret comparatively as well since crops with low means tend to have higher coefficients of variation (C.V.). The garlic crop grown by farmers in the Chiang Mai valley -T_1- had a large C.V. because the mean net return was only 2 baht per rai. However, the net return standard deviation of the T_1 garlic observations was high as well. Peanut net incomes varied substantially from their means for both T_1 and T_2 observations. Again, rice and soybeans rank near the bottom on this risk criteria as well.

The observed probability of not being able to pay all labor costs, supply expenses, and equipment charges was quite high for peanuts grown by traditional methods. Garlic, sweet corn, peanuts T_2, and cool season tomatoes had very few observations so the reported probabilities of losing money are subject to wide errors. Rice and soybeans again tend to be ranked low.

A simple average of the ranks for risk criteria reveals that garlic T_2 and T_1 ranks highest followed by peanut T_1, cool season tomatoes, and sweet corn. The middle third of the average ranks includes peanuts T_2, hot season tomatoes, tobacco T_2 and T_1 and rice T_1. The least risky crops by these combined criteria are soybeans T_1 and hot season peanuts followed by rice T_2 and soybeans T_2.

An inspection of table 4 shows why rice is a popular crop for economic reasons. It ranks in the middle of the profitability criteria, requires little cash costs comparatively and is one of the least risky crops. The methods suggested by the MCP personnel for growing rice and applied by farmers in the test villages has higher net returns and is less risky than rice T_1. Therefore, these practices appears to have substantial potential

for extension.

Soybeans T_2 also appears to offer promise. This crop has an above average ranking on profitability, utilizes relatively little labor and cash costs and ranks low on the risk scale.

Tomatoes and garlic are characterized by high potential returns, high cash and labor requirements, and high risk. The latter two factors account for the smaller areas farmers are willing to plant to tomatoes. More information is needed on these crops over time

Tobacco rankings reveal why that crop tends to be popular. It has potential for high net returns but the risks are relatively low. Farmers, then, are willing to invest substantial cash costs in its production.

The observations on peanuts for these two years indicate that this crop does not compare very favorably with alternate crops. It may be grown in areas of lower fertility and more variable conditions where other crops would not do as well. However, it appears as if peanuts would not compete well with other crops in areas with good irrigation and soil fertility.

System comparisons

The number of observations on total systems is small so the discussion of these results will be somewhat more limited than for the individual crops. Five cropping systems have been grown by farmers under the MCP supervision while data has been collected on four traditional systems. Table 5 gives the net returns by system for the nine sets of observations.

The rice-peanut-tomato T_2 system had by far the highest net returns per rai of any of the systems. This was due primarily to the highly

profitable tomato crop in the hot dry season. If a more profitable crop could replace peanuts in the cool season and be compatible with the following tomato crop, this system's already high net income might be improved substantially depending on the carry-over effects of the legume. Since tomatoes have high cash and labor requirements as well as being somewhat risky, alternative crops should be suggested for the hot season if this system is to be adopted on large areas by farmers. While this system does have substantial promise for extension to farmers, credit provision would need to be made along with arrangements for seedling production and distribution.

The rice-tomato-peanut T_2 system ranked 2nd in profitability primarily because of the tomato crop in the cool season. In addition, the cash cost requirements are low. Short duration rice varieties must be grown so that the cool season tomato crop can be harvested before prices fall. If a hot season crop could be substituted for peanuts, this system's performance could be improved substantially. However, water requirement would be a key criteria this third season crop as many areas in the Chiang Mai valley lack dependable water supply during this time. Peanuts may be an appropriate choice for certain areas with more sandy soils and irregular water availability. This system is relatively risky due to tomato disease and price problems, but careful management can reduce these risks substantially.

The rice-garlic-sweet corn system ranked 3rd or 4th in the nine systems depending on which net return criteria is used. Since this system shows substantial promise, further farmer testing is being done by the Project. Sweet corn technology appears to be good and can be managed by farmers. More research and experience is needed on the market problems that might accompany substantial sweet corn production. Credit provision is important for the

garlic crop with its high cash requirement.

The rice-tomato-rice system tested by the Project in 1975/76 had lower returns than expected because two of the three hot dry season rice crops failed from lack of water. Even with those failures that system did rank 4th or 5th. For areas that have reasonable water supply in the hot dry season, this system would be attractive especially since the traditional rice-rice system would be only slightly altered by growing a shorter season first crop and placing a tomato crop immediately after.

The rice-soybean-chinese cabbage system ranked relatively low due to the performance of chinese cabbage. The first two crops in this system are among the least risky of all crops observed and have low cash and labor requirements. If more profitable hot dry season crops can be developed that are compatible with soybeans, this system could be quite attractive to farmers in terms of labor and cash cost requirements and risk considerations.

Of the traditional systems, the rice-tobacco alternative is the most attractive followed by rice-chili peppers and rice-soybeans.

The total labor requirements of the MCP systems as grown by farmers are not substantially larger than the labor used on the traditional systems observed. Rather than requiring more labor, the newer systems tend to spread labor requirements over the year more evenly. The traditional systems generally require 50 percent less cash costs than do the systems grown under MCP supervision. The average net returns to the traditional systems is 59 percent less than for the farmer tested MCP systems.

The above averages can be easily mis-interpreted since comparative net returns must be made on certain specific farms and areas. What is

best economically for an individual farmer depends on a number of factors this can best be determined by developing farm level analysis using farm management techniques.

Table 5 Comparison of Systems by Selected Criteris

System	Net returns/ rai not counting land	Net returns/rai not counting land and labor	Cash cost	Labor use
New systems	(---------- baht/rai	----------	----------	)
Rice-peanut-tomato	4,093	5,739	1,208	1,565
Rice-tomato-peanut	2,283	3,965	858	1,675
Rice-Garlic-Sweet corn	1,999	3,456	3,055	1,451
Rice-tomato-rice	1,863	3,374	974	1,551
Rice-soybean-chinese cabbage	1,772	2,760	718	1,138
traditional systems				
Rice tobacco	2,120	3,622	1,051	1,493
Rice chili pepper	1,743	3,068	1,023	1,036
Rice soybeans	1,076	1,864	233	822
Rice peanuts	723	1,872	544	1,137

Labor use among systems

One of the ways to estimate how the new systems might fit into farmers traditional cropping patterns is to look at the use of labor over time among systems. Most farmers will not adopt the new three-crop-a-year systems on the whole farm area. Usually the new systems will be allotted a certain part of the farmers land while the rest will be devoted to systems with which he is more familiar. Therefore, the question is not simply can farmers successfully grow three crops a year but whether 3 crop systems can be managed on the same farm as traditional 2 crop systems.

Chart 30 shows the labor profile for two systems - a rice - peanut - tomato new system and a popular rice-tobacco traditional system. Labor use by week in man hours per rai are shown for the entire year. These labor profiles are averages of several observations and hence tend to even out the peaks individual families might experience. Taking the systems seperately, it is obvious that the new rice-peanut-tomato system extending over one year and would cause the following rice crop to be delayed. This was primarily due to the peanut crop taking longer to mature than was expected because of abnormally cool weather during the flowering stage. This is another reason for more research on peanut varieties. However, for the other systems tested in the villages farmers were able to complete them within the cropping year and the rice-peanut-tomato system was completed for this year.

The combination of the two systems on the same farm shown in chart is interesting in terms of possible labor constraints at certain times of the year. The rice variety used in the more intensive system was a shorter duration variety which allowed earlier peanut and tomato plantings. This illustrates the importance for intensive cropping patterns of having shorter season rice varieties. The variety used in the new system was being harvested in the 18th - 20th week after nursery preparations. Land preparation and peanut planting was being done in weeks 22 through 26. In the traditional rice-tobacco system, we found that the rice was being harvested in the 21st through the 25th week which was precisely the time farmers would be preparing land and planting peanuts. This was a problem for certain participant farmers as they were trying to harvest their traditional varieties of rice at the time we were advising them to begin land preparation for the second crop of a three crop system. The development of small equipment in harvest and land preparatio activities becomes important in this situation.

Another interesting analysis involves the amount of family labor available for working in cropping activities and the size of farm. Suppose the farm size is 6 rai - the median in the villages of the MCP testing program - and there are 2.5 adult equivalents for working in cropping activities per farm. The average family is slightly under 5 people. If one considers 40 hours per week as full time for working on cropping activities then in this situation there would be 100 hours of family time available for the week. With 6 rai, this would mean there are 16.7 hours of labor per rai per week from the farm family. This level of labor is labeled A in chart 30. This situation would require substantial hired labor in rice harvesting, peanut land preparation, planting and harvesting and in almost all of the tomato crop activities. Obviously, 6 rai of tomatoes is more than would normally be grown and the hired labor requirement is one reason. The traditional system would require hired labor in rice harvest and much of the tobacco work.

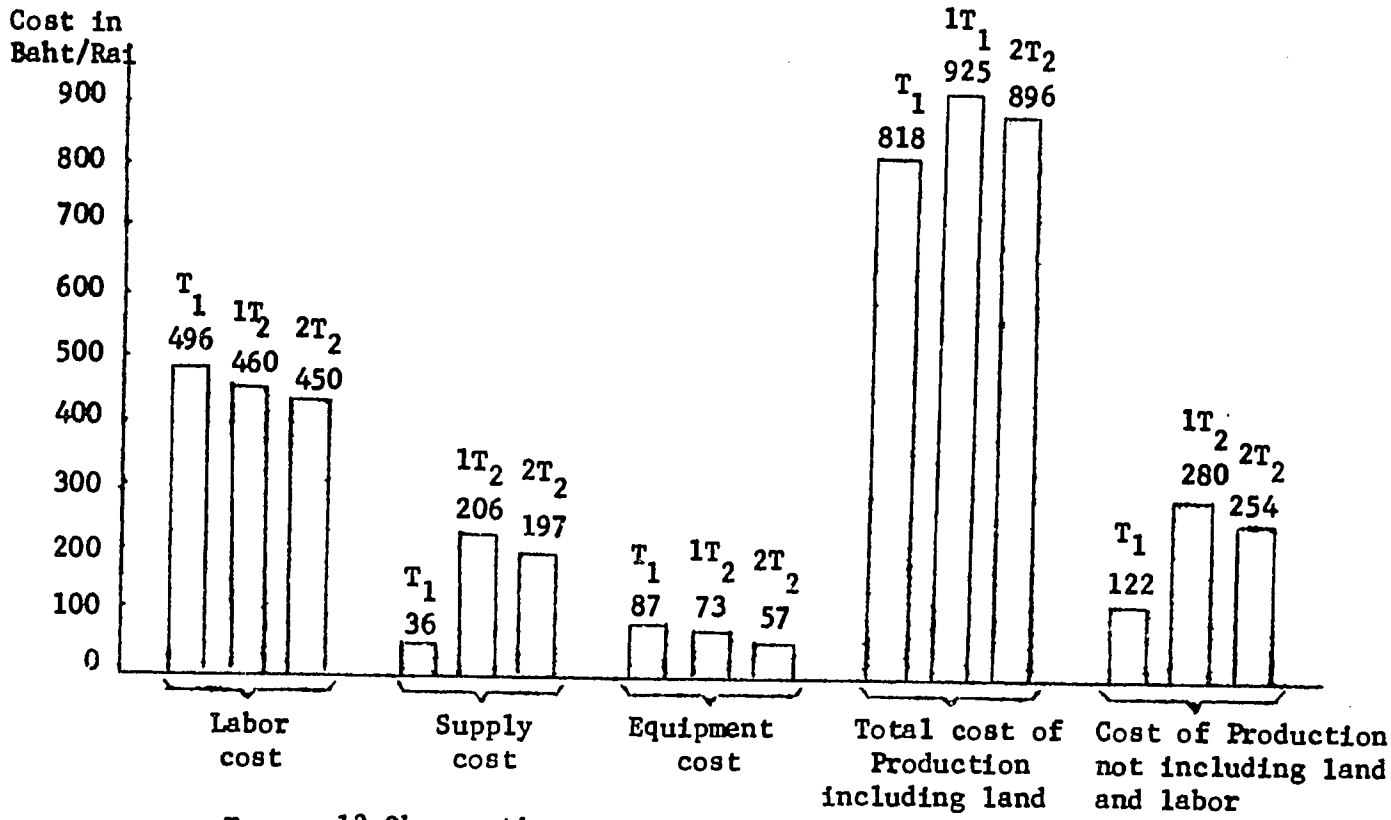
Situation B represents a small farm of 4 rai with 2.5 adults available for cropping activity. The number of times hired labor would be necessary are not reduced substantially, but the amount required would be less. The line labeled C represents a larger farm of 8 rai with 2.5 adult equivalents working full time at 12.5 hours per week per rai. In this case substantial labor would be required from rice harvest on through the tomato crop in the new system. Even the traditional system of rice-tobacco would need non-family labor for many weeks up through later March. The small farm sizes existing in these villages reflect, in part, the labor intensive nature of many cropping activities. It may be that small farm sizes have resulted partly by design reflecting labor needs and management complexities occurring on farms over 7-8 rai.

