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The Impact of Agricultural Product Price Changes on Labor Absorbtion in Thai Agriculture: A Non-Linear Programming Approach

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1. INTRODUCTION

Like most other developing countries, the majority of the Thai labor force is still employed in agriculture. Thus, the overall employment situation during the Sixth Five Year National Development Plan period (1987-1991) will depend critically on labor absorption in agriculture.

Agriculture employment, which has been fairly steady at around 70% of total employment in recent years, is now jeopardized by reduced growth of cultivated land, by crop price changes, and will also be affected by the diversification of agriculture to crops with widely varying temporal and total labor requirements per unit land area. Because the pattern of labour usage vary so much depending on the crop, and the cropping pattern also vary a great deal by region, a model to analyze the detailed employment patterns and outlook needs to be fairly rich. One approach which has previously been utilized to look at this issue is based on the linear programming approach; see eg. Chalamwong and Khatikarn (1985). One benefit of this approach is that a great deal of information on the production technologies and land types can be utilized. A major draw back however is that due to the linear nature of the relationships, the response of cropping patterns to changes in parameter values, such as crop prices, can be too extreme. To obtain sensible results, many a priori assumptions concerning the degree to which different crops can be substituted in production need to be imposed, (particularly as the data available on these issues are still not as rich as one would like).

The purpose of this paper is to construct a non-linear programming model of the agriculture sector in Thailand, which is then used to analyze the employment consequences of crop price changes during the period of the Sixth Plan. This model is a simple extension of the standard linear programming model, with the main difference being that the present approach takes into account likely diminishing marginal productivity of land as the cultivated area for a particular crop is expanded further and further. The parameters which govern the speed of the decline in the marginal product of land can be estimated econometrically. The solution from the model is an interior solution, and changes smoothly with changes in parameter values. This model is used to estimate the labor demand effects of changes in crop prices. Price projections based upon those from the World Bank are used to look at cropping patterns and the associated labor demand patterns during the period of the Sixth Plan. The model is also used to look at across crop substitution possibilities.

2. OVERVIEW

Table 1 presents the overall picture of employment in Thailand with breakdowns into agriculture, industry and services, and given separately for the periods January-March and July-September. The table shows that there is a definite seasonal pattern. The July-September period corresponds roughly to the peak cultivating season in most areas, while January-March is part of the dry season. We can' see clearly that agricultural employment declines drastically between the two seasons. On average, agricultural employment is around 5-6 millions less during the January-March period comparing to the July-September period except for the years 1981 and 1982 when the figures were around 8 millions. Employment in industry and services increases by around 1 million workers in the dry season.

The share of employment by major sector in table 2 indicates that agricultural employment accounts for about 70% of total employment. Since 1977, the agriculture share has declined from 73.6% to 69.7% in 1984, although since about 1979, the share seemed to stabilized at around 70%.

As far as the ability of agriculture to absorb labor is concerned, it is clearly related to the availability of new cultivated areas. Indeed, this has been the main reason why agriculture has been able to retain a very high share of employment even though its share in value-added is now

Table 1 Employment by Major Sectors and Periods

Year	January-March				July-September			
	Agric	Industry	Services	Total	Agric	Industry	Services	Total
1977	9,841,199	2,428,177	3,831,754	16,101,130	15,012,786	1,760,950	3,626,516	20,400,252
1978	10,597,460	2,250,593	3,972,204	16,820,257	16,084,181	1,830,244	3,843,412	21,807,837
1979	9,796,872	2,896,196	4,242,172	16,935,240	15,161,841	2,228,103	3,987,839	21,377,783
1980	0	0	0	0	16,092,129	2,322,839	4,265,863	22,680,831
1981	9,421,052	3,019,853	5,102,668	17,543,573	17,809,850	2,346,319	4,555,917	24,712,086
1982	9,790,624	3,305,928	5,519,624	18,616,176	17,428,853	2,630,079	5,260,335	25,369,267
1983	11,528,677	3,458,247	5,653,372	20,640,296	17,401,473	2,511,636	5,270,418	25,183,527
1984	13,398,676	3,318,997	5,602,838	22,320,511	18,130,356	2,767,493	5,101,085	25,998,934
1985	13,383,271	3,368,254	5,851,217	22,602,742	0	0	0	0

Source: Labor Force Surveys 1977-1985, NSO

Table 2 Shares of Employment by Major Sectors
(July-September Labour Force Surveys)

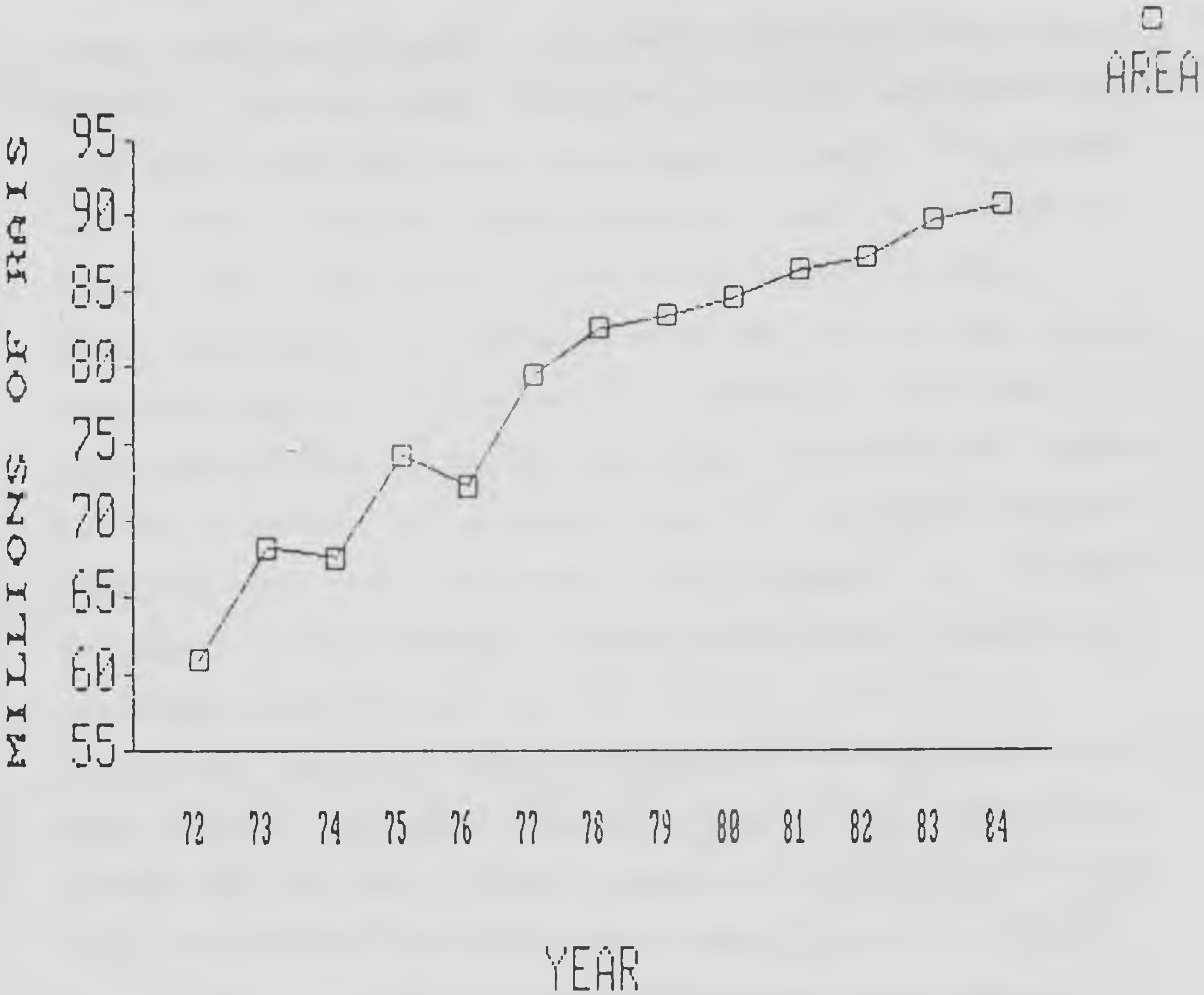
Year	Agric	Industry	Services	Total
1977	73.6%	8.6%	17.8%	100.0%
1978	73.8%	8.6%	17.6%	100.0%
1979	70.9%	10.4%	18.7%	100.0%
1980	71.0%	10.2%	18.8%	100.0%
1981	72.1%	9.5%	18.4%	100.0%
1982	68.7%	10.6%	20.7%	100.0%
1983	69.1%	10.0%	20.9%	100.0%
1984	69.7%	10.6%	19.6%	100.0%

fairly small (around 23% in 1984). In response to past population pressures, a portion of the rural population has migrated to other rural areas to open up new land for cultivation. Figure 1 shows the increase in cultivated areas of major crops between 1972 and 1984. The picture indicates that there seems to be a turning point around 1978, when the rate of expansion in cultivated areas slowed down. Between 1972 and 1978, the average growth in cultivated areas was around 3.3% per annum. Between 1978 and 1984, the rate declined sharply to 1.4% per annum. It is unlikely that the rate of growth will be any higher than this in the future, and is more likely to decline further due to environmental concerns.

In addition to total cultivated areas, the distribution among different crops is also important from the employment point of view, not only because each crop has different labor requirements for a given amount of land but also because the pattern of labor usage by month varies a great deal for different crops. Paddy is the most important crop in Thai agriculture in terms of its share in agricultural GDP and also in cultivated area. However, the importance of paddy has been declining. In 1976, for example, paddy accounted for 69% of all cultivated land, but this declined to 64% in 1983. In terms of value added, the share of paddy compared to all crops declined from 66.6% in 1972 to 53.6% in 1984. Of the other crops, cassava showed the largest

FIGURE 1

TOTAL CULTIVATED AREAS OF MAJOR CROPS
(excluding rubber and second rice crop)



Source: Office of Agricultural Economics
Ministry of Agriculture & Co-operatives

gain, with its share in increasing from 6.8% to 15.9% between 1972 and 1984. Sugar also almost doubled its share, from 6.7% to 11.2%, and maize increased slightly from 5.8% to 8.9% during the same period.

Table 3 shows the labor requirements for various major crops relative to paddy. It can be seen that this varies widely. The most labor intensive are cotton and sugarcane, with about twice the labor requirement of paddy. The lowest is 'sorghum, requires 28% of paddy's, and also mungbean (49%). What this means is that to estimate the demand for labor in agriculture, one must have some idea of the likely cropping pattern to be expected. Actually, the issue is quite complicated due to the fact that, depending on where one is located, the possibilities for changing cropping patterns are very different. For example, in flooded lowlands, it is difficult to grow other crops in substitute for paddy in the wet season.