Conclusion

The farm testing activities have been necessary to accomplish the MCP goal of developing more productive cropping systems that could be adopted by farmers. Without these farmer managed system tests, our research productivity would be severely impaired.

Several interesting observations on constraints were made during these tests. A few of the important problems were as follows. Water scheduling and control at the farm level are crucial problems to be solved before more intensive and diversified cropping can be adopted. An equally important constraint is the availability of quality seed for all crops. A high quality tomato seedling distribution system will be crucial if this profitable crop is to be successfully grown by farmers. Tenure security for the entire year was also a problem with some farmer participants. If a farmer renting land can not be assured of having control thoughout the year, crop system planning will be impaired. Labor bottle-necks are also important between the rice harvest and second crop planting when farmers grow longer season first rice crop varieties. Development of a shorter season glutinous rice variety that is acceptable to rural people's taste is an important requirement for more intensive cropping system adoption.

Chart 1 Cost of Production of Rainy Season Paddy in Ban Mae Kung and Ban Han Kaew in 1975 and 1976.



T_1 = 12 Observations

$1T_1$ = 48 Observations - 1975 and 76 rainy seasons

$2T_2$ = 26 Observations - 1976 rainy season only

Chart 2 Yields of Rainy Season Paddy in Ban Mae Kung and Ban Han Kaew in 1975 and 1976

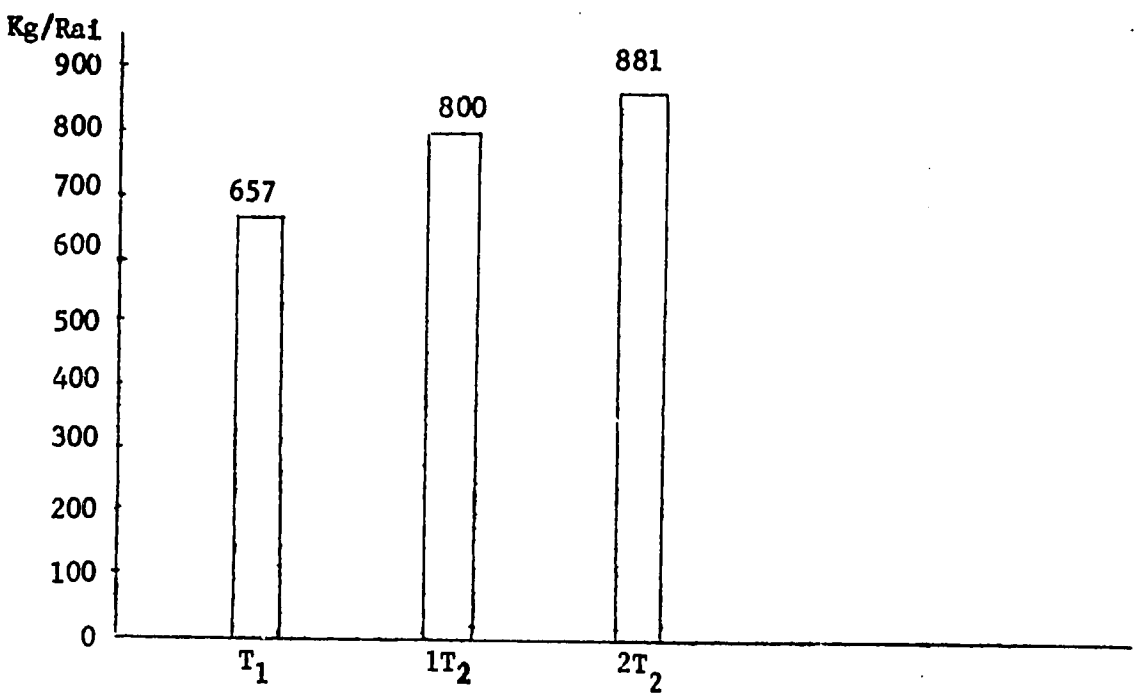


Chart 3 Cost of Producing a kilogram of Rainy Season Paddy in Ban Mae Kung and Ban Han Kaew in 1975 and 1976.

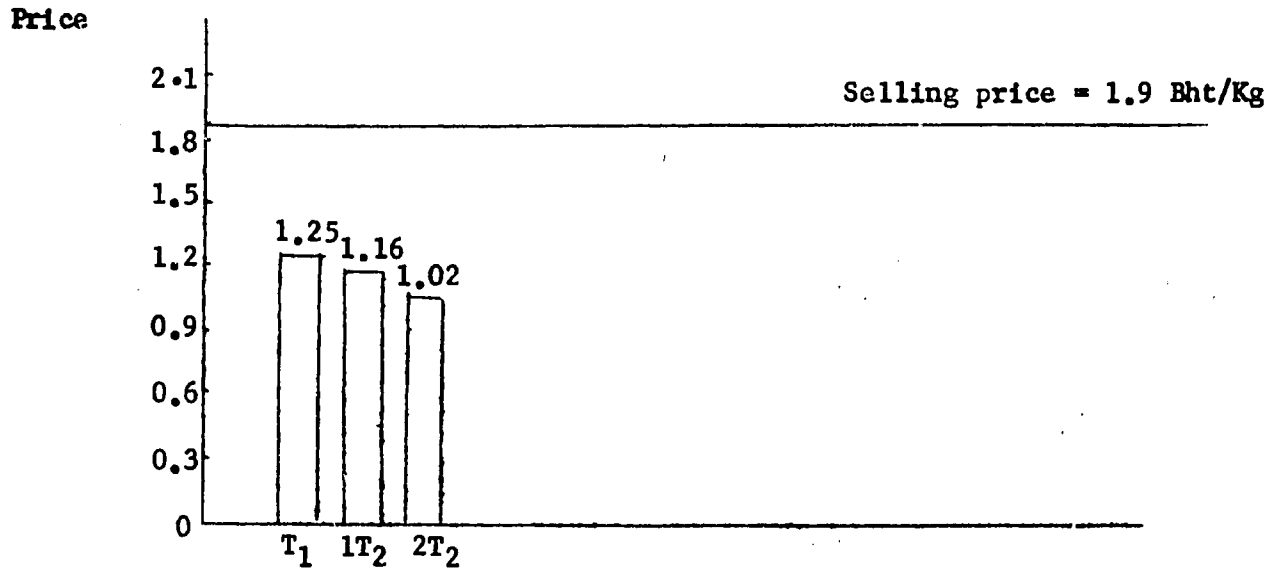


Chart 4 Net Returns per Rai of Rainy Season Paddy in Ban Mae Kung and Ban Han Kaew in 1975 and 1976.