Besides the different intensities, the various crops also differ in terms of the requirements on labor time through out the year. This is particularly relevant for the issue of seasonal employment patterns. In the North-east, for example, the percentage of yearly labor requirements for two broad periods of the year (January-May and June-September) are shown in table 4. It can be seen that for most of the crops the labor requirements are almost totally

Table 3 Labour Requirement per Rai Relative to Paddy

Crop	Man/Rai
Paddy	100%
Maize	86%
Sorghum	28%
Mungbean	49%
Soybean	96%
Groundnut	165%
Cotton	203%
Cassava	84%
Sugarcane	182%
Rubber	158%
Coconut	67%

Table 4 Share of Labour Use by Cropping Activities in the North-east (January-May and June-December)

Activities	January-May	June-December
First Non-Glutinous Rice	.5%	99.5%
First Glutinous Rice	.6%	99.4%
Second Non-Glutinous Rice	100.0%	.0%
Second Glutinous Rice	100.0%	.0%
First Maize Crop	20.4%	79.6%
Second Maize Crop	.0%	100.0%
Sorghum	.0%	100.0%
First Mungbean Crop	100.0%	.0%
Second Mungbean Crop	.0%	100.0%
First Soybean Crop	100.0%	.0%
Second Soybean Crop	.0%	100.0%
First Groundnut Crop	100.0%	.0%
Second Groundnut Crop	.0%	100.0%
Kenaf	30.3%	69.7%
Cassava	39.3%	60.7%
Sugarcane	70.9%	29.1%

within one or the other of the two periods. A little preparation is required in May for the first rice crop, but 99% of labor time is used during the latter part of the year starting from June. The second rice crop is grown in the first 5 months of the year. The first maize crop starts in May, and continues until August, and the second crop occupies September to December. The first and second crops of mungbean, soybean and groundnut occur exclusively in the first and second part of the year respectively. Cassava and sugarcane require labor through out the year, with cassava requires more labor in the latter part while sugarcane is the opposite. Kenaf is grown between April and October, with heavy labor requirements in May and October, but in terms of the two periods, more labor is required in the latter.

The above picture of labor utilization for different crops shows that to analyze the issue of labor demand in agriculture, the model used must be extremely rich. Each crop is different, and a single crop grown in different areas and land types are also slightly different in terms of labor use and the distribution of labor time over the year.

The seasonal pattern of labor use is particularly important, because a major labor market problem in Thailand is that of seasonal unemployment. This can be seen from table 5, which gives the seasonal unemployment figures and rates based on the January-March rounds of the Labor Force

Table 5 Seasonal Unemployment Numbers and Rates (1977-1985)

	North	North-east	South	Central	Total
Labour Force Survey 1977 Round 1:					
Seasonal Unemployment	1,065,740	2,306,910	53,660	537,310	3,963,620
Seasonal Rate	24.51%	30.32%	2.34%	13.78%	21.84%
Labour Force Survey 1978 Round 1:					
Seasonal Unemployment	863,930	2,673,870	38,850	445,410	4,022,060
Seasonal Rate	19.55%	35.20%	1.54%	11.09%	21.68%
Labour Force Survey 1979 Round 1:					
Seasonal Unemployment	985,570	2,823,780	128,080	431,890	4,369,320
Seasonal Rate	21.60%	36.18%	5.38%	10.86%	23.34%
Labour Force Survey 1981 Round 1:					
Seasonal Unemployment	1,497,200	3,274,970	48,440	749,980	5,570,590
Seasonal Rate	28.98%	39.48%	3.01%	16.48%	28.39%
Labour Force Survey 1982 Round 1:					
Seasonal Unemployment	1,482,030	3,442,910	71,470	460,620	5,457,030
Seasonal Rate	27.35%	40.13%	2.57%	9.75%	25.38%
Labour Force Survey 1983 Round 1:					
Seasonal Unemployment	992,420	2,775,220	75,320	573,810	4,416,770
Seasonal Rate	20.05%	35.90%	2.89%	13.00%	22.42%
Labour Force Survey 1984 Round 1:					
Seasonal Unemployment	675,410	2,770,270	77,880	244,020	3,767 580
Seasonal Rate	12.79%	33.26%	2.87%	5.37%	18.05%
Labour Force Survey 1985 Round 1:					
Seasonal Unemployment	946,680	2,771,820	121,390	348,620	4,188,510
Seasonal Rate	17.41%	31.47%	4.29%	7.24%	19.14%

Surveys. The data shows that seasonal unemployment is a problem that affects a great number of people. The total is around 4 million workers, except for 1981 and 1982 when the figure was around 5.5 millions. The seasonal unemployment rates are around 20%, again except for 1981-2. In the South, there is not much seasonal unemployment. The Central region has around 400,000, but is less than 10% of the labor force recently. The main problem of seasonal unemployment occurs in the North and particularly the North-east, where it is severest, affecting over 30% of the work force.

Disregarding the years 1981 and 1982, when the figures suddenly jumped, and may possibly be due to sampling methodology, the total number of persons seasonally unemployed appears to be fairly stable at around 4 million workers. The problem appears to be getting much better in the Central region, presumably because of the rapid diversification of agriculture in the region. The number of persons seasonally unemployed appears to be quite stable in the North and North-east at around 1 million and 2.7 millions respectively, and the South shows a slight increase.

The large number of seasonally unemployed each year represents a huge waste of resources. While some have argued that the seasonally unemployed are mostly voluntary withdrawls from the labour force (see Bertrand and Squire

(1980)), recent evidences, based on seasonal migration patterns, indicate that this is not the case. Most of the seasonal unemployed are quite active in seeking jobs, and a major impediment to their being able to find jobs is the lack of information on job opportunities (see Sussangkarn, Ashakul and Myers (1986)).

Over the period of the Sixth Plan, the outlook for the prices of major crops are rather poor. Thus, the prospects for agricultural employment and incomes are poor. To understand the major implications on employment, both overall and seasonally, we need to look at the way farmers are likely to adjust their cropping patterns in response to the price changes. It is hoped that the present study on labor absorption in the agriculture sector will provide more information on this issue.

3. Analytical Framework and Methodology

In the section, we will develop a non-linear programming model of the agricultural sector in Thailand which will extend the linear programming approach used by Chalamwong and Khatikarn (1985).

In this study, the country is divided into 6 regions; Central, North, North East, South, East, and West. Within each region there are different types of crops based on the existing cropping pattern. In addition, the land areas in each region are combined into 3 major groups by using land type and seasonality as the criterion. There are

1. Wet Season Low Land
2. Dry Season Low Land
3. Upland

The cropping pattern by regions for these 3 major groups are shown in table 6.

Each group has a combination of cropping pattern that is generally suitable for a particular group. Under the profit maximization's framework, given the limit of the total available land, the representative farmer within each region-landtype combination allocates the total available land to the different crop to maximize net income. The mathematical relationships can be written as:

$$\text{Max}_{L^i}\ \pi = \sum_i (P^i Q^i - \theta^i L^i) \qquad [1]$$

Table 6 Cropping Pattern by Land Types by Regions

Region	Land Type Wet Season Low Land	Dry Season Low Land	Upland
Northeast	Rice Glutinous Rice	Rice, Glutinous Rice Soybean Mungbean Groundnut	Maize, Sorghum, Sugarcane, Kenaf Cassava, Soybean, Mungbean
North	Rice Glutinous Rice	Rice, Glutinous Rice Mungbean, Soybean Groundnut	Maize, Sorghum, Sugarcane, Mungbean Groundnut, Cassava
Central	Rice Glutinous Rice	Rice, Mungbean Groundnut, Sugarcane	Maize, Sorghum, Soybean, Mungbean, Groundnut, Cassava, Sugarcane, Cotton.
West	Rice	Rice	Maize, Cotton, Cassava, Sugarcane
East	Rice	Rice	Maize, Cotton, Cassava, Sugarcane.
South	Rice	Rice	

subject to $\sum_i L^i = \bar{L}$ (2)

where P^i = Price/unit of product Q^i

θ^i = Input cost per unit of land for producing Q^i

L^i = Amount of land used to produce crop Q^i

$\bar{L}$ = Total land available

From equations (1) and (2), the Lagrangian function can be formed as:

$$Z = \sum_i (P^iQ^i - \theta^iL^i) + \lambda(\bar{L} - \sum_i L^i) \quad (3)$$

where λ is an as yet undetermined multiplier. The first-order conditions are obtained by setting the first derivative of (3) with respect to decision variables L^i equal to zero:

$$\frac{\partial Z}{\partial L^i} = P^if_i - \theta^i - \lambda = 0 \quad (4)$$

where f_i is marginal product of land L^i. Transposing the third term in equation (4) to the right, the equation can be rewritten as:

$$P^if_i - \theta^i = \lambda \quad (5)$$

where f_i is a marginal product of land L^i for crop Q^i. If there are n crops in a particular land group, the equation (5) can be elaborated as:

$$P^1 f_1 - \theta^1 = P^2 f_2 - \theta^2 = --- = P^n f_n - \theta^n = \lambda \qquad (6)$$

In some regions a particular land group has only one crop. Rice, for example, is the only crop grown in the wet season low land in the East, West and South. Since there is no substitution, the λ value can be set equal to zero. he relationship in (5), can thus be transformed to the marginal condition, where, marginal value product is equal to input cost.

In the Linear Programming approach, all the marginal products and input cost coefficients are assumed to be fixed, and the solutions are corner solutions (with equalities in the marginal conditions replaced by appropriate inequalities). Thus, in general, in order to obtain more than one crop in the solution for each region-landtype combination, further constraints on how much a particular crop can be expanded need to be imposed. This will be based on data concerning land suitability etc.

In this study, the idea is to formulate the model so that we obtain interior solutions. We follow the LP approach by assuming that the input cost coefficients are fixed per unit of land. This, of course, ignores choice of techniques considerations, and we recognize this weakness, but hope to extend the analysis to cover this aspect in the future. Here, we focus instead on the marginal product of land. Rather than a fixed marginal product as in the LP approach, we shall assume that there are diminishing marginal productivities on land as a particular crop is expanded more and more within a region-landtype combination. This takes into account the varying land suitability but in a different way from the LP approach.

Since Q_i is the function of land L_i, the relationship between these 2 variables needs to be established. In this study, the idea is to assume that productivity will eventually decrease as the planted area for a particular crop increases. This is intended to capture effects related to quality of the land. Normally, in a particular area, the best land for a crop will be used first. If income from a certain crop is higher than others, then more and more people will shift to that crop. The limit of expansion sets in when the marginal returns on all crops are equalized (as previously shown), and this gives the solution for the model. Because of diminishing marginal productivity, returns are no longer linearly related with land as in the linear programming framework, and changes in crop prices will generally lead to gradual changes in the cropping pattern.