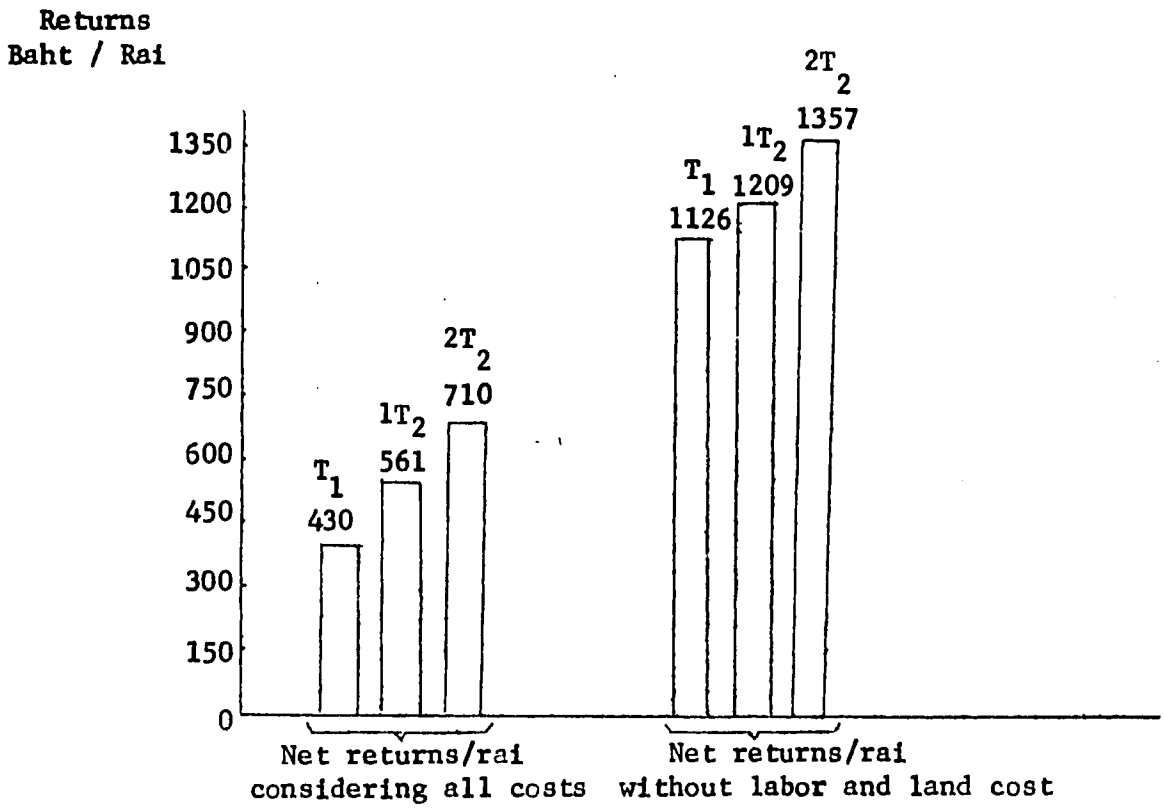


Chart 5 Percent of Observations Falling within Net Returns Intervals for Paddy

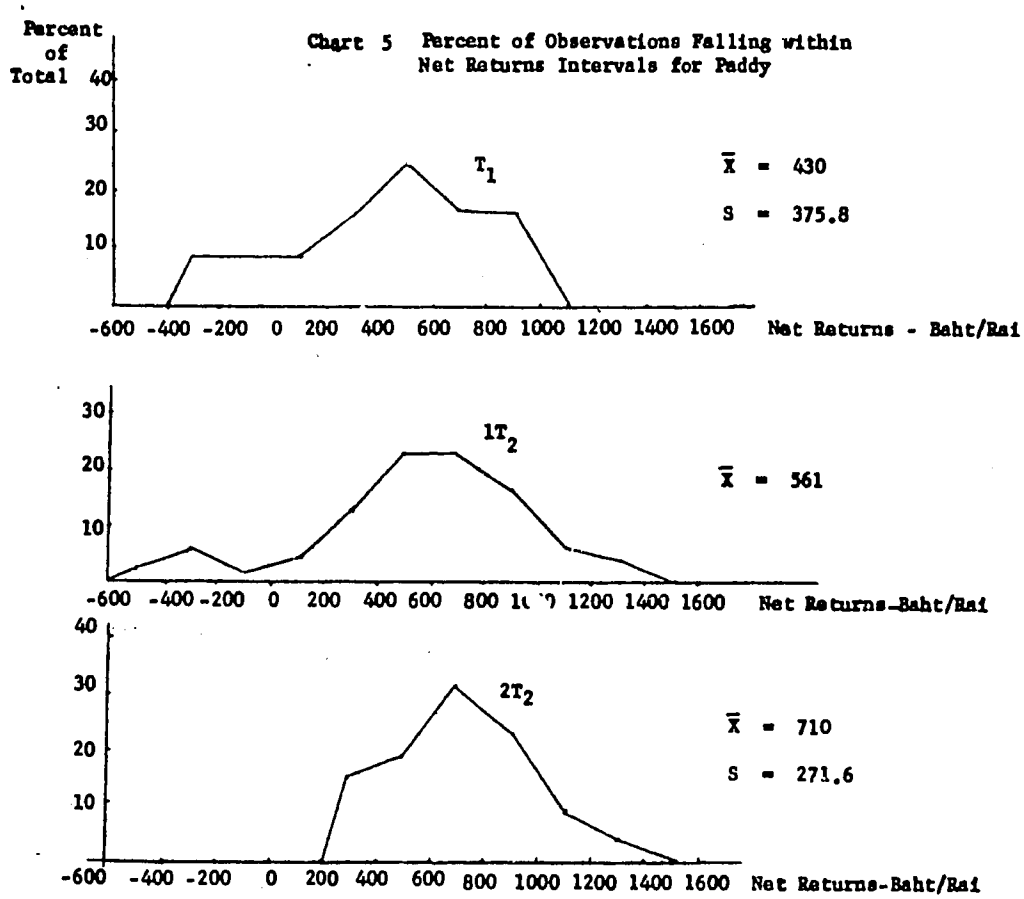


Chart 6 Probability of Obtaining more than Stated Net Returns for Paddy

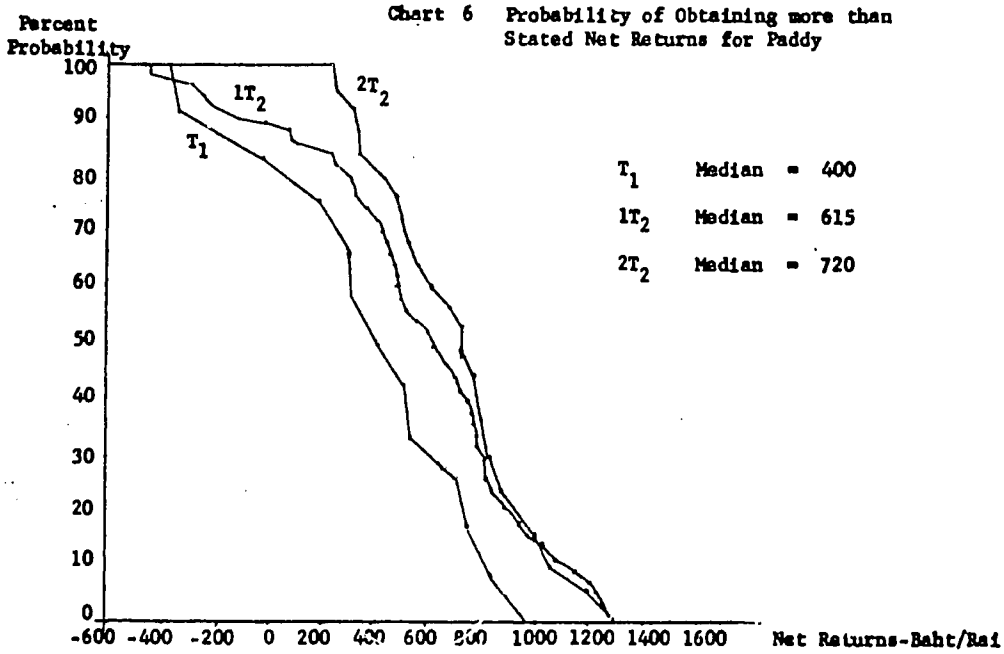


Chart 7 Cost of Production of Peanuts in Chiang Mai during 1975 and 1976.

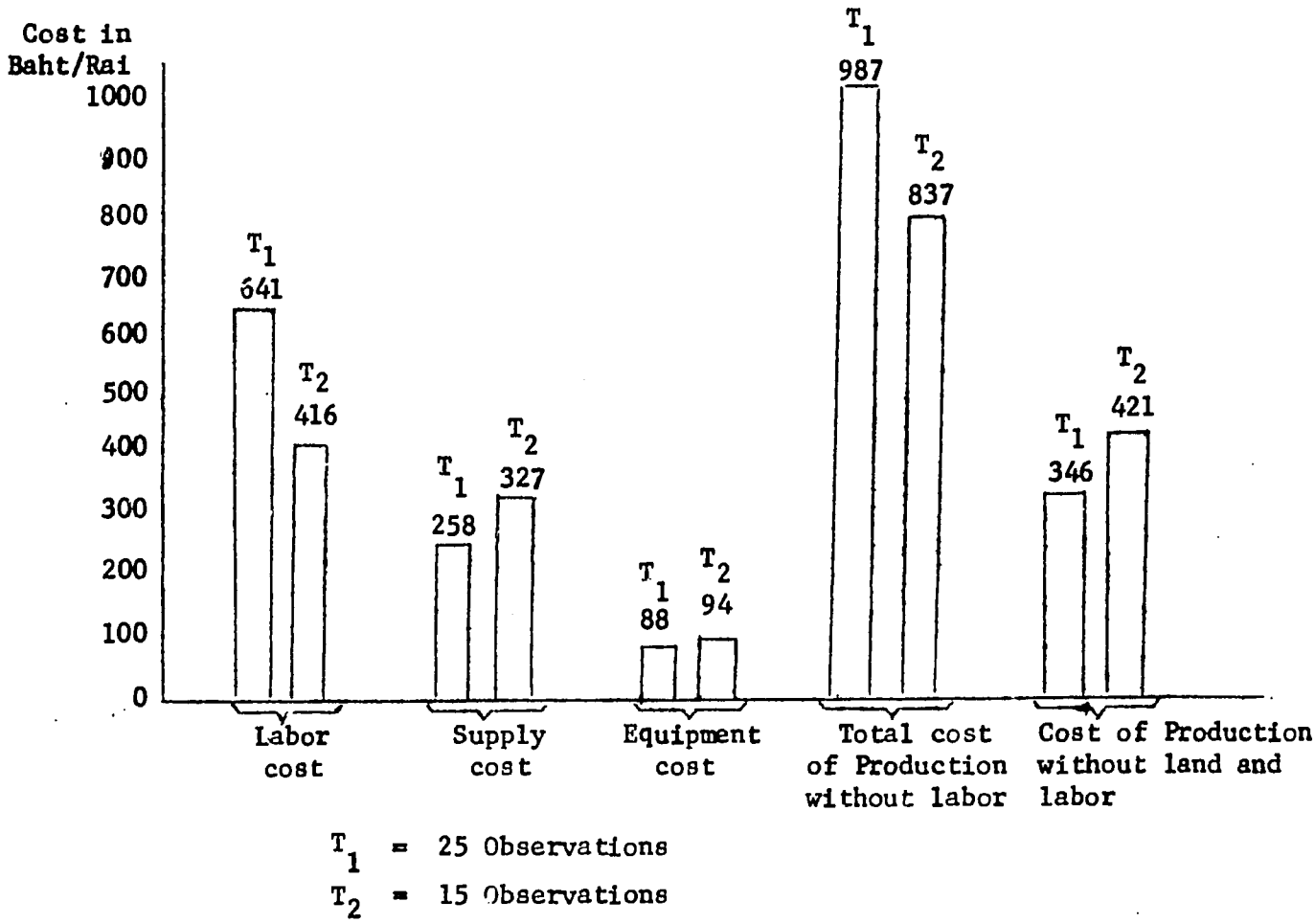


Chart 8 Yield of Peanuts in ChiangMai during 1975 and 1976.

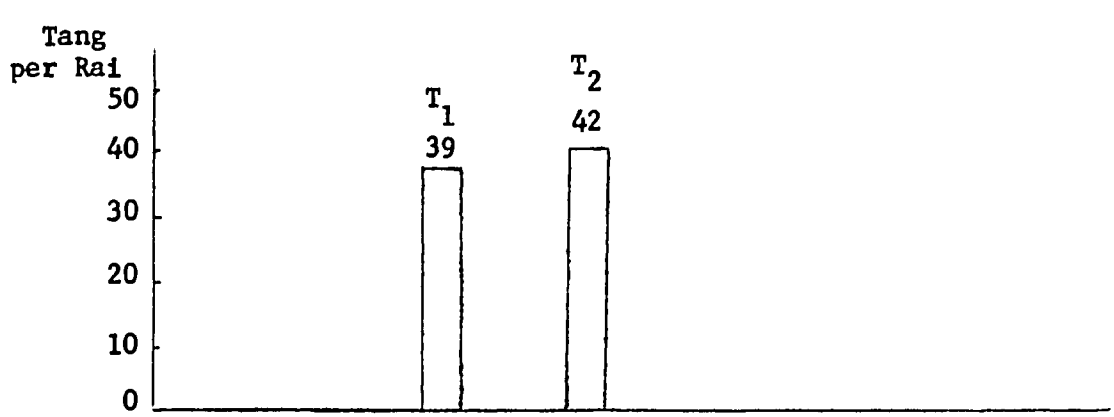


Chart 9 Net Returns per Rai of Peanuts in Chiang Mai during 1975 and 1976.

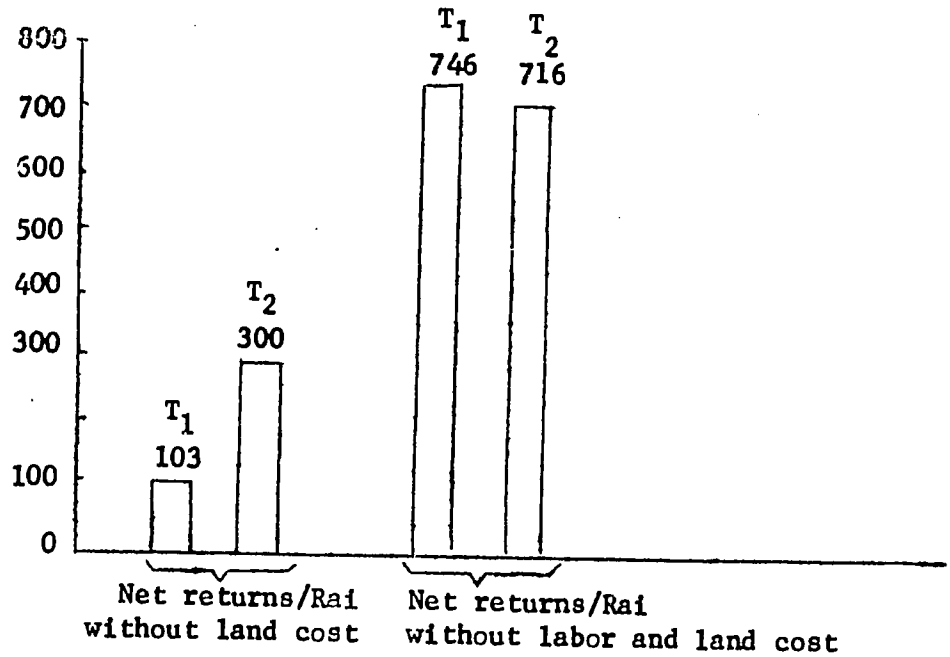
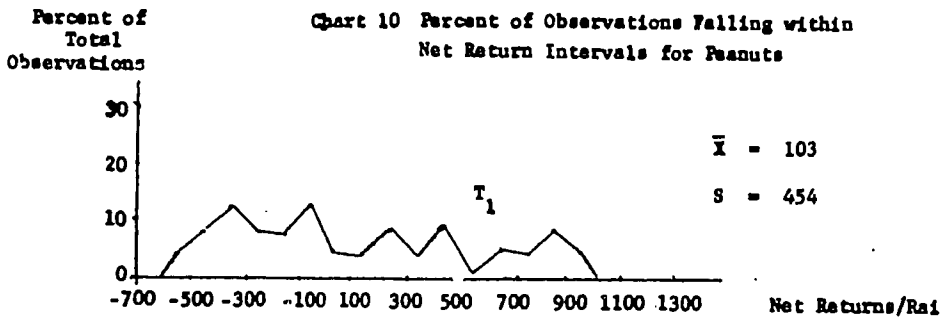