To empirically implement this idea, a specific functional form relating output of a crop to land needs to be assumed. One criterion is that we should be able to econometrically estimate the parameters that determine the rates of diminishing marginal productivities. After some experimentation, the following functional form was settled upon:

$$Q^i = a_1^i(1-e^{-a_2^i m^i L^i}) \qquad (7)$$

where a_1^i and a_2^i are coefficients and m^i is a ratio of harvested to cultivated land area. The shape of this relationship between Q^i and L^i is illustrated in figure 2. This function shows that the marginal product increased at a decreasing rate as more land are used. The maximum output for a crop (i) is at point a_1^i. Note that it is quite possible for a_1^i to be very large, and a_1^i and a_2^i be such that the curve is almost linear in the range of land that is available in a region-landtype combination. We do not impose any a priori constraints on these. From the relationship in (7), the equation (6) can be expanded to,

$$P^1 a_1^1 a_2^1 m^1 e^{-a_2^1 m^1 L^1} - \theta^1 = P^2 a_1^2 a_2^2 m^2 e^{-a_2^2 m^2 L^2} - \theta^2 = --- = P^n a_1^n a_2^n m^n e^{-a_2^n m^n L^n} - \theta^n \qquad (8)$$

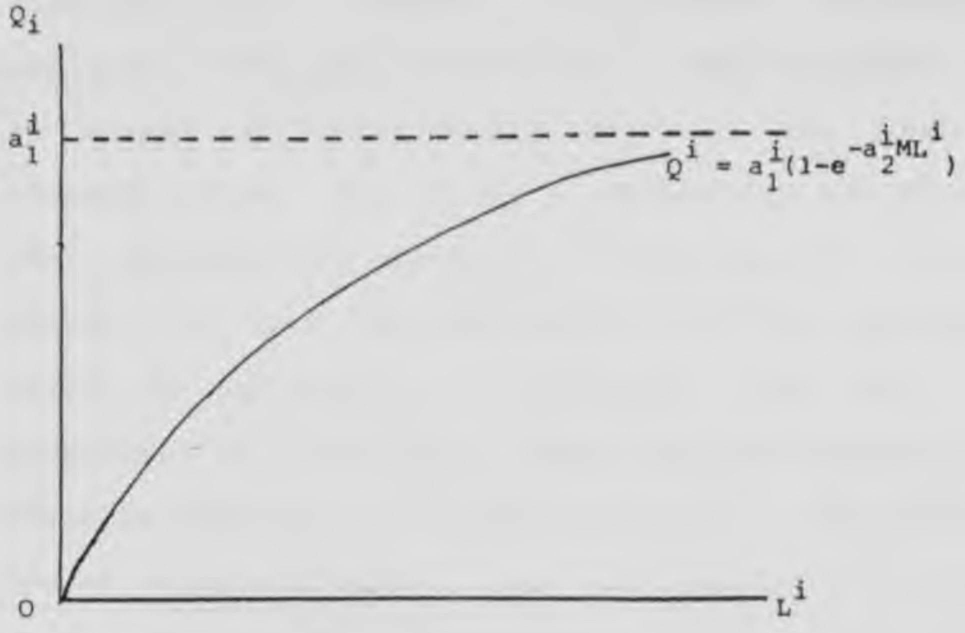


Figure 2 The Shape of the Relationsnip between Output and Land

Equation (8) equate the optimum relationship among crops within each land group.

The unknown parameters a_1^i and a_2^i for individual crops will be estimated by utilizing the above equation.

Ideally, the varous a_1 and a_2 should be estimated simultaneously. However, in practice, the amount of data available does not permit this. What was done instead was to select a "base" crop in each of the region-landtype classification. The a_1 and a_2 parameters for this crop were then estimated by appealing to equation (7), using a time series for output and cultivated area (the m parameter, the ratio of harvested to cultivated area was calculated separately for each crop, based upon an average of the past ratio of harvested to cultivated area). The choice of the "base" crop was based on the availability of a fairly long time series data and a reasonably smooth trend in the calculated yield. These were to ensure that the estimates for this base crop would be fairly robust, as the estimates for the base crop will be used in estimating those for the other crops as described below. Using the value $\hat{a}_1^i$ and $\hat{a}_2^i$ for the base crop, and substituting into (8) we get for the other crops:

$$P^i \hat{a}_1^i \hat{a}_2^i m^i e^{-\hat{a}_2^i m^i L^i} - \theta^i = P^j a_1^j a_2^j m^j e^{-a_2^j m^j L^j} - \theta_i^j \qquad (9)$$

where $j = 1, 2, \ldots n-1,$

$$a_1^j = \frac{P^i \hat{a}_1^i \hat{a}_2^i m^i e^{-\hat{a}_2^i m^i L^i} - \theta^i + \theta^j}{P^j a_2^j m^j e^{-a_2^j m^j L^j}} \quad (10)$$

By substituting equation (10) in (7) for crop j, the relationship becomes,

$$Q^j = \left[\frac{P^i \hat{a}_1^i \hat{a}_2^i m^i e^{-\hat{a}_2^i m^i L^i} - \theta^i + \theta^j}{P^j m^j} \right] \frac{1}{a_2^j} (e^{a_2^j m^j L^j} - 1) \quad (11)$$

From (11) the parameter a_2^j can be estimated by utilizing non-linear maximum likelihood routine and then substitute its estimated value $(\hat{a}_2^j)$ in (10). By substituting the estimated $\hat{a}_2^j$ into (10) the estimated value of a_1^j can be found,

$$\hat{a}_1^j = \frac{P^i \hat{a}_1^i \hat{a}_2^i m^i e^{-\hat{a}_2^i m^i L^i} - \theta^i + \theta^j}{P^j \hat{a}_2^j m^j e^{-\hat{a}_2^j m^j L^j}} \quad (12)$$

In this study, the latest year (1984) for the value of ^{i}, P^j, θ^i and θ^j are used in (12) in order to calibrate the base year solution. Since, the estimated value of a_1 and a_2 for all crops are found, these values will be subsequently applied in the programming model. The estimated values of a_1 and a_2 for each region, soil type, and cropping pattern are shown in table 7.

In the solution procedure, because the only non-linear feature involves the relationships between output and land, an extension of the linear programming method called Separable Programming can be used. This procedure sets up the separable function which is represented by a polygonal approximation. An example of a polygonal approximation of a separable function y = f(x), defined in the interval from $x = x_o$ to $x = x_r$ is shown in figure 3. The grid is defined by a set of r+1 points on the x-axis. The lengths of the resulting intervals on the x-axis are D_{x1}, D_{x2}, .., D_{xr}, and the lengths of the resulting intervals on the y-axis are D_{y1}, D_{y2}, .., D_{yr}. The separable variable x can be developed as a function of special variables X_1, X_2, .., X_r where X_1 defines the first interval of length D_1, X_2 defines the second interval of length D_2, and so on. Any value of X from $X = X_o$ to $X = X_r$ can be expressed in terms of the equation:

$$X = X_o + D_{x1} * X_1 + D_{x2} * X_2 + .. + D_{xr} * X_r \qquad (13)$$

Equation (13) is referred to as the grid equation. Similarly, the separable function Y can be expressed in

Table 7 Estimated Coefficients a1 and a2 by Regions, Land Types and Crops.

Region/Crops	Estimated Coefficients a1	a2
Northeast		
Group 1: Glutinous Rice	10.426	0.019183
Rice	1.04985	0.21141
Group 2: Glutinous Rice	10.35999	0.048239
Rice	9.12426	0.052579
Soybean	0.20471	0.9157
Mungbean	0.59072	0.13798
Groundnut	0.28259	1.9198
Group 3: Soybean	0.06453	3.87
Groundnut	0.227979	1.0297
Mungbean	0.389439	0.28986
Sugarcane	6.173093	2.723
Maize (1)	1.715397	0.56083
Maize (2)	0.703525	1.8385
Maize + Sorghum	0.217518	4.9613
Kenaf	0.37477	0.67384
Cassava	23.00859	0.27034
North		
Group 1: Glutinous Rice	1.0766	0.52896
Rice	1.08124	0.47862
Group 2: Glutinous Rice	1.359063	0.4461
Rice	0.65982	1.3015
Mungbean	0.61462	0.18741
Soybean	0.89187	0.18841
Groundnut	0.603222	0.32112
Group 3: Soybean	2.669941	0.073885
Sugarcane	7.803679	2.2153
Groundnut	7.2486	0.029215
Cassava	3.068183	0.99707
Cotton	29.34951	0.05731
Mungbean	0.967075	0.18741
Maize (1)	29.57833	0.016003
Maize (2)	0.494458	3.6441
Maize + Sorghum	3.45132	0.16482
Sorghum (2)	1.060552	0.31675

Table 7 Estimated Coefficients a1 and a2 by Regions, Land Types and Crops. (Cont'd)

Region/Crops		Estimated Coefficients a1	a2
Central			
Group 1:	Glutinous Rice	1.2495	0.27033
	Rice	0.640381	1.7389
Group 2:	Rice	3.844184	0.22073
	Mungbean	1.8328	0.049977
	Groundnut	0.006235	37.584
	Sugarcane	0.598119	24.996
Group 3:	Soybean	0.037083	5.1187
	Mungbean	0.22287	0.58423
	Groundnut	0.015549	18.574
	Cassava	1.730953	11.314
	Cotton	0.576597	3.8348
	Sugarcane	7.327752	1.9473
	Maize (1)	0.754156	0.87255
	Maize (2)	39.24334	0.015204
	Maize+Sorghum	1.931948	0.29772
South			
Group 1:	Rice	3.297201	0.072177
Group 2:	Rice	2.789643	0.10554
West			
Group 1:	Rice	1.345249	0.15656
Group 2:	Rice	7.1934667	0.044776
Group 3:	Cassava	4.0492	0.69979
	Cotton	5.944851	0.23448
	Sugarcane	20.02103	0.49372
	Maize (1)	1.33944	0.36412
	Maize (2)	10.49528	0.065577
East			
Group 1:	Rice	1.766889	0.12326
Group 2:	Rice	15.583594	0.019686
Group 3:	Cassava	10.595	0.37051
	Maize (1)	6.705282	0.040839
	Cotton	4.173173	0.28004
	Sugarcane	5.963943	2.223

Maize (1) : only one crop annually
Maize (2) : two crop annually
Maize + Sorghum : first season maize and second season sorghum
Sorghum (2) : two crop annually