Chart 10 Percent of Observations Falling within Net Return Intervals for Peanuts



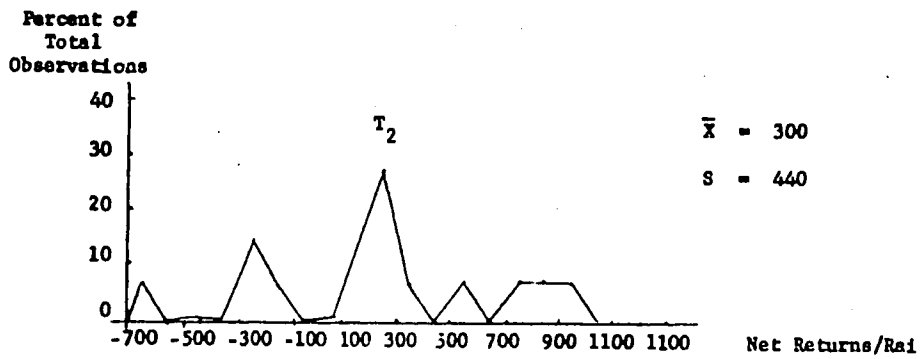


Chart 11 Probability of Obtaining more than Stated Net Returns for Peanuts

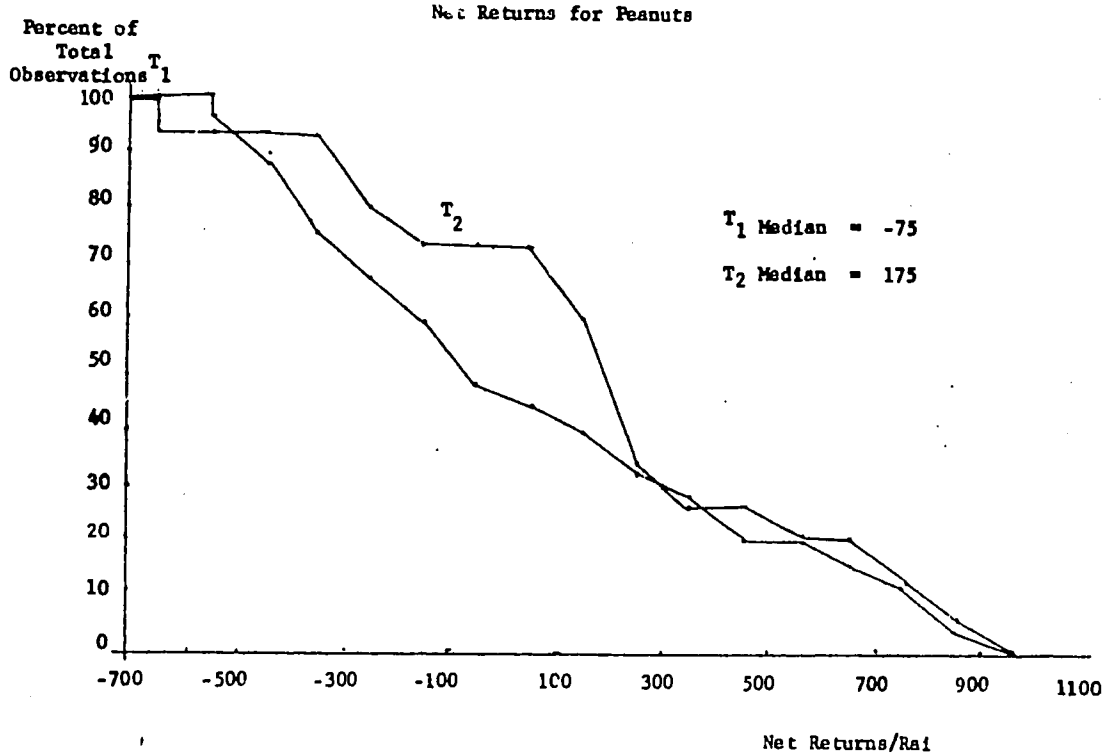
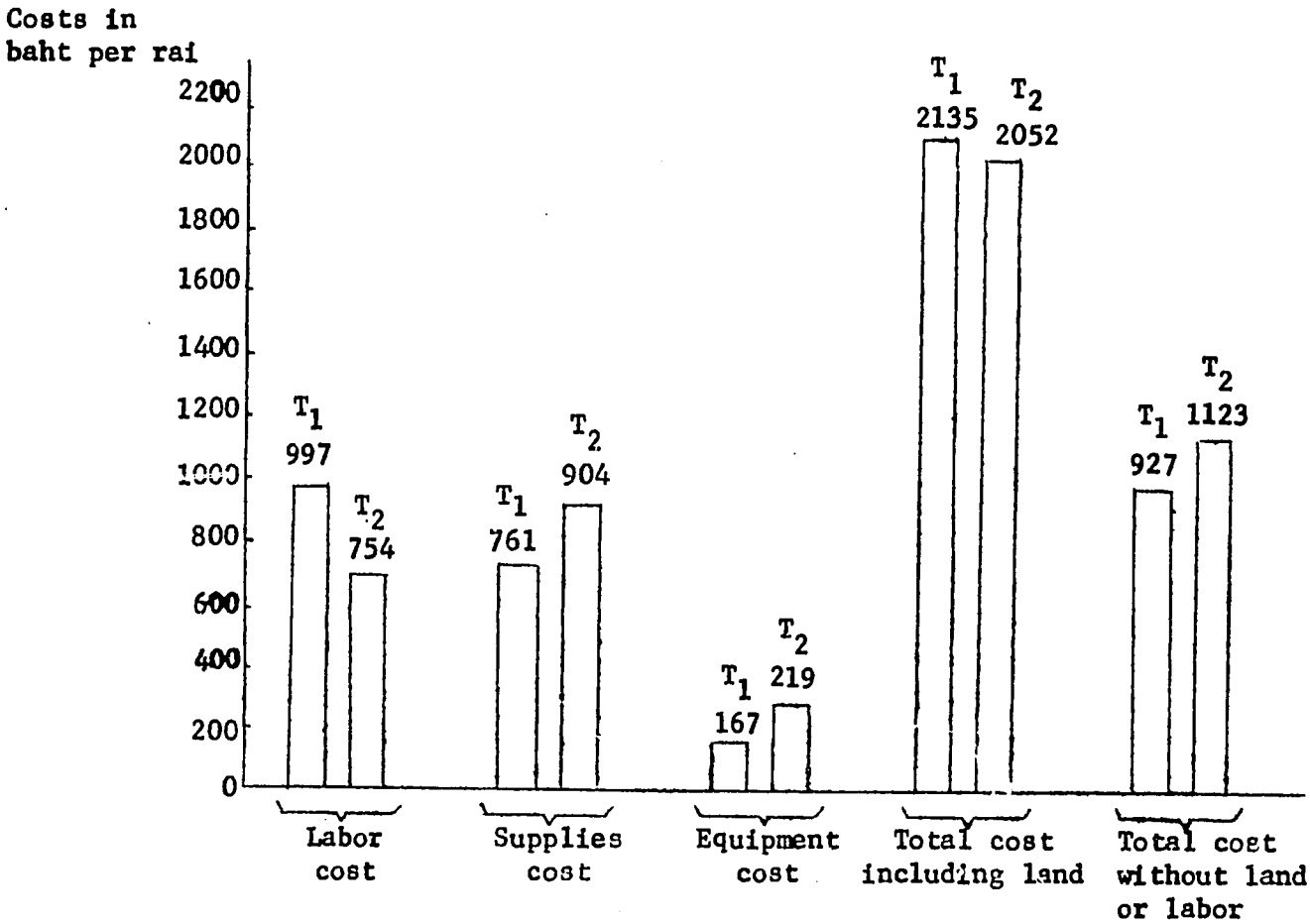


Chart 12 Production Costs for Tobacco in Ban Mae Kung and Ban Han Keaw in 1975 and 1976



T_1 = 7 observations

T_2 = 7 observations

Chart 13 Yield of Tobacco in Ban Mae Kung and Ban Han Keaw in 1975 and 1976

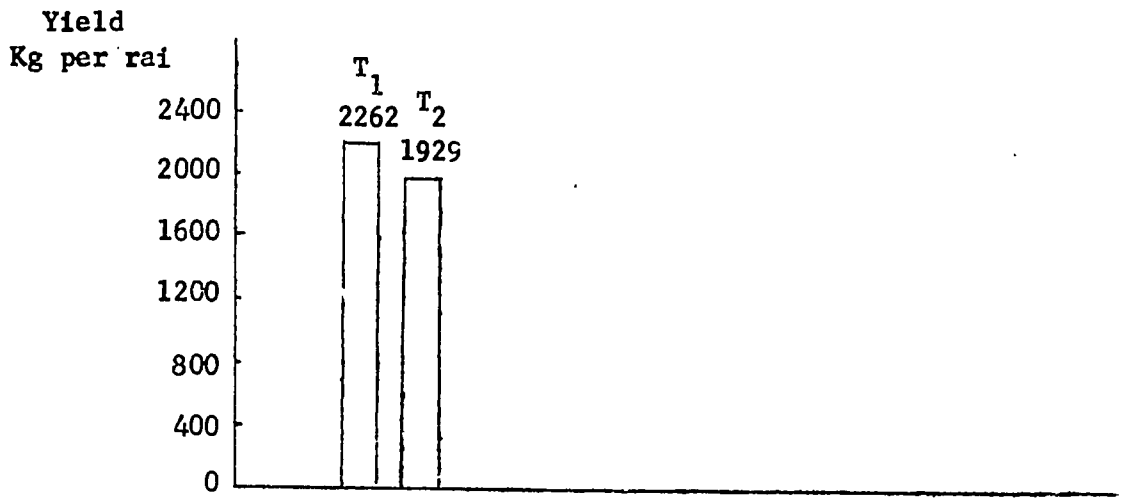


Chart 14 Net Returns for Tobacco in Ban Mae Kung and Ban Han Kaew in 1975 and 1976.

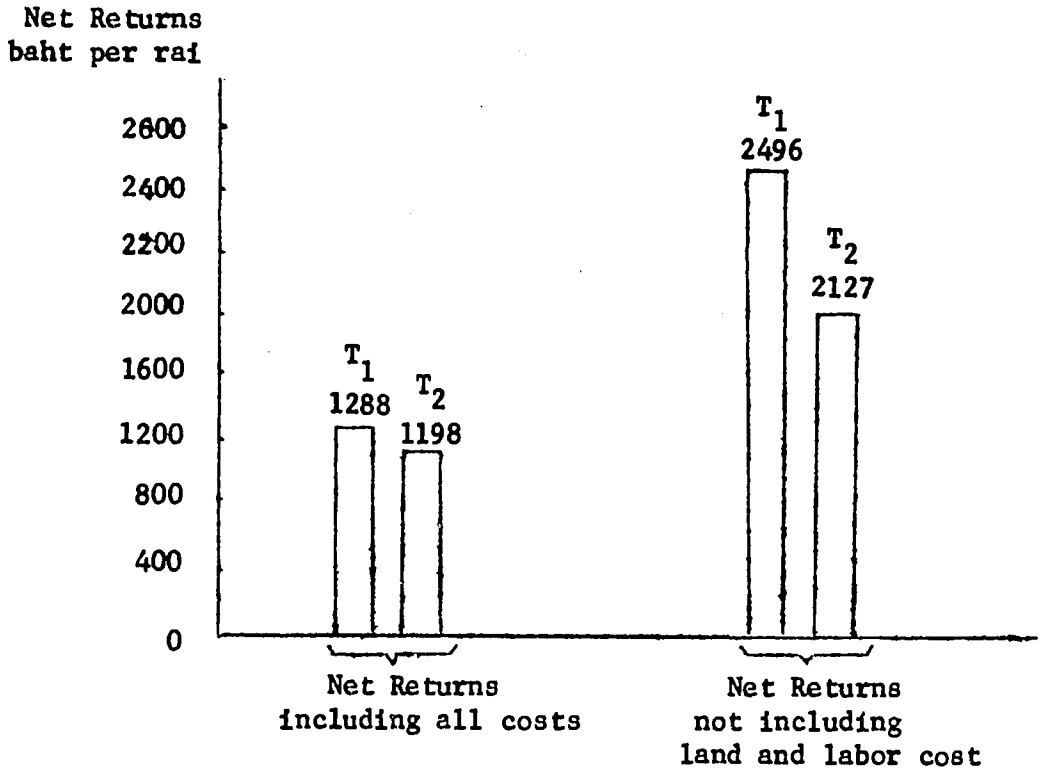


Chart 15 Costs of Production for Garlic in Ban Han Kaew and Ban Mae Kung in 1976.

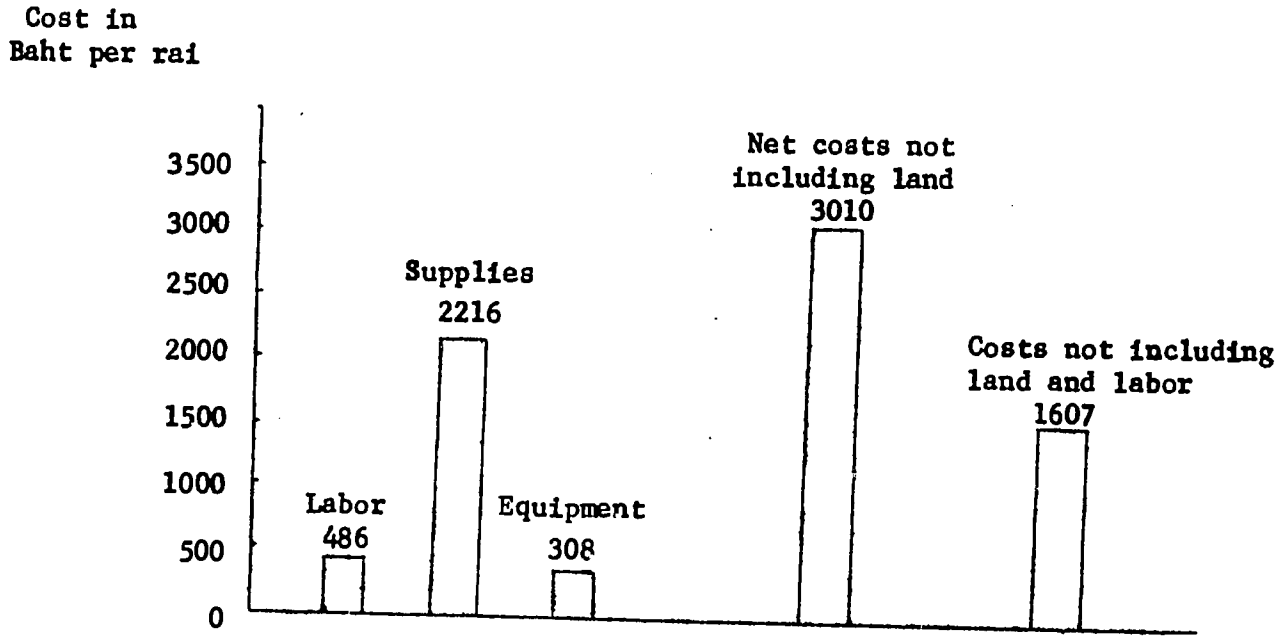


Chart 16 Net Returns for Garlic in Ban Han Kaew and Ban Mae Kung in 1976.