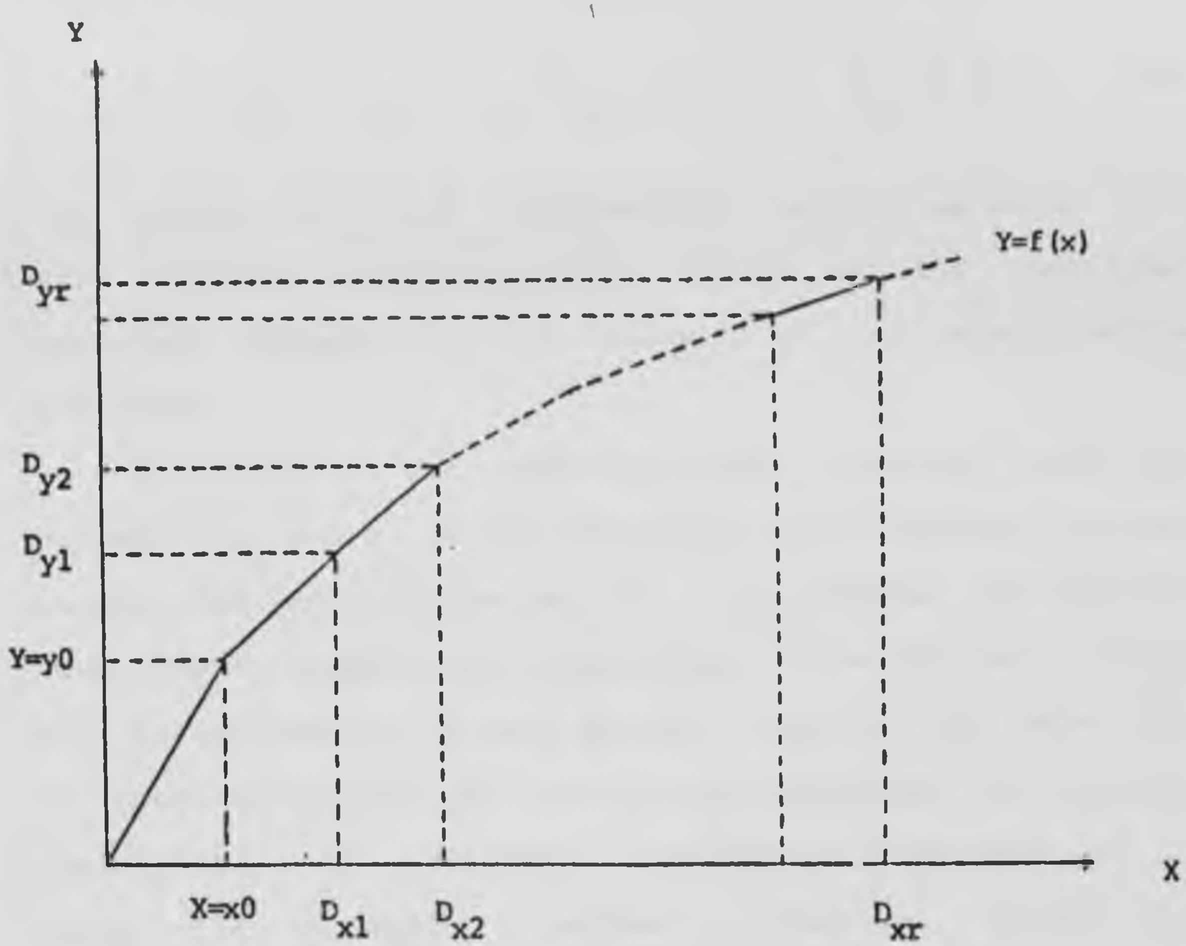


Figure 3 Polygonal Approximation of a Separable Function

terms of the same special variables and the lengths of the resultant intervals along the y-axis as follows:

$$Y = Y_o + D_{y1} * X_1 + D_{y2} * X_2 + \ldots D_{yr} * X_r \qquad (14)$$

The values of X_1 to X_r that satisfy the grid equation (13) also satisfy equation (14), known as the functional equation, because of the linearity of the approximating functions.

By applying the previous method together with the estimated a_1 and a_2 to the production relationships between output and land in equation (7), the optimum land used for each crop in a particular land group can be derived. Since the coefficients a_1's were derived from the 1984 base year in conjunction with the equilibrium conditions for profit maximization, the resulting land use in 1984 obtained by using the separable programming procedure should be approximately the same as the actual land used in that year. The solutions from the model and the actual land used are shown in table 8. Even though the values are not exactly the same because it involved the piece-wise linear approximations, the results, however, are very close to the actual base year values. This is in contrast to the usual linear programming method, where the base solutions are usually rather different from the actual base year values.

The total labor demand in each region by month is illustrated in table 9. From the solution, total labor demand are high during the months of October to December. These months are both cultivated and harvested period for most crops, thus requiring a lot of labor. On the other hand, total demand for labor is small in January, February, and September. The gap of labor demand between the peak and the bottom period is high. This is clearly related to the seasonal unemployment problem. Aside from total cultivated areas, the spread among different crops is also important from the employment point of view, because each crop has different labor requirements for a given amount of land and also because the pattern of labor use by month varies a great deal for different crops. The data on labor requirements for each crop by region are shown in Appendix I. The next section will illustrate some of the application of the developed model regarding the impact of changes in products' prices on the issue of agricultural labor demand.

Table 8 Comparison Between Actual Land Used and Solution Value for 1984

	Actual Land Used (1,000 Rai)	Solution (1,000 Rai)
North-Eastern		(1,000 Rai)
Group 1 : Rice	11,399.93	11,800.00
Glutinous Rice	17,167.71	17,200.00
Group 2 : Rice	246.24	246.00
Glutinous Rice	138.85	140.00
Soybean	23.04	23.00
Mungbean	54.78	54.00
Groundnut	55.41	55.00
Group 3 : Maize 1	2,434.27	2,433.00
Maize 2	452.37	453.00
Sorghum 2	180.23	180.00
Sugarcane	493.15	490.00
Kenaf	1,004.01	1,000.00
Cassava	5,103.70	5,100.00
Soybean	102.07	101.00
Groundnut	128.77	130.00
Mungbean	236.21	238.00
North		
Group 1 : Rice	9,697.13	9,701.00
Glutinous Rice	3,613.57	3,610.00
Group 2 : Rice	453.56	453.00
Glutinous Rice	106.81	106.00
Mungbean	463.31	463.00
Soybean	297.86	300.00
Groundnut	90.15	90.00
Group 3 : Maize 1	5,354.67	5,365.00
Maize 2	264.66	264.00
Sorghum 2	723.70	721.00
Mungbean	2,097.87	2,090.00
Soybean	737.95	737.00
Groundnut	358.07	358.00
Cassava	399.89	399.00
Sugarcane	562.84	562.00
Sorghum 1	81.78	81.00
Cotton	266.56	268.00

Table 8 Comparison Between Actual Land Used and Solution Value for 1984 (Cont'd)

	Actual Land Used (1,000 Rai)	Solution (1,000 Rai)
Central		
Group 1 : Rice	7,486.52	7,480.00
Glutinous Rice	100.82	107.00
Group 2 : Rice	2,877.79	2,877.00
Mungbean	121.94	121.00
Groundnut	8.66	8.00
Sugarcane	43.65	43.00
Group 3 : Maize 1	1,746.79	1,748.00
Maize 2	248.79	250.00
Sorghum	811.19	811.00
Soybean	57.20	57.00
Mungbean	209.62	211.00
Groundnut	21.90	22.00
Cassava	236.31	234.00
Cotton	126.63	127.00
Sugarcane	572.26	572.00
South		
Group 1 : Rice	3,728.50	3,720.00
Group 2 : Rice	223.98	223.00
East		
Group 1 : Rice	3,225.58	3,223.00
Group 2 : Rice	407.24	407.00
Group 3 : Maize	502.76	504.00
Cotton	60.55	61.00
Cassava	2,745.88	2,745.00
Sugarcane	574.76	575.00
West		
Group 1 : Rice	1,395.75	1,390.00
Group 2 : Rice	76.33	76.00
Group 3 : Maize 1	206.89	208.00
Maize 2	97.94	100.00
Cotton	46.02	46.00
Cassava	293.70	293.00
Sugarcane	1,147.45	1,147.00

Table 9 Total Labor Requirement at the Base Year Optimum by Regions and by Months

LABOUR

REGION	JAN.	FEB.	MAR.	APR	MAY	JUN.	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
NORTH EASTERN	98895	29496	54593	84882	56482	106027	283543	152988	40730	721963	924065	209158	29630[illegible]
NORTHERN	54124	30495	42292	50129	39351	380941	177280	27747[illegible]	48725	97587	309169	506735	211430[illegible]
CENTRAL PLAIN	63965	26736	34182	209159	69003	175396	87296	34441	21111	21184	262933	146007	11514[illegible]
EASTERN	25495	18885	42843	55663	46097	141002	33009	14944	10625	121266	104515	103357	[illegible]
WESTERN	29581	27634	34458	22536	24272	92228	21680	12044	9121	17394	41960	51087	383995
SOUTHERN	20457	88952	145898	15934	8968	46221	11674	47135	56291	167667	30687	[illegible]	[illegible]
TOTAL	292517	222198	354266	438303	444173	941815	614482	539025	186603	1147061	1673329	1048458	902230

4. <u>Price Change Effect on Optimum Solution of the Model</u>

The purpose of this section is to assess the impact of the expected change in crop prices on the optimum land use and labor demand in each region.

The projected future prices for the various crops were based to some extent on The World Bank price projection. However, they were adjusted to round out the numbers, or where the forecasts was thought to be rather unrealistic. The major adjustment is on the price of sugar on which the World Bank expects an increase in real terms of over 12% per annum to 1990. For the purpose of the simulation, this is assumed to increase only 4% per annum in real term. The projected prices are shown in table 10. If one assumes that the domestic prices of these crops move in the same direction, the annual percentage changes in table 10 can be used as a proxy for future domestic commodity prices. The projection for some commodity prices, such as glutinous rice, mungbean, cassava, are derived by using the movement of the closely related crops and also based on long term price trends.

Expected inflation rate of 3.0% is used to adjust for both future labor cost and other costs. Future land available for each group in each region is based on the projection by Chalamwong and Khatikarn (1985). Labor force constraint is also accommodated by utilizing a 2.0% average

Table 10 Major Crop Price Assumptions 1986 - 1991

Commodities	Real Price Increase Per Annum
Non - Glutinous Rice	0%
Glutinous Rice	0%
Maize	-2%
Sorghum	-2%
Mungbean	0%
Soybean	1%
Groundnut	-2%
Kenaf	-4%
Cassava	-0.5%
Sugarcane	4.0%
Cotton	0.5%
Rubber	0%

labor force growth. When the information are incorporated into the Separable Programming model developed earlier, the new optimum solutions can be generated to find the impact of price changes on labor demand.