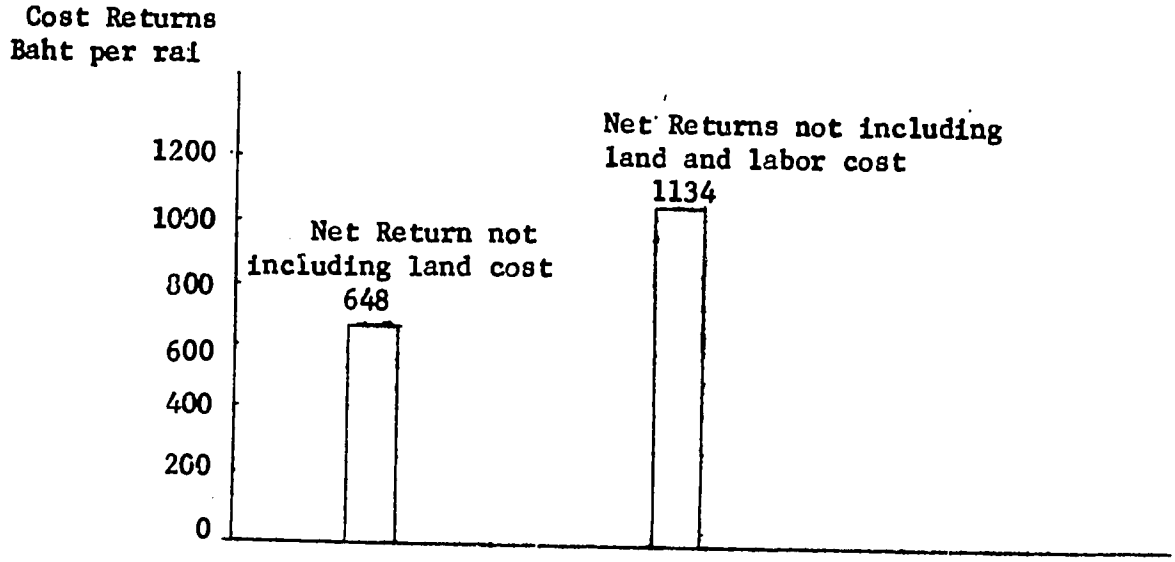


Chart 17 Cost of Production for Cool Dry Season Tomatoes in Ban Mae Kung in 1975/76

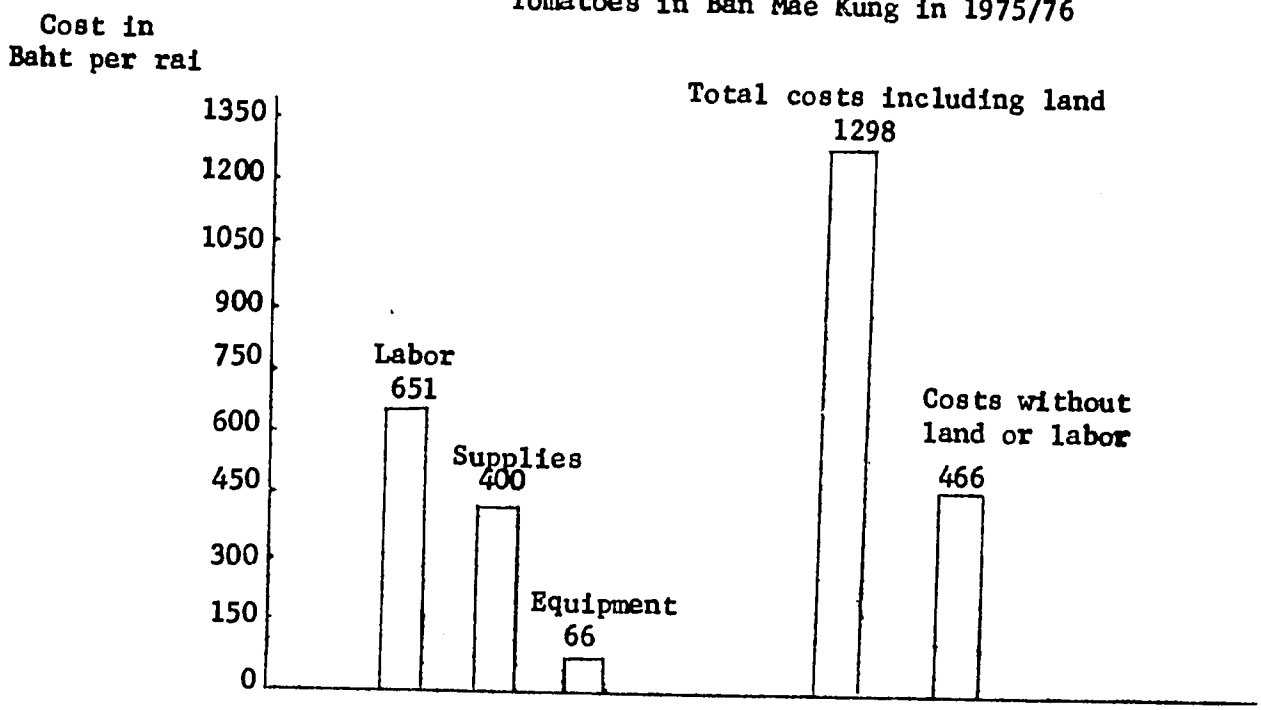


Chart 18 Net Returns for Cool Dry Season Tomatoes in Ban Mae Kung in 1975 and 1976.

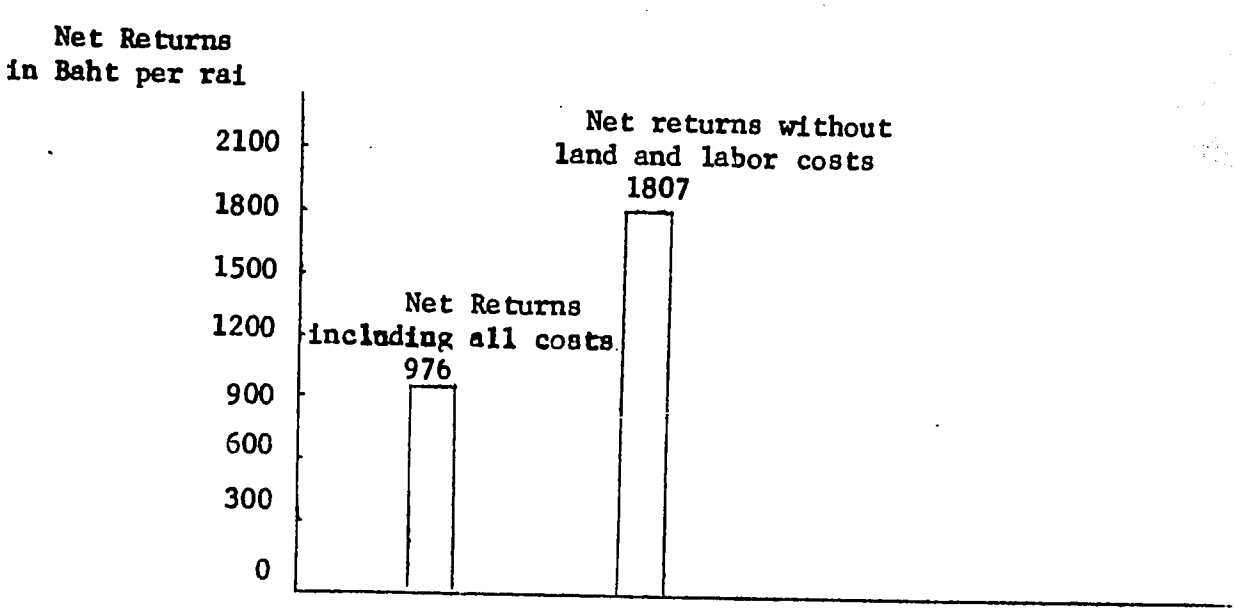


Chart 19 Costs of Production for Soybeans in Chiang Mai in 1976 and 1977.

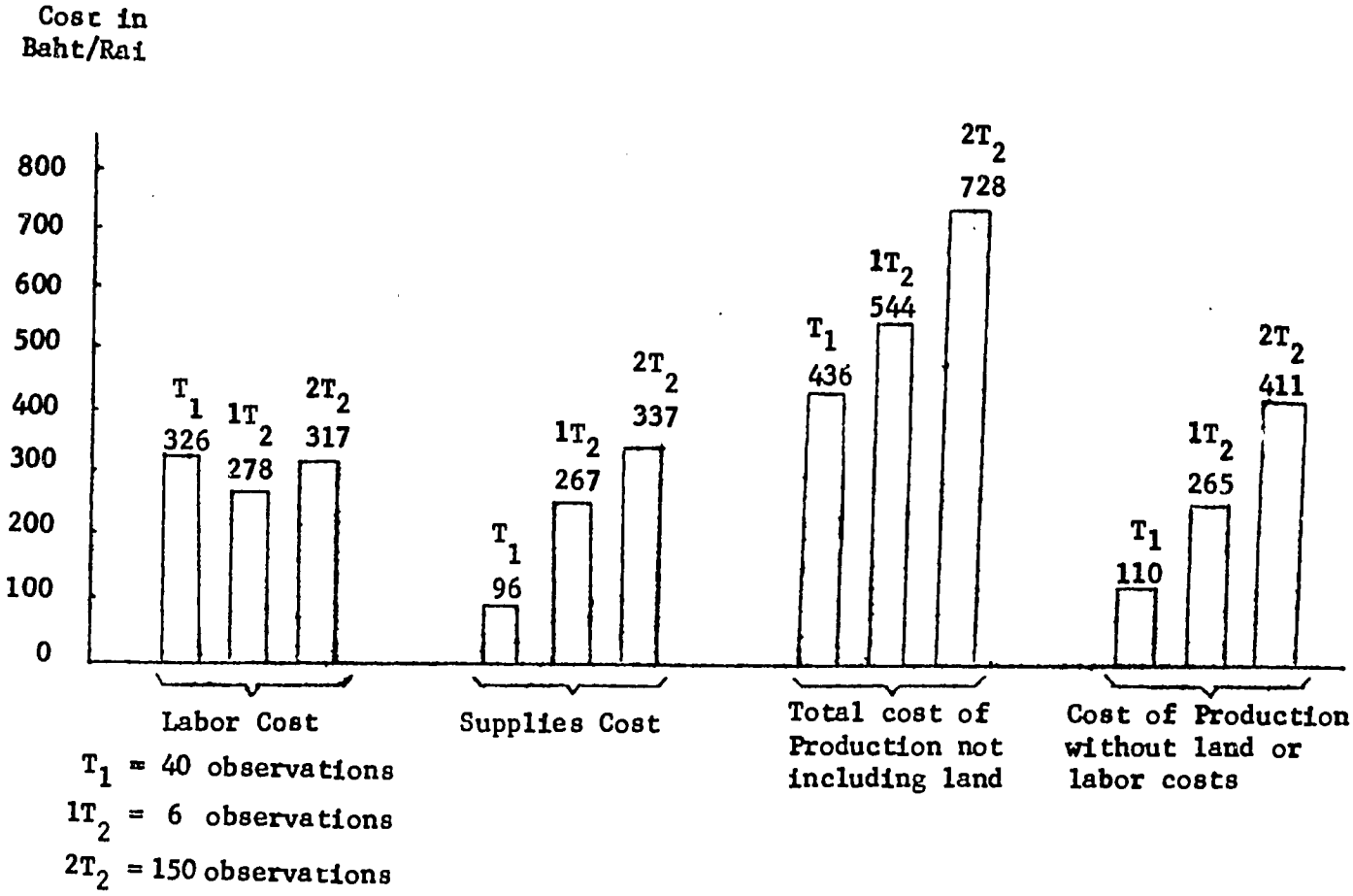


Chart 20 Yields of Soybeans in Chiang Mai in 1976 and 1977

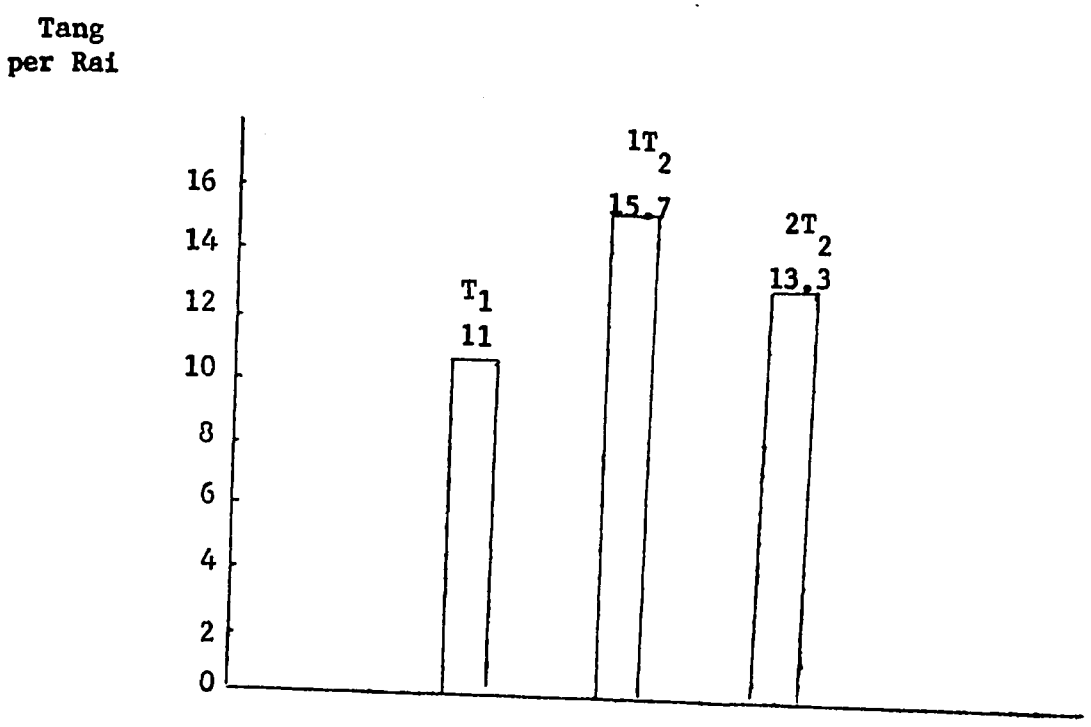


Chart 21 Net Returns for Soybeans in Chiang Mai in 1976 and 1977

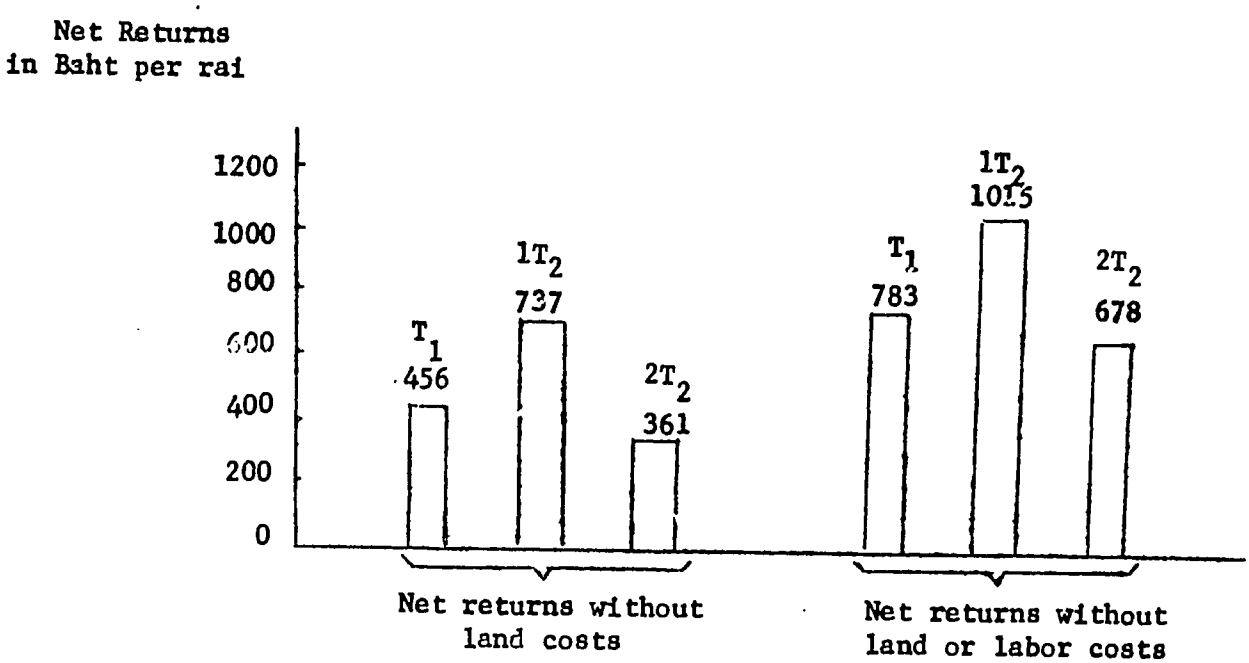
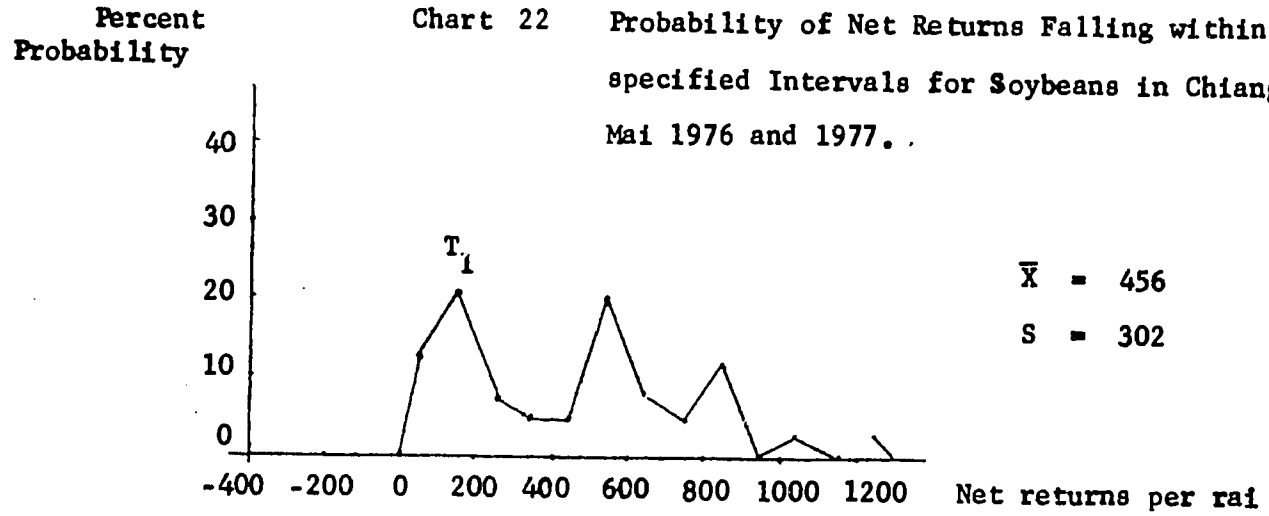
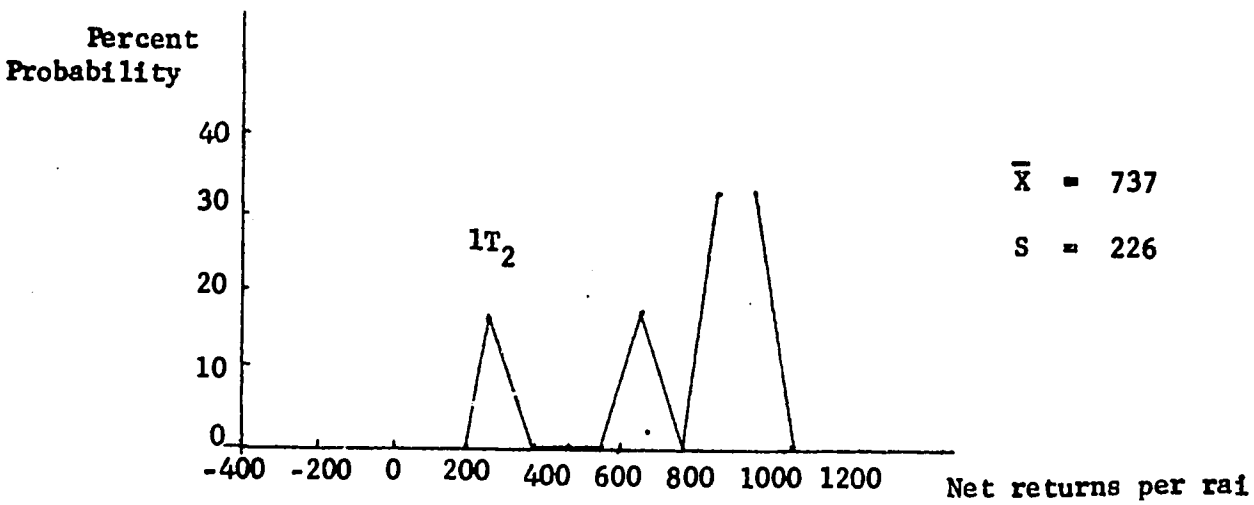


Chart 22 Probability of Net Returns Falling within specified Intervals for Soybeans in Chiang Mai 1976 and 1977.





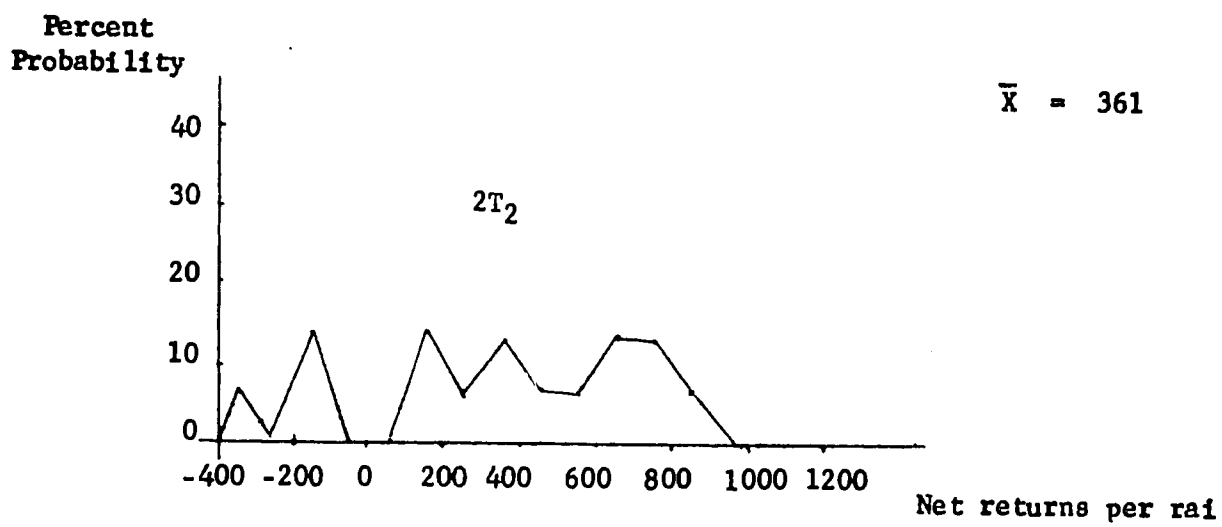


Chart 23 Probabilities of Obtaining More Than Given Net Returns for Soybeans in Chiang Mai in 1976 and 1977.