North-Eastern Region The scenario to be considered in this study is during the period of the Sixth Five-Year Plan (1987-1991). One of the major assumption here and in other regions is that no new crop will be introduced into the region. This is of course a strong assumption, and there are two aspects which should be indicated. First, the crops that are dealt with in the model are restricted to the major crops. Such things as fruits and vegetables are not included. The main reason is the lack of data which would allow estimates of the model parameters. As better data become available, these can be integrated in the future. Secondly, the model also does not take into account the introduction of a new crop which previously is not grown in the area, although it may be grown in other areas. Here again there is a lack of data on what would be the input coefficients and land productivity were such crops to be introduced. Given these qualifications, the optimum land use for each crop in 1984 and 1991 are presented in table 11. The simulation results show a change in land utilization for most crops. Mungbean is the crop which illustrates the highest percentage change. Its utilization of land increased from 292,000 rais in 1984 to approximately

Table 11 Land Utilization in the North-East by Crops Between 1984-91 (1,000 Rais)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	29000	29000	0	0.00
Second Rice	386	208	-178	-8.45
Maize	2886	2992	106	0.52
Sorghum	180	180	0	0.00
Mungbean	292	1230	938	22.81
Soybean	124	177	53	5.22
Groundnuts	185	600	415	18.30
Kenaf	1000	800	-200	-3.14
Cassava	5100	5083	-17	-0.05
Sugarcane	490	600	110	2.94
Sum	39643	40870	1227	0.44

Table 12 Labor Requirement in the North-East by Crops Between 1984-91 (Man-Day)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	13354146	13354146	0	0.00
Second Rice	212889	114712	-98177	-8.45
Maize	1027764	1065577	37813	0.52
Sorghum	22639	22639	0	0.00
Mungbean	73295	314510	241215	23.13
Soybean	65918	93745	27827	5.16
Groundnuts	138522	472675	334153	19.17
Kenaf	615515	492412	-123103	-3.14
Cassava	2901439	2891702	-9737	-0.05
Sugarcane	365029	446974	81945	2.94
Sum	18777156	19269092	491936	0.37

1,230,000 rais in 1991. Groundnut also increased a lot. On the other hand, the second rice crop and kenaf are the only two crops that show a significant decline in production from 386,000 rais to 208,000 rais and 1,000,000 rais to 800,000 rais accordingly.

When the projected labor requirement is considered, the requirements for mungbean and groundnut are expected to increase by about 23% and 19% per annum. The overall labor demand for the existing crops is expected to increase from approximately 18 million man-days to 19 million man-days, or at less than an average 0.5% per annum.

<u>Central Region</u> Here, as in the Northeast, mungbean has the highest percentage increase in cultivated area of about 17% per annum. In absolute terms, however, The major rice crop has the highest area growth in spite of no real price increase. The highest drop in area is maize. It declined about 2% per annum or by 258,000 rais from 1984 to 1991. The reduction is caused by the projected real price decline for maize at 2% per annum. The changes in land used by crop are illustrated in Table 13. It should be noted that in this region, and some other regions, planted area for Coconut was also included. This crop, however, was treated as an exogenous factor which was not derived from the above described model. The total land used in this region show a slightly increase of about 1.5 million rais or 1.4% annual growth.

Table 13 Land Utilization in the Central by Crops Between 1984-91 (1,000 Rais)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	7587	8407	820	1.48
Second Rice	2877	2950	73	0.36
Maize	1998	1740	-258	-1.96
Sorghum	811	850	39	0.67
Mungbean	334	989	655	16.78
Soybean	57	85	28	5.87
Groundnuts	31	27	-4	-1.95
Cotton	127	145	18	1.91
Cassava	234	220	-14	-0.88
Sugarcane	615	799	184	3.81
Coconut	53	54	1	0.27
Sum	14724	16266	1542	1.43

Table 14 Labor Requirement in the Central by Crops Between 1984-91 (Man-Day)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	2633772	2908842	275070	1.43
Second Rice	1256775	1288665	31890	0.36
Maize	782184	684548	-97636	-1.89
Sorghum	113437	118892	5455	0.67
Mungbean	73261	237189	163928	18.27
Soybean	21476	32025	10549	5.87
Groundnuts	18710	16772	-1938	-1.55
Cotton	109499	125415	15916	1.96
Cassava	99870	93894	-5976	-0.88
Sugarcane	494993	641138	146145	3.76
Sum	5603977	6147380	543403	1.33

Rice which is a major user of labor in this region, will still continue to dominate the labor usage even though the expected real price is assumed to be stagnant over the studied period. At the end of the Sixth Plan, the rice sector will utilize roughly 68% of agricultural labor time. When it is considered in percentage term, however, mungbean has the highest growth at 18% per annum. This crop will absorb slightly more than 230,000 man-days in 1991 or an increase of about 160,000 man-days from 1984. Maize, on the other hand, is the crop that shows the highest decline in labor usage. Labor needed in this activity will decline to less than 700,000 man-days in 1991 or decreasing by approximately 2% per annum. To sum up, the total labor demand for all crops in this region will increase to about 6 million man-day in the next 5 years. This represents an average growth of around 1.3% per annum.

Northern Region Maize which is one of the main crops in the north besides rice, illustrates a decline by about 3% per annum. In addition, sorghum, groundnut and cassava also show a decline in producing area. Groundnut is the only one crop which lost the competitive position, hence it shows a sharp drop in the area to almost none in 1991. The big gain is coming from soybean, the growing area anticipated to increase slightly more than 2.6 million rais or at 20% per annum. Rice shows the second highest increase in land area at the 2% annual growth rate which is the total increase about 1.7 million rais. The overall utilized area will increase by 2.9 million rais or 2% increase per annum.

Total labor requirement in terms of man-days also shows a similar increase at 1.6% per annum. Among all crops, soybean will take most of the increases in labor. The highest decline for the labor used in absolute term is from maize.

Eastern and Western Regions Since these two regions have similar cropping patterns, they will be combined under one section. The results from the simulation, nevertheless, showed some differences. Maize and cassava in the west will be replaced by other more profitable crops. The producing areass for these crops in the West will sharply decline to become minimal. In the east, on the other hand, land use for cassava will decrease only 2% per annum. In absolute term, however, producing area for cassava in the east will be reduced more than those in the west. In contrast to the west, maize activity in the east shows the biggest gain in producing area from 504,000 rais to 800,000 rais from 1984 to 1991 respectively or about 7% annual growth rate.

Rice in both regions illustrates moderate annual growth in planted area which is approximately 1%. The increase in producing area, however, is not high comparing to other regions. The total increase is less than 500,000 rais for both regions. Sugarcane is also one of the crops which has

Table 15 Land Utilization in the North by Crops Between 1984-91 (1,000 Rais)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	13000	14750	1750	1.82
Second Rice	559	563	4	0.10
Maize	5629	4646	-983	-2.70
Sorghum	802	600	-202	-4.06
Mungbean	2553	2629	76	0.42
Soybean	1037	3700	2663	19.93
Groundnuts	448	0	-448	-100.00
Cotton	268	400	132	5.89
Cassava	399	250	-149	-6.46
Sugarcane	562	680	118	2.76
Sum	25257	28218	2961	1.60

Table 16 Labor Requirement in the North by Crops Between 1984-91 (Man-Day)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	5476544	6221573	745029	1.84
Second Rice	288553	290649	2096	0.10
Maize	2101401	1734061	-367340	-2.71
Sorghum	81654	60606	-21048	-4.17
Mungbean	527346	544460	17114	0.46
Soybean	419027	1453028	1034001	19.44
Groundnuts	316719	0	-316719	-100.00
Cotton	240588	359089	118501	5.89
Cassava	233629	146384	-87245	-6.46
Sugarcane	474756	574438	99682	2.76
Sum	10160217	11384288	1224071	1.64

Table 17 Land Utilization in the West and East by Crops Between 1984-91 (1,000 Rais)

East Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	3223	3500	277	1.18
Second Rice	407	450	43	1.45
Maize	504	800	296	6.82
Cotton	61	62	1	0.23
Cassava	2745	2300	-445	-2.50
Sugarcane	575	700	125	2.85
Rubber	952	1016	64	0.93
Coconut	154	214	60	4.81
Sum	8621	9042	421	0.68

West Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	1390	1547	157	1.54
Second Rice	76	88	12	2.12
Maize	308	0	-308	-100.00
Cotton	46	80	34	8.23
Cassava	293	0	-293	-100.00
Sugarcane	1147	1672	525	5.53
Coconut	536	616	80	2.01
Sum	3796	4003	207	0.76

Table 18 Labor Requirement in the East and West by Crops Between 1984-91 (Man-Day)

East Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	1208220	1312061	103841	1.18
Second Rice	172210	190403	18193	1.45
Maize	189769	301361	111592	6.83
Cotton	53302	54624	1322	0.35
Cassava	1297576	1087223	-210353	-2.50
Sugarcane	415121	505629	90508	2.86
Sum	3336198	3451301	115103	0.49

West Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	499825	556179	56354	1.54
Second Rice	33046	38176	5130	2.08
Maize	108968	0	-108968	-100.00
Cotton	37691	65550	27859	8.23
Cassava	141624	0	-141624	-100.00
Sugarcane	920257	1341472	421215	5.53
Sum	1741411	2001377	259966	2.01

a positive annual growth rate in both regions. The planted area is expected to increase by about 650,000 rais during the studied period. The shift from other crops to sugarcane is a result of the relative price increase of sugarcane compared to other crops in the regions. In the eastern region the anticipated land used for both rubber and coconut were also presented while in the west there was only coconut as an exogenous crop.

Total labor requirements in both regions demonstrate an increase of about 1% per annum. The highest annual percentage increase is in the cotton activity in the west and maize activity in the east.

Southern Region Apart from rubber and coconut, which are treated exogenously in the model, rice is the only crop in the model in this region. The total area change is roughly 500,000 rais. The annual growth rate is about 2%. Total labor requirements for both crops increase at 2% per annum.

In general, we can see that the results are intuitively reasonable. There tends to be a shift out of crops whose price outlook are bad to those where prices are relatively better. There are nevertheless variations among regions in the crops which are expected to expand or contract as a result of the price changes. These depend on which other crops are grown in the area and their price outlook. For example, in the north, central and the western regions, the

Table 19 Land Utilization in the South by Crops Between 1984-91 (1,000 Rais)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	3720	4132	412	1.51
Second Rice	223	314	91	5.01
Rubber	9302	9934	632	0.94
Coconut	1332	1428	96	1.00
Sum	14577	15808	1231	1.16

Table 20 Labor Requirement in the South by Crops Between 1984-91 (Man-Day)

Commodities	Year 1984	Year 1991	Changes	Annual Growth (%)
Major Rice	1718026	1908203	190177	1.51
Second Rice	115644	163048	47404	5.03
Sum	1833670	2071251	237581	1.76

production of maize is expected to decline quite fast, while in the east, maize output show an increase. This is because in the east maize is expected to substitute for cassava, an important crop in the east whose price prospect is also not good, while in the other areas, other crops such as soybean and mungbean and mungbean are more profitable than maize. Thus, the potential substitution pattern in each area is quite important for determining the resulting response to price changes, and this will be looked at in more detailed in the next section.

Looking at the aggregate picture on labor requirements, Table 21 shows the average growth per annum of labor use for the various crops between 1984 and 1991.