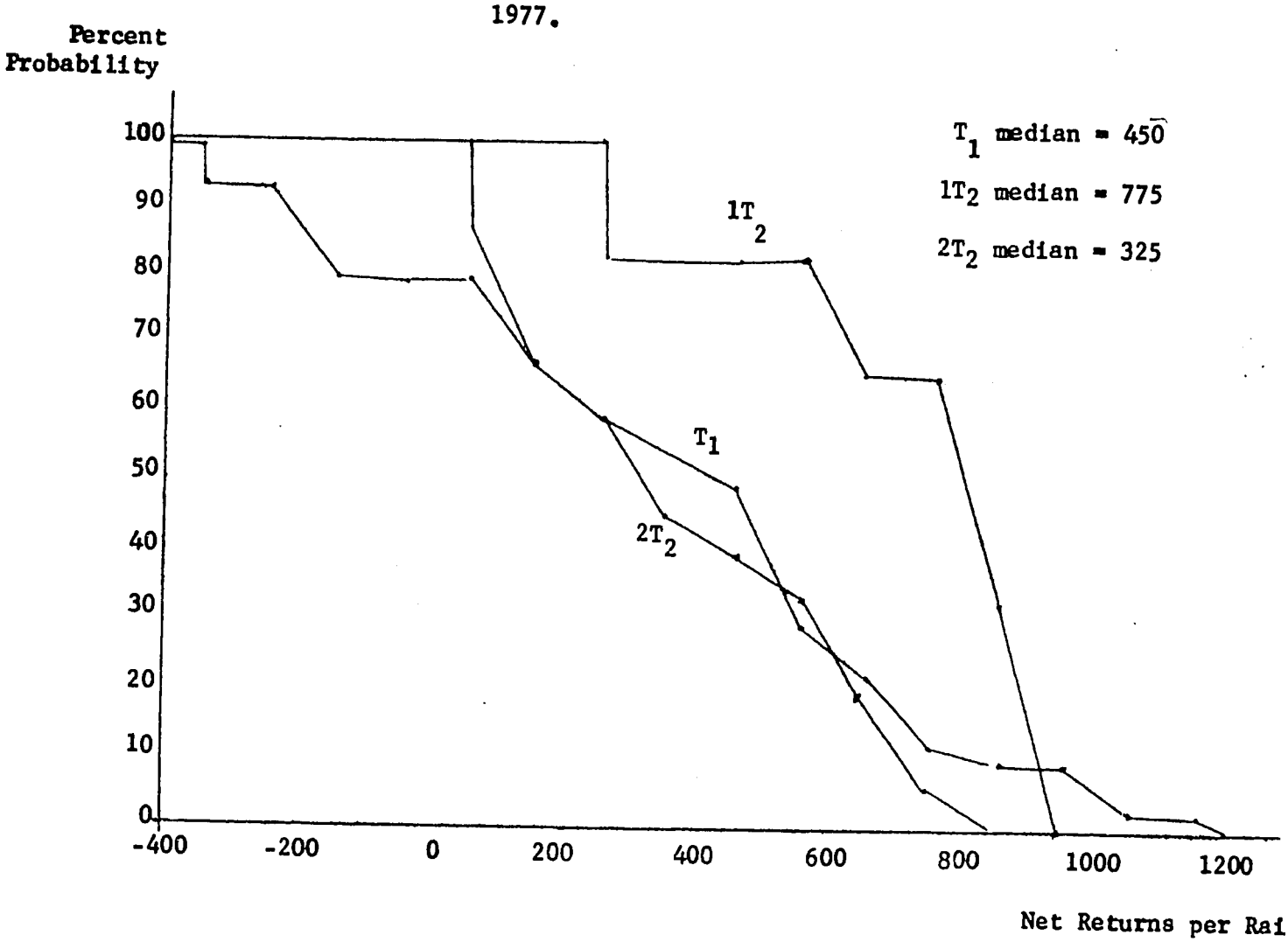


Chart 24 Cost of Production for Hot Dry Season Tomatoes in Ban Han Kaew and Ban Mae Kung in 1975 and 1976.

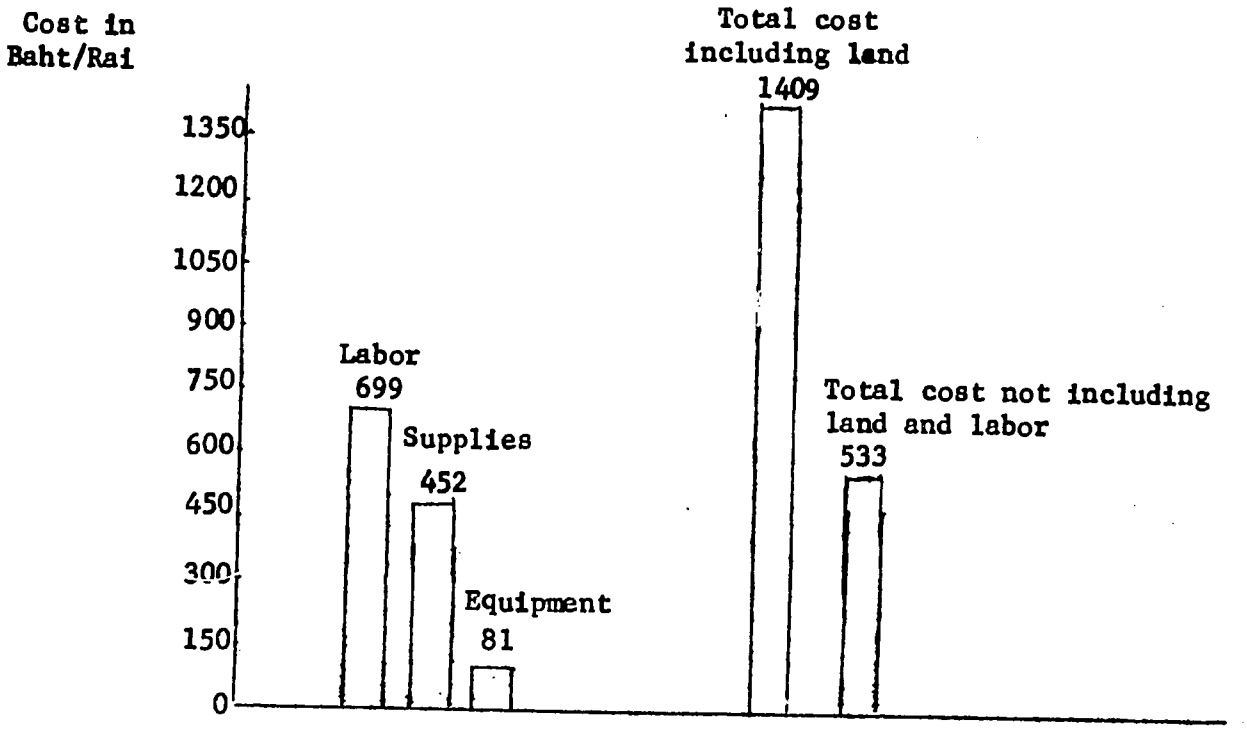


Chart 25 Net Returns for Hot Dry Season Tomatoes in Ban Han Kaew and Ban Mae Kung in 1975 and 1976.

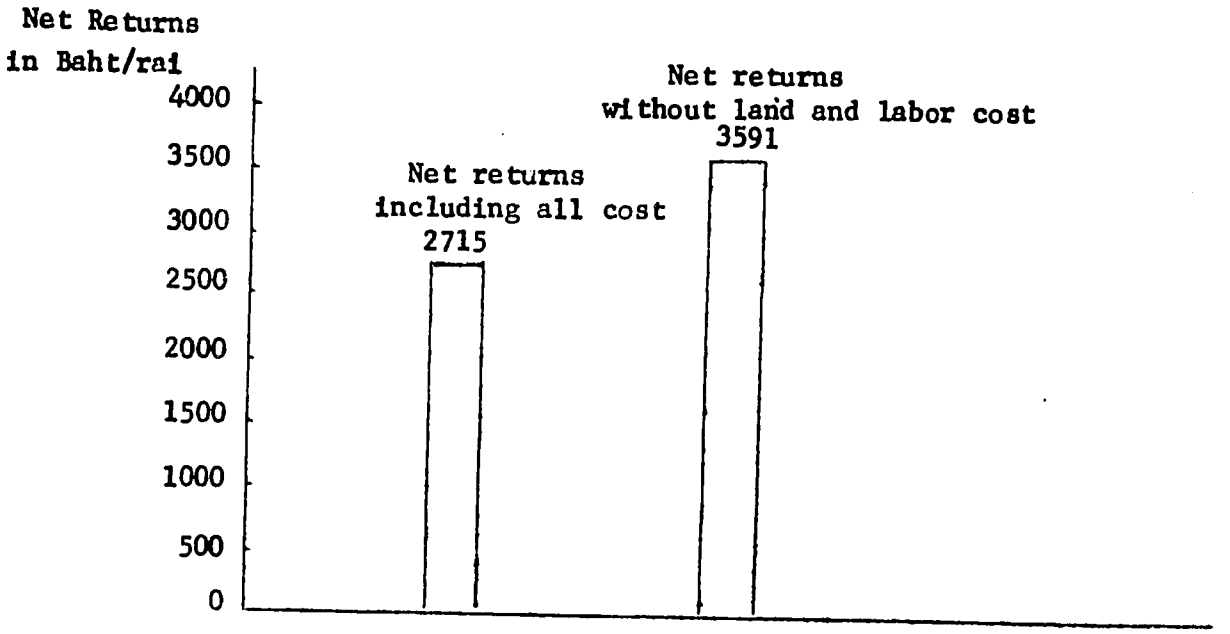


Chart 26 Cost of Production for Hot Dry Season Peanuts in Ban Han Kaew and Ban Mae Kung in 1976.

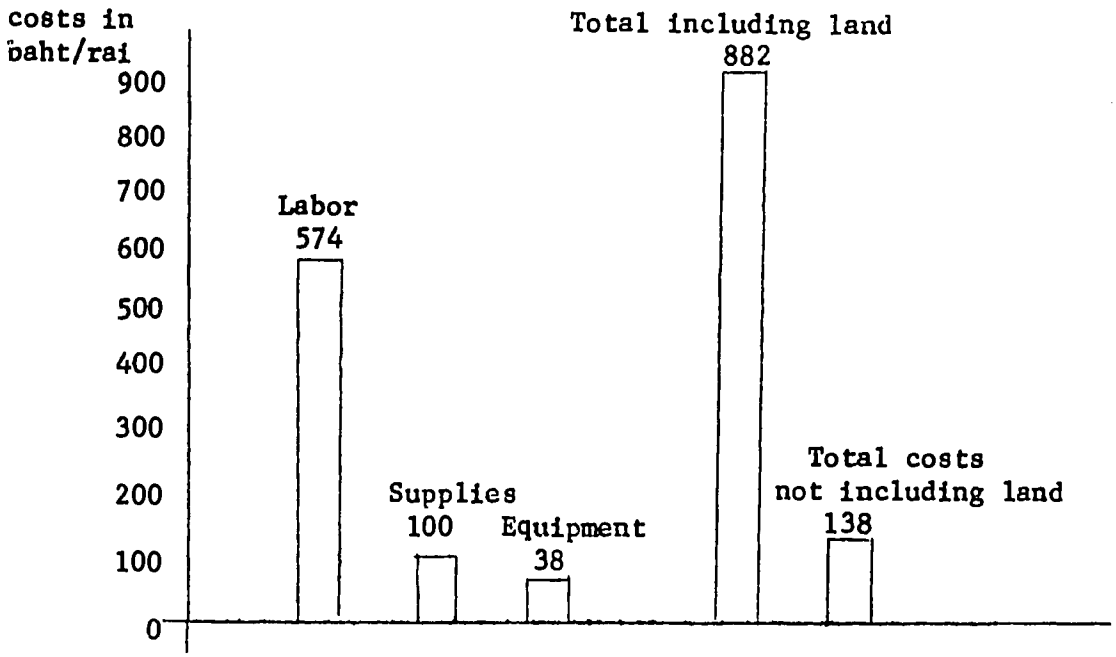


Chart 27 Net Returns for Hot Dry Season Peanuts in Ban Han Kaew and Ban Mae Kung in 1976.