Employment in paddy production is expected to increase by about 1% per annum. In fact, the substitution possibilities for the main rice crop is fairly limited, so one does not expect any dramatic changes. For the other crops, the situation is different.

TABLE 21

INCREASE IN LABOUR USE BY CROPS
(1984-1991)

	PERCENT PER ANNUM
FIRST RICE CROPS	1.1%
SECOND RICE CROPS	.0%
CASSAVA	-1.7%
MAIZE	-1.8%
SUGARCANE	4.7%
SORGHUM	-1.2%
MUNGBEAN	8.4%

SOYBEAN	20.8%
GROUNDNUT	.5%
COTTON	5.4%
KENAF	-3.1%
RUBBER	1.3%

Maize, which is a major of user of labor in the north, shows a decline by 1.8% per annum. This results from a shift out off maize in the north into mungbean, sugarcane, cotton and particularly soybean, crops whose price prospects are better. Employment in cassava is expected to decline by 1.7% per, annum. Again, there is shift out off cassava in all regions where it is grown. The other losers are sorghum and kenaf, crops where prices are expected to decline a lot in real terms.

Sugarcane expands as expected, with employment growth increasing at 4.7% per annum. This occurs everywhere but is most pronounced in the west, where there is a shift from both cassava and maize into sugarcane. Mungbean and Soybean are big gainers, particularly the latter, because of their relatively better price prospects compared to some of the other crops. In the north, employment in soybean is expected to almost triple, and in the north-east and central plains, it is expected to expand by around 45% between 1984 and 1991. Mungbean expands most rapidly in the north-east, especially at the expense of kenaf. Cotton also show a big increase in employment, with the gains being substantial in the north, east and the west.

The case of groundnut is quite interesting. While over all it only show a growth in labor usage of .5% per annum, the pattern is very different across regions. In the north-east, it is a big gainer, with labor usage increasing at almost 20% per annum. However, in the north, production of groundnut is expected to decline to almost nothing. This latter result seems to be due to easy substitution possibilities between groundnut and soybean in the north. This does not seem to be the case in the north-east. Also, in the north-east there are shifts from kenaf, a crop whose price prospect is the worse, into groundnut.

Looking at the seasonal pattern, Table 22 shows the pattern of labor demand by season derived from the solution. The results were adjusted to be comparable with the Labour Force Survey figures in 1984, by taking the growth rates from the model and adjusting the employment figures from the Labour Force Survey. (This of course assumes that the average working hours of each worker remains about the same). For the dry season, average labor use between January and May was used, because from the labor use figures this seems to correspond to the period when the dry season crops are grown. The average for the rest of the year was used for the wet season figures.

TABLE 22

EMPLOYMENT GROWTH IN WET AND DRY SEASON
(1984-1991)

	1984		1991		AVERAGE GROWTH	
	DRY SEASON	WET SEASON	DRY SEASON	WET SEASON	DRY SEASON	WET SEASON
NORTH	3539760	4525186	4074981	4552721	2.86%	.12%
NORTH-EAST	4625913	8182253	5155577	8304627	2.19%	.30%
SOUTH	1859400	1960637	2025006	2112888	1.72%	1.51%
CENTRAL	2777426	2964966	3158299	3155455	2.60%	1.25%
TOTAL	12802499	17633042	14413863	18125691	2.40%	.55%

A clear pattern is that the growth in labor demand is expected to be much greater during the dry season compared to the wet season. The fact that wet season labor demand does not increase very much is because of the very poor outlook on prices. The growth in cultivated area is slower than that for the maximum available cultivated area assumed in the model. In the dry season, the growth comes mainly from sugarcane, where the price is good, and this is the crop that is fairly labor intensive (1.82 times that of paddy), and also uses more labor in the dry season than the wet season, see table 3.

The implication for labor demand is not good. While it is true that dry season employment is to grow more than in the wet season, the overall rate is about the same as that expected for the rural labor force of around 2.5%, see Sussangkarn, Ashakul and Myers (1986), chapter 3.

Currently, the rate of seasonal unemployment is around 19% of the labor force, and given a dry season employment growth in agriculture of around 2.4% the problem of seasonal unemployment will not improve much.

The growth of only .5% per annum in wet season labor demand is very worrying. This is far less than the expected increase in the labor force indicated earlier. To understand the implications of this result, we have to bear in mind the assumptions in the model used for these scenarios. The most important are that real input costs (including the real wage rate) will remain as in 1984, and also that there are no changes in the production techniques, eg. labor intensities. Clearly, if these assumptions lead to labor demand growing at only around half a percent per annum while the labor supply increases at 2.4% per annum, then the imbalance in the labor market may make these assumptions untenable. Wages are likely to adjust downwards, and farmers may choose techniques that are more labor intensive. Other types of adjustments may also occur. Over all, from the analysis, a number of adjustments are likely to occur in the rural areas.

1. Real wages in the rural areas may fall during the period of the Sixth Plan, rather than be constant as assumed in the simulation. This would be a severe blow to the prospects of the rural

population, who are already much worse off than those in the urban areas, particularly those in Bangkok.

2. Underemployment may increase rapidly, so that in effect, agricultural work is more shared out among the rural population. Again, this will not help in terms of per capita income growth in the rural areas.

3. There will be an accelerated move in the expansion of other currently minor activities, such as fruits, vegetables, and other minor crops. This would be in line with the trend emphasized in the Sixth Plan. However, because their employment base is still very small, it is unlikely that this will have much over all impact on the employment prospects of the rural labor force in the next 5 years. Of course, over the longer term the impact can be much greater.

4. There will a faster shift towards off-farm employment in industries or services in the rural areas. However, because much of rural industries and services are related to the general prospects of agriculture, if the latter is poor then rural industries and services are unlikely to be able to expand much. One thing that would help would be an expansion of industries, particularly those

currently going through a boom phase, eg. the labor intensive exporting industries, into the rural areas. This may occur to some extent near the larger cities, but may be mainly only around the central, east and south regions.

5. Migration from the rural areas will accelerate. Indeed, currently the ratio of employment in agriculture in Thailand (70%) seems to be much higher than other countries with a comparable share of agriculture in GDP. In the future, with the poor prospects in the major crops, the out-migration from the rural areas is likely to dominate the picture on population change in Thailand.

There is no doubt that with the expected trends in the prices of major crops, the outlook for the rural population cannot be anything but bad. This modeling exercise has tried to quantify part of the problem, at least as far as it relates to the demand for labor in the major crops, which is of course a major determinant of incomes in the rural areas. While the model did not take into account the minor crops and such things as livestock and forestry, the results do nevertheless give the likely trends for the major crops. The results indicate the substitutability patterns that can be expected given the change in relative prices. In the next section, the possibilities for crop substitution are explored further.

5. Crop Substitutability

The last section gave the outlook for the cropping pattern and labor demand in light of the expected prices for the major crops over the period of the Sixth Plan. The outcomes depended on the substitution possibilities between different crops in various areas. In this section, we look at this issue in more detailed because the model is particularly well suited for such an analysis. The extent of crop substitutability is related to the yield curves for the various crops which are estimated in the model, as these will determine the changes in yield as the cultivated area of a particular crop is expanded or reduced. The analysis will indicated which crops are good substitutes in various areas, and the responsiveness of the substitution possibilities to price changes.

We carried out experiments where for each experiment the price of one particular crop is increased by 5% while all the input costs and the prices of other crops are kept constant. Then the percentage changes in production of the various crops are observed.

Table 23 illustrates, for each region and for each crop, the production before and after the price increase of that crop, and also the proportion of the percent changes in production to the percent changes in price (which is 5%). This latter value is an approximate estimate of the own price elasticity of supply of each crop. In the north-

Table 23 The Proportion of the Percent Changes in Production to 5 Percent Changes in Price

North-East Commodities	Production (Tons)		Proportion
	Before	After	
Rice	8873567	8989748	0.2619
Maize	1040592	1062829	0.4274
Sorghum	36557	37036	0.2621
Mungbean	29179	32305	2.1426
Soybean	22593	24618	1.7926
Groundnuts	38065	42530	2.3460
Kenaf	166176	173576	0.8906
Cassava	13335554	13492225	0.2350
Sugarcane	3501396	3545202	0.2502

East Commodities	Production (Tons)		Proportion
	Before	After	
Rice	1211509	1318829	1.7717
Maize	135999	214647	11.5660
Cotton	6249	6403	0.4929
Cassava	5722931	5799306	0.2669
Sugarcane	3476726	3565849	0.5127

West Commodities	Production (Tons)		Proportion
	Before	After	
Rice	578173	804775	7.8386
Maize	119386	134109	2.4665
Cotton	6262	10848	14.6471
Cassava	684336	804986	3.5260
Sugarcane	7846623	8134187	0.7330

Table 23 The Proportion of the Percent Changes in Production to 5 Percent Changes in Price (Cont'd)

Central Commodities	Production (Tons) Before	After	Proportion
Rice	4510593	4542841	0.1430
Maize	693079	764031	2.0474
Sorghum	141496	147611	0.8643
Mungbean	33295	52356	11.4498
Soybean	8943	9490	1.2233
Groundnuts	6521	6732	0.6471
Cotton	20985	22089	1.0522
Cassava	613119	616768	0.1190
Sugarcane	4234781	4317057	0.3886

North Commodities	Production (Tons) Before	After	Proportion
Rice	5450318	5909976	1.6867
Maize	2357117	2613825	2.1782
Sorghum	143933	160787	2.3419
Mungbean	331637	345060	0.8095
Soybean	176954	252286	8.5143
Groundnuts	91450	163659	15.7920
Cotton	42958	63891	9.7458
Cassava	919429	1016324	2.1077
Sugarcane	4301862	4488613	0.8682

South Commodities	Production (Tons) Before	After	Proportion
Rice	1111184	1324341	3.8366

eastern region, for example, groundnut has the highest own-price elasticity of supply, at about 2.35, while that for cassava is the lowest, at 0.235. The basic determinant of these elasticities are the rate at which the yield of a crop changes as the cultivated area is changed. If the yield curve for a crop is rather flat at the base cultivated area, then ceteris paribus as the price increases the cultivated area of the crop will tend to expand by more than if the yield curve shows rapid diminishing returns. Crops with rather low own-price elasticities are generally those where most of the suitable land in the area has been exploited, and diminishing returns will set in fast with further expansion in the cultivated area. Of course, the own price elasticity will depend also on the yield curves of other crops in the area, because in general the expansion in one crop is at the expense of other crops (unless there are a lot of unused area for cultivation in the region-landtype combination), thus how fast the yield of other crops change as their cultivated areas is changed will also affect the final solution point as given by the first order conditions.

Looking at table 23, we can see that there are a great deal of variation in the pattern of the own-price elasticities across regions. As already indicated, mungbean has the highest elasticity in the north-east, and this is also true in the central region. However, in the north, the own-price elasticity of mungbean is only 0.81, while the highest elasticity in the north is that for groundnuts.

In the north-east, apart from mungbean, soybeans, and groundnuts, where the elasticity is greater than one, all the other elasticities are less than one. Thus, it appears that for most crops the suitable cultivation areas have been exploited, and production increases in response to price increases will not be rapid. It should be borne in mind, however, that this presumes that there are no major changes which will alter the yield patterns, such as might happen with the introduction of new large scale irrigation projects in the north-east.

In the east, the potential for an increase in the production of maize seems to be very good, given an increase in price. The elasticity is very high, at over 11.5. However, the base production of maize in the east is still very small, and the model indicates that its production can still be expanded quite a lot without substantial declines in yield. For the other crops except for paddy, the elasticities are all very small. In contrast, in the west, the elasticities are generally high. This means that the yield curves for most crops are fairly flat, and crop substitution can occur easily. This explains the reason why the output of maize and cassava are expected to decline to just about nothing in the simulation reported in the last section. These crops have poor price prospects when compared to cotton and sugarcane, and because substitution can occur fairly easily, farmers shift out of these crops to cotton and sugarcane.

In the central region, the crops are fairly evenly spread out between those with relatively high and low own-price elasticities. Rice and cassava have the lowest elasticities, at 0.14 and 0.12 respectively. Sorghum, groundnuts and sugarcane also have elasticities less than one. For the other crops, mungbean has by far the highest elasticity, at 11.45. Maize follows at 2.05, with soybean and cotton at just slightly above one.

The north is similar to the west in that elasticities are generally high. Apart from mungbean and sugarcane, whose elasticities are less than one, all the other crops have elasticities greater than one. Groundnut, cotton and soybean in particular have rather high elasticities, indicating substantial scope for increased production, if price prospects are good. Those for maize, sorghum and cassava are also larger than 2. Thus, one can expect that the cropping pattern can change quite a lot in the north if relative prices change substantially. This was reflected in the simulation result in the last section. There we find that the production of groundnut is expected to decline to almost nothing; that for soybean expected to increase by almost 20% per annum; and for sorghum, cotton and cassava expected to change (both positively and negatively) by around 5% per annum.

One trend common to all regions is quite interesting. This is the fact that the own-price elasticity of sugarcane is less than one everywhere. This is the crop with the best price prospects in the assumed price scenario. Given the low elasticity, however, the shift towards sugarcane in the simulation is not as great as if the price of some other crops had increased by as much as that for sugarcane is expected to. Nevertheless, in terms of the increase in land area, this is still quite substantial, with the cultivated area for sugarcane expected to increase from 3.39 million rais in 1984 to 4.45 million rais in 1991, or an average 4% per annum growth.

Apart from looking at the impact of the increase in price of a particular crop on its own production, we can also examine the cross effects. These are shown in table 24. The table indicates the cross price elasticities derived from the experiments. Thus, in the table for the west, the entry of -2.46 in the sugarcane column and maize row indicates the ratio of the percentage change in the production of maize to the percentage change in the price of sugarcane (5%), holding all other prices and costs constant. The cross elasticities are useful in indicating the substitution possibilities across crops.

Table 24 Cross Price Elasticities by Crop by Region

	Changes in Price								
Northeast Commodities Output	Rice	Maize	Sorghum	Mungbean	Soybean	Groundnut	Kenaf	Cassava	Sugarcane
Major Rice	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Second Rice	1.86	0.00	0.00	-1.09	-0.21	-0.16	0.00	0.00	0.00
Maize	0.00	0.43	0.02	-0.05	0.00	-0.01	-0.25	-0.34	0.00
Sorghum	0.00	0.00	0.26	-0.88	0.00	-0.16	-0.88	-0.88	0.00
Mungbean	-1.76	-1.28	-0.21	2.14	-0.58	-1.28	-1.28	-1.99	-0.58
Soybean	-0.40	0.00	0.00	-0.27	1.79	0.00	0.00	0.00	0.00
Groundnuts	-0.10	-0.42	0.00	-0.42	-0.09	2.35	-0.42	-0.42	-0.19
Kenaf	0.00	0.00	0.00	0.00	0.00	0.00	0.89	-0.24	0.00
Cassava	0.00	-0.10	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Sugarcane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25

East Commodities Output	Rice	Maize	Cotton	Cassava	Sugarcane
Major Rice	1.70	0.00	0.00	0.00	0.00
Second Rice	2.11	0.00	0.00	0.00	0.00
Maize	0.00	11.57	-0.06	-1.33	-0.78
Cotton	0.00	-8.74	0.49	-1.81	-1.81
Cassava	0.00	-1.21	0.00	0.27	0.00
Sugarcane	0.00	-0.53	0.00	-0.34	0.51

West Commodities Output	Rice	Maize	Cotton	Cassava	Sugarcane
Major Rice	8.05	0.00	0.00	0.00	0.00
Second Rice	4.99	0.00	0.00	0.00	0.00
Maize	0.00	2.47	-2.35	-2.35	-2.46
Cotton	0.00	-2.60	14.65	-2.60	-2.60
Cassava	0.00	0.00	0.00	3.53	-1.47
Sugarcane	0.00	-0.30	-0.16	-0.40	0.73

Table 24 Cross Price Elasticities by Crop by Region
(Cont'd)

	Changes in Price								
Central Commodities	Rice	Maize	Sorghum	Mungbean	Soybean	Groundnut	Cotton	Cassava	Sugarcane
Output									
Major Rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Second Rice	0.40	0.00	0.00	-0.98	0.00	0.00	0.00	0.00	0.00
Maize	0.00	2.05	-0.03	-0.35	-0.03	0.00	-0.10	-0.01	-0.26
Sorghum	0.00	0.86	0.86	0.00	0.00	0.00	0.00	0.00	0.00
Mungbean	-3.76	-3.21	-0.12	11.45	-0.12	-0.07	-0.12	-0.07	-0.12
Soybean	0.00	-3.10	0.00	0.00	1.22	0.00	0.00	0.00	0.00
Groundnut	-0.13	-1.10	0.00	-0.34	0.00	0.65	0.00	0.00	0.00
Cotton	0.00	-1.49	0.00	0.00	0.00	0.00	1.05	0.00	0.00
Cassava	0.00	-0.28	0.00	0.00	0.00	0.00	0.00	0.12	0.00
Sugarcane	0.00	-1.38	-0.35	-0.39	0.00	0.00	0.00	0.00	0.39

North Commodities	Rice	Maize	Sorghum	Mungbean	Soybean	Groundnut	Cotton	Cassava	Sugarcane
Output									
Major Rice	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Second Rice	3.23	0.00	0.00	-2.12	-2.12	-0.20	0.00	0.00	0.00
Maize	0.00	2.18	0.09	0.00	-0.41	-0.82	-0.15	-0.08	-0.08
Sorghum	0.00	0.07	2.34	0.00	-0.27	-0.27	0.00	0.00	0.00
Mungbean	-0.36	-0.45	0.00	0.81	-0.68	0.00	0.00	0.00	0.00
Soybean	-0.53	-2.11	0.00	-0.88	8.51	-0.61	-0.53	0.00	0.00
Groundnuts	-0.20	-11.73	-0.09	-0.81	-3.44	15.79	-0.18	-0.09	0.00
Cotton	0.00	-5.80	-2.08	0.00	-2.08	-2.08	9.75	-2.08	-1.29
Cassava	0.00	-0.26	0.00	0.00	0.00	0.00	0.00	2.11	0.00
Sugarcane	0.00	-1.44	-0.66	0.00	-1.44	-1.44	-1.44	-0.01	0.87

South Commodities	Rice
Output	
Major Rice	4.17
Second Rice	0.09

In the northeast, cassava showed the highest increase in cultivated area at about 100,000 rais in responding to a 5 percent rise in its own price (see appendix II). From table 24, we can see that cassava will replace maize, sorghum, mungbean, groundnut and kenaf, as the elasticities for these crops with respect to an increase in the price of cassava are all negative. The crop that has the highest proportionate decline in output is mungbean with an elasticity with respect to the price of cassava of around -2. However, while one crop may have a low cross elasticity with respect to the price of another crop, the absolute decline in area may be very large, simply because the base cultivated area is large. Thus, in the case of the increase in the price of cassava by 5%, the largest substitution in absolute terms occurs in maize, whose cultivated area declined by 50,000 rais (see appendix II). This shows that maize and cassava are important substitutes in the northeast. Another thing that should be borne in mind in interpreting the results in table 24 is that many of the zero cross elasticities are the result of the linear approximation used in deriving the solutions, so that small changes in cultivated areas are not captured. Of course, with some crop such as the major rice crop the reason is technological, because it is grown in a landtype in which it is difficult to grow other crops.

In the northeast, other crops which show a lot of substitution possibilities are mungbean, groundnut and kenaf. An increase in the price of mungbean leads to a shift away from the second rice crop, maize, sorghum, soybean and groundnut. The crops which will be substituted by an increase in the price of groundnut are the second rice crop, maize, sorghum and mungbean. For kenaf, the substitution are with maize, sorghum, mungbean and groundnut. As far as sugarcane is concerned, the own-price elasticity is very low, and mungbean is the main substitute.

In the eastern region, the most important substitution possibility is between maize and cassava. Although the cross-elasticity of cotton output with respect to the price of maize is the highest, the base cultivated area of cotton in the east is quite small, so the absolute substitution impact of maize and cotton is not that large. In response to an increase in the price of maize by 5%, the cultivated area for maize is expected to increased by about 296,000 rais by replacing 245,000 rais of cassava, and only 27,000 rais of cotton and 25,000 rais of sugarcane. Similarly, when the price of cassava is increased by 5%, the shift towards cassava is mainly out of maize.

In the west, sugarcane is by far the most important crop apart from the main rice crop. Here, sugarcane shows a wide degree of substitution with the other crops in this region. When the price of sugarcane is increased by 5 percents, there will be a shift out of maize, cotton and cassava. The biggest impact is on maize, followed by cassava.

For the central region, except for the impact of an increase in the price of maize, the cross-elasticities are generally low. An increase in the price of maize will shift some of the resources from mungbean, soybean, groundnut, cotton, cassava and sugarcane. The largest elasticities are for mungbean and soybean. In absolute terms, however, the cultivated area of sugarcane will decline the most in response to the increase in the price of maize, because the base cultivated area of sugarcane in the central region is much higher than that for mungbean and soybean. Mungbean price also shows a wide range of impact on many crops. It will make a decline in cultivated areas for second rice, maize, groundnut and sugarcane. These cross elasticities are small however. Rice is one of the most important crop in the central region. Currently, the total cultivated area for both major and second rice are about 10 million rais. The simulation shows that 5 percent increase in rice price does not affect the cultivated area for the major rice, nevertheless, it increases the area for the second rice by reducing the areas for mungbean and groundnut. The area for major rice does not response to the rice price increase because the suitable area for major rice (land type 1) is exhausted at the current land constraint (and also because of the technological assumptions). Presently, the government has a policy to try to reduce the cultivated area of the second rice crop. From the analysis, one way this may happen is for the price of mungbean to rise, as the model indicates a substantial decline in the cultivated area of the second rice crop where this to occur.