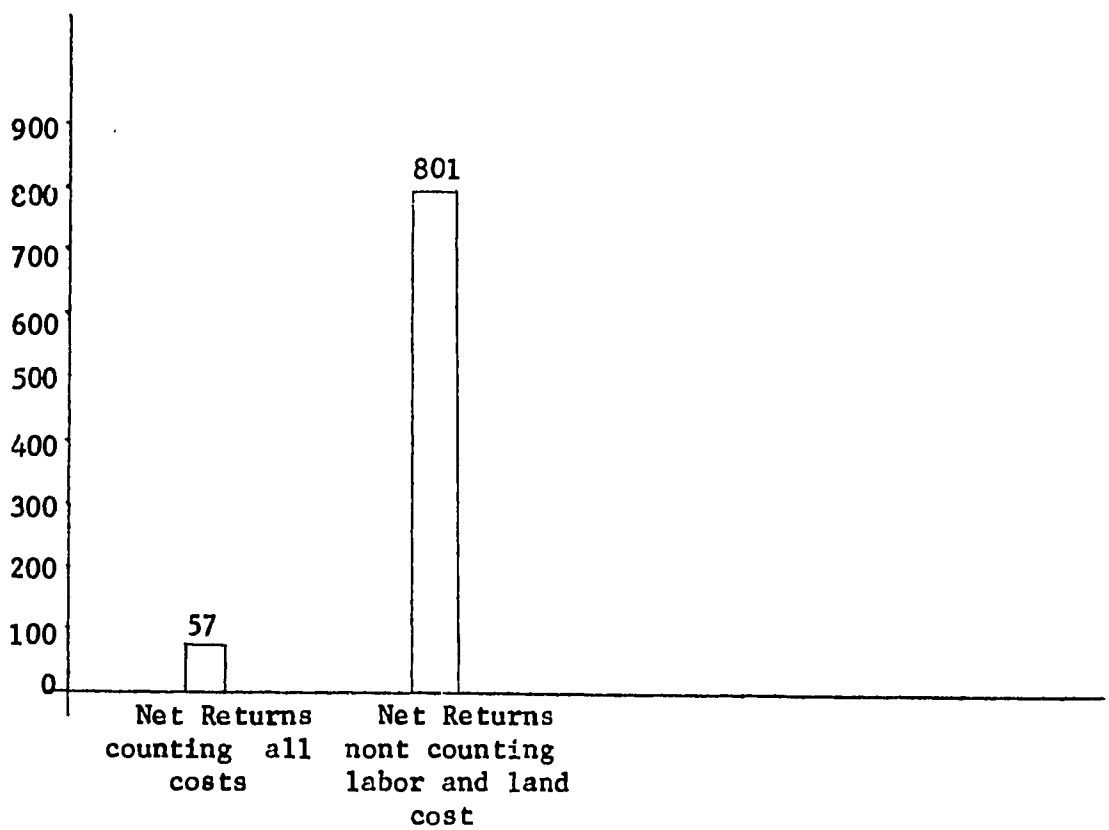


Chart 28 Costs of Production for Sweet Corn in Ban Han Kaew and Ban Mae Kung in 1976.

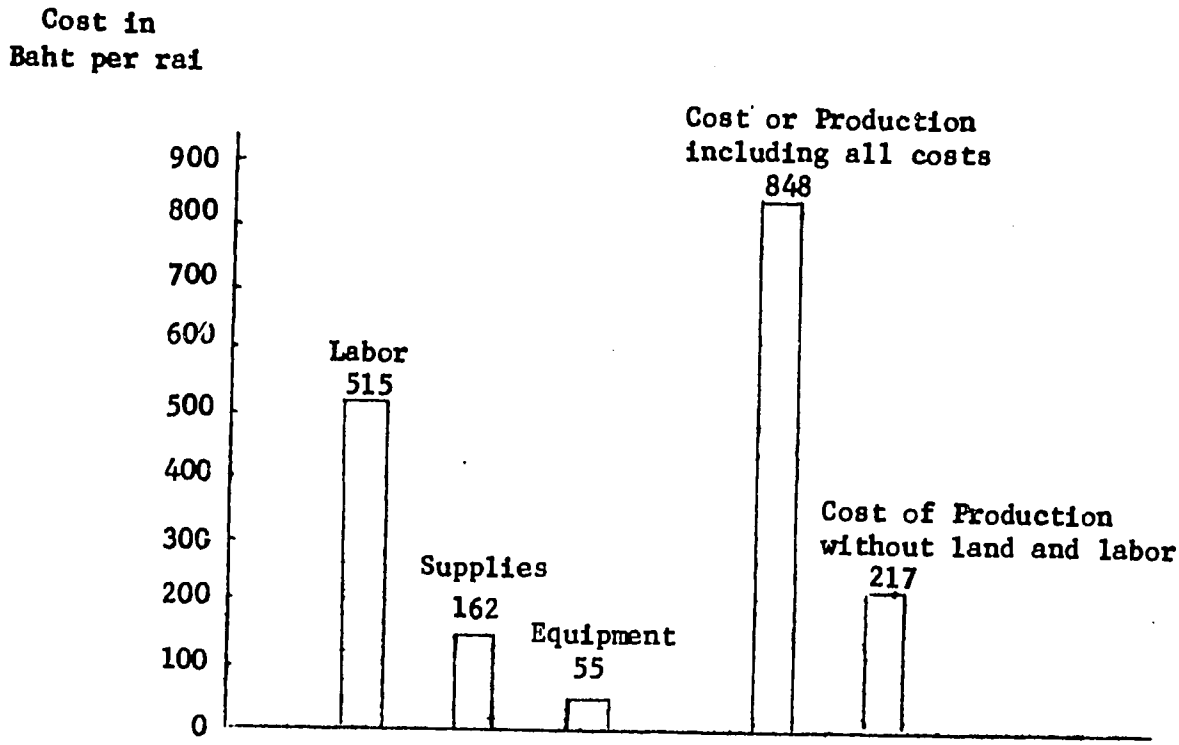


Chart 29 Net Returns of Sweet Corn in Ban Han Kaew and Ban Mae Kung in 1976.

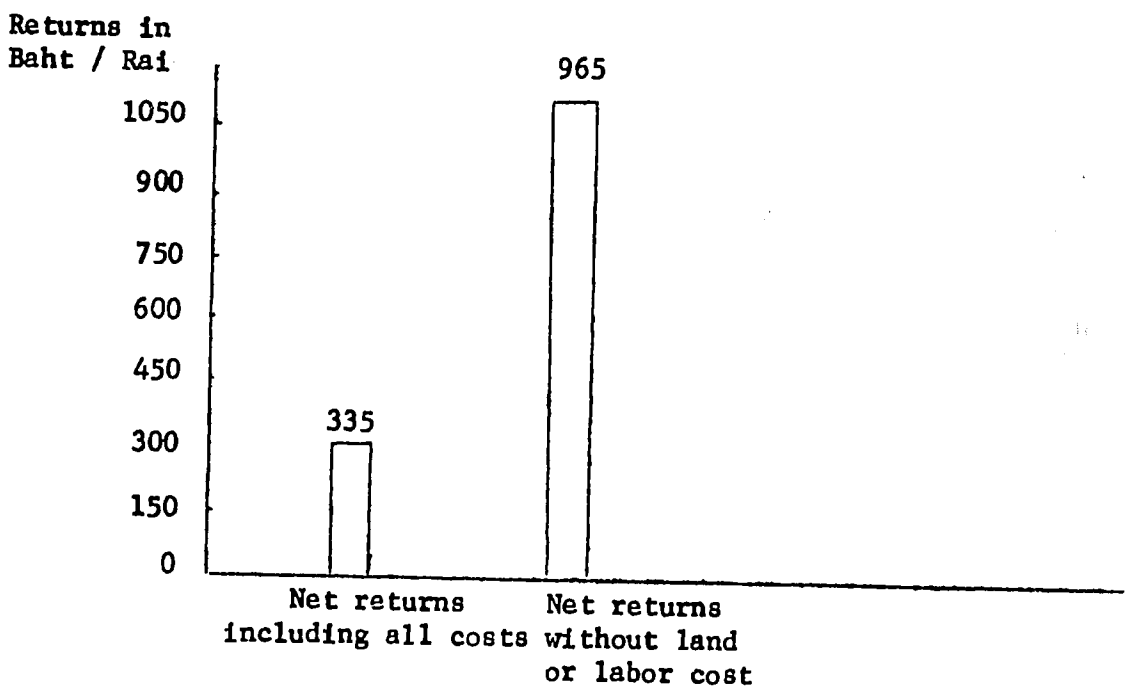
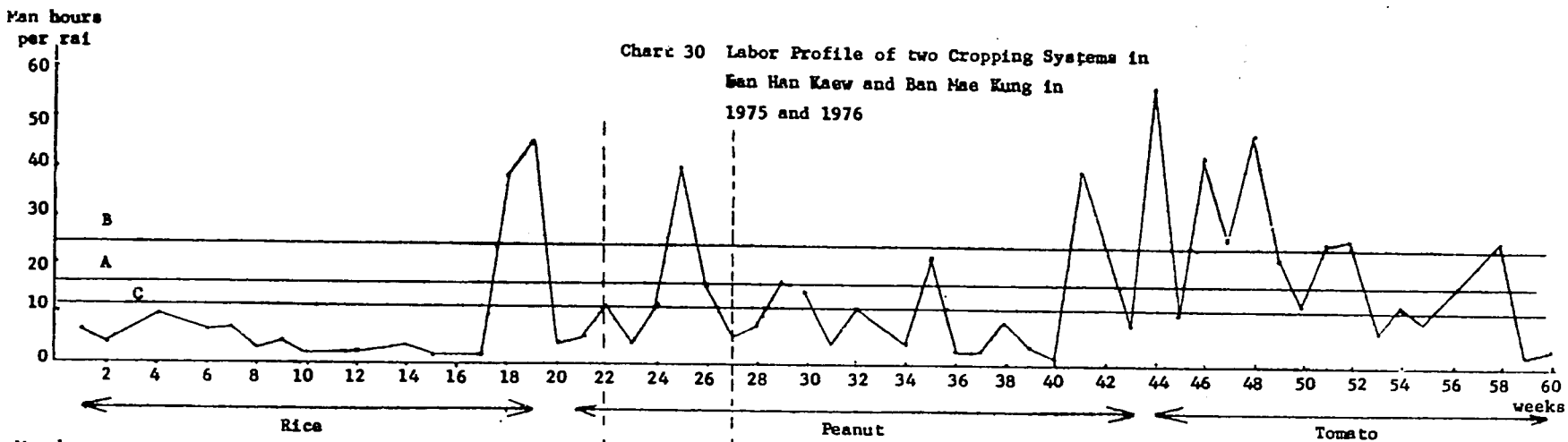
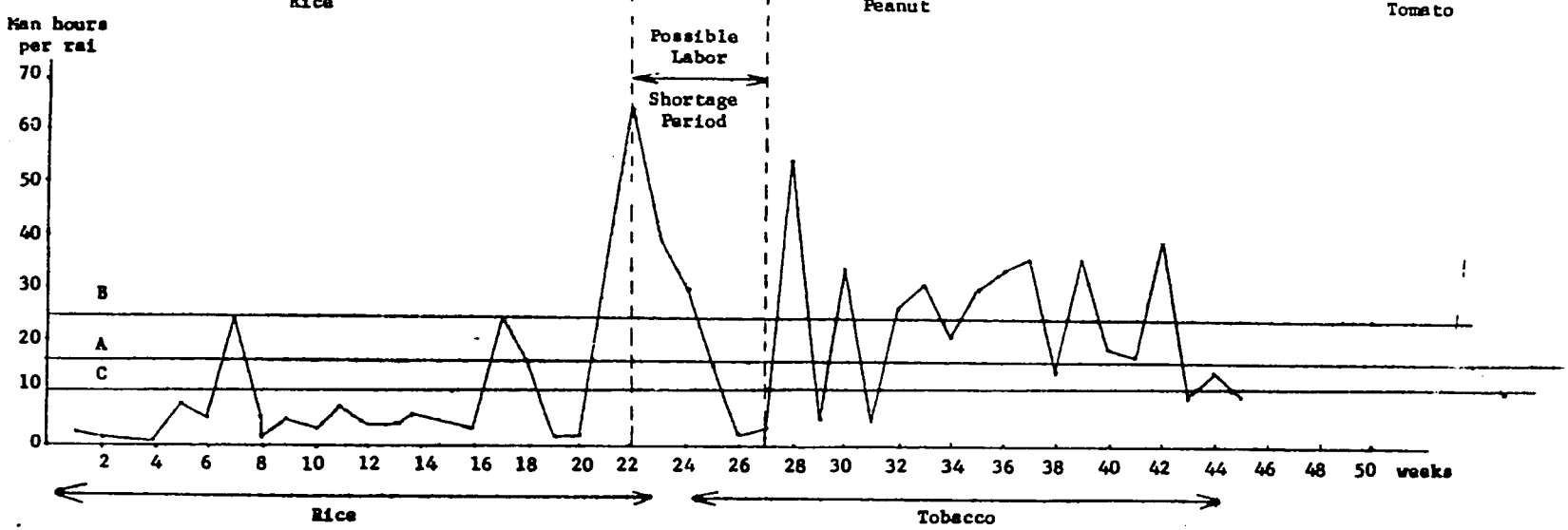



Chart 30 Labor Profile of two Cropping Systems in Ban Han Kaew and Ban Mae Kung in 1975 and 1976