Maize price increase has an effect on all crops except for rice in the northern region. The largest percentage decline in output is that of groundnut, followed by cotton and soybean. In absolute terms, groundnut also shows the largest decline as the price of maize is increased, followed by soybean and cotton. Unlike the other regions, soybean price increase in the north has a wide impact on many crops except cassava, suggesting that it is a suitable crop in this region. Groundnut also shows a wide substitution impact on many crops. The main substitutes for cassava are cotton and maize. The cross-elasticity of the latter with respect to the price of cassava is very low, but the base cultivated area of maize in the north is the highest after rice. Maize and cotton are also the two main substitutes for sugarcane in the north. A five percent increase in rice price in the north will increase the cultivated area for both major and second rice by 7 and 16 percent respectively. The gain in area for the second rice crop is at the expense of mungbean, soybean and groundnut. These are the crops for which if price increases occur, will lead to a shift from the second rice crop. Thus, the policy to reduce the cultivated area for the second rice crop can be implemented if price of mungbean, soybean, and groundnut rise sufficiently.

These results from the model yield a lot of useful information on the pattern of crop substitutability in various regions. They can act as a guide for policy makers interested in influencing the cropping pattern in agriculture. While the model concentrated on the major crops, the results should be useful as a guide on which crops can more feasibly by promoted compared to others, and which can be more easily substituted for others. As already seen, the pattern tends to vary a great deal depending on the regions and landtypes.

6. Conclusion

The results derived from this study in general seem to be intuitively reasonable. The changes in cropping pattern appears to relate in a sensible fashion the changes in relative prices. In the simulation on future outlook, the total cultivated areas are expected to expand in all regions; however, the annual growth rates are rather small. Rice, cotton, mungbean, soybean and sugarcane are the crops whose cultivated area rise in all regions but this is not the case for the rest. On the contrary, cassava and kenaf show a decline in cultivated area in all regions. To sum up, one would suspect that there would be a shift out of crops whose price outlook are poor to those whose prices are better. Certainly, there is a limit on how far this can occur, because an expansion of a given crop will usually imply the utilization of land which is less suitable with a decline in productivity. Nevertheless, some substitution is bound to take place, and this is actually what the solution shows.

Concerning the labor market for agriculture, the total increase in labor use by crops by regions were summarized and shown in the section 4. These tables illustrated the growth per annum of labor requirement for the various crops between 1984 and 1991. Rice which is the main crop in every region showed a small increase in labor needed. In reality, there is also a limited chance for other crops to replace rice. Cassava, which is a major user of labor in the northeast, shows a slide in labor requirement not only in this region but also in other regions. Maize also demonstrated a big drop in labor requirement in the north, central and west but showed some increases in the northeast and east. The other losers are sorghum and kenaf, crops whose prices are expected to decrease in real term. Sugarcane, on the other hand, indicated labor requirement growth everywhere due to relative price jump. Mungbean and soybean are anticipated to use more labor because of their relative price prospects is better compared to some of the other crops.

A feature of the solution which should be of great concern to policy makers is the very low expected growth in total labor demand in the peak agricultural season. This is expected to increase at only around .5% per annum, while the total labor supply in the rural areas, given normal migration conditions, is expected to grow at more than 2% per annum. As already outlined in section 4, this is likely to imply that real income in the rural areas may stagnate and even decline during the period of the Sixth Plan, and out-migration from the rural areas will probably accelerate substantially.

The outlook for the dry season employment situation is better, as the change in cropping tends to favor dry season employment. However, the expected growth in labor demand in the dry season is only in line with the expected increase in the labor supply. Thus, the seasonal unemployment problem is likely to stabilize, but unlikely to improve much.

In this study, the cross substitution effects among crops were also simulated from the model to show how the output of a particular crop responds to changes in other crops' prices. The results were useful from the policy point of view because it showed the degree of substitutability among crops. The cultivated area of the second rice crop in the north and northeast, for example, was influenced by the price of mungbean, soybean, and groundnut. Thus, the policy to raise paddy prices by reducing its cultivated area, particularly of the second rice crop, can be indirectly implemented by using price or production policies on these crops. Among these crops, mungbean showed the highest impact on second rice output since a price increase of 1 percent for mungbean is expected to lead to a decline in the output of the second rice crop by 1.09, 2.12 and 0.98 percent in the northeast, north and central region respectively.

In addition to mungbean, soybean was also an important substitute for the second rice crop in the north and northeast. In the north, it is also an important substitute for many other crops. If the cultivated area in the north was partitioned into two parts, soybean could be a substitute for the second rice crop in irrigated dry season low land, and for other crops in the upland areas.

Cassava is another important crop that should be mentioned here. Presently, the government has a policy to reduce the cultivated area for cassava because of its limited export market. This is due to the fact that it faces quotas in the major export market, the EEC. From this study, the simulation showed that maize is generally the most important substitute for cassava. Again one of the policies that can be used to discourage cassava production is to increase the profitability for maize; such as encouraging the use of technology to raise yield, or improving post-harvest procedure to reduce Alfa-Toxin. However, a severe limitation is that the price outlook for maize is also not very good, with the real price of maize expected to decline on average by 2% per annum.

Presently, mungbean is one of the promoted crops by the government to be grown during the dry season. If the price of mungbean increases, given other things equal, many crops's production will be replaced by mungbean. These crops are the second rice crop, soybean, sorghum, groundnut and maize. The degree of substitution between mungbean and each crops, however, tends to vary from one region to another.

Other minor crops in this model such as cotton, kenaf, and groundnut also had an impact on the other crops's production when their prices changed. Nevertheless, it did not show a systematic effect among crops across all the regions. In addition to all the crops in this study, there were important minor activities which had been left out from the model due to data limitations at present. These activities include the production of sesame seed, castor seed, vegetables, tree crops, inland fishery, and livestock. Some of these activities were policy crops introduced by the government to replace the second rice crop and cassava. In 1987, for example, government set a target to encourage farmers in 10 provinces to replace 17,000 rais of the second season rice crop by vegetables and tree crops.

Presently, most of these other minor activities are not playing an important roles in terms of the total cultivated area. However, the situation may eventually change in the future due to tremendous support by the government, and the poor prospects on the prices of the major crops. If it is true, the whole picture of labor utilization in the rural area will be affected. Thus, in the future, if more data became available, then one should think about improving the model by rectifying some of the limitations in this current study.

Apart from the exclusion of many minor activities which may become important in the future, there are also other limitations in this study. Many data series have only a few observations available to estimate the relationship between land and output. The methodology used also had some weak points, such as for example, the sensitivity of the estimated coefficients to the choice of a base crop in each region-landtype. Also by using the Separable Programming technique, the linear approximation inevitable lead to some rigidities in the substitution process, and thus, as can be seen in the cross-elasticity tables, there were many cases where the production of a crop did not change, although if full non-linear programming techniques had been used on would expect some changes, though small.

Another important limitation is the lack of treatment of the choice of production techniques. The introduction does not present technical difficulties, however, but one would need a much richer database for the model, which would include the input requirements for other available techniques for production. This can be attempted in the future.

Detail land suitability is another limitation regarding this model. In this study, land had been grouped into three categories in each region. In some regions, however, it may be more appropriate to have a finer break-down due to special physical soil characteristics. These characteristics, such as sandy or clay type soil, can physically influence the type of crop that can be grown in such areas.

The problems previously mentioned are the qualifications major points that should be borne in mind in the interpretation of the results of this study. Future researches are expected to correct some of these weaknesses.

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Appendix I

LABOUR LABOUR USED (NORTH-EASTERN) (MAN)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	11800					693	50327	10782	3717	988	31713	37760	6033
Major Glutinous Rice	1	17200					1140	67833	13739	4730	1183	45774	54481	8708
Second Rice	2	246	26	1134	323	774	1069							
Second Glutinous Rice	2	140	15	645	183	440	608							
Maize	3	2433					4261	736	8969	8199				
Maize	3	453									793	109	1672	1502
Sorghum	3	180								98	113	13	353	
Mungbean	2	54	50	51	26	180								
Mungbean	3	238									220	305	155	874
Soybean	2	29	10	169	67	86								
Soybean	3	101							45	687	328	318		
Groundnut	2	55	25	308	329	464								
Groundnut	3	180						58	677	709	1000			
Kenaf	3	1000				448	4050	2114	553	369	221	7583		
Cassava	3	5100	11316		4278	6439	6904	10710				3863	21242	9008
Sugarcane	3	490	920	1361	1619	1780	835	756	459	369	303			920
TOTAL			12362	3688	6625	10611	19560	132534	35224	18818	5155	89679	115664	27045

LABOUR LABOUR USED (NORTHERN)

(MAND)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	9701	–	–	–	–	1006	23645	2607	4717	1407	170	26119	42004
Major Glutinous Rice	1	6310	–	–	–	–	704	9251	1137	2017	587	208	10934	17919
Second Rice	2	453	1732	283	509	151	2484	725	–	–	–	–	–	–
Second Glutinous Rice	2	106	418	66	119	35	510	149	–	–	–	–	–	–
Maize	3	5365	–	–	–	–	9274	10796	10293	21472	–	–	–	–
Maize	3	264	–	–	–	–	–	–	–	–	456	531	907	875
Sorghum	3	81	–	–	–	–	34	51	6	101	–	–	–	–
Sorghum	3	721	–	–	–	–	–		–	–	306	452	53	1100
Mungbean	2	463	391	341	185	1715	–	–	–	–	–	–	–	–
Mungbean	3	2090	–	–	–	–	–	–	1766	1505	810	6628	–	–
Soybean	2	300	1031	346	886	1464	–	–	–	–	–	–	–	–
Soybean	3	737	–	–	–	–	–	–	2233	483	1237	2970	–	–
Groundnut	2	90	368	162	246	783	–	–	–	–	–	–	–	–
Groundnut	3	358	–	–	–	–	1760	663	1008	3116	–	–	–	–
Cotton	3	268	–	–	–	–	–	574	2152	614	607	–	933	1213
Cassava	3	999	1526	786	628	935	354	667	292	229	250	20	41	231
Sugarcane	3	562	1219	1828	2713	1182	1253	1097	666	431	431	1219	–	–
TOTAL			6765	3812	5396	6265	17419	47618	22160	34685	6091	12198	38647	63342

LABOUR USED (CENTRAL PLAIN)

(MAN)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	7430					870	15699	2384	2375	645	701	28396	15287
Major Glutinous Rice	1	107					18	307	26	26	7	8	307	165
Second Rice	2	2677	5412	1151	1701	20358	2960							
Maize	3	1746				3042	3518	3354	7299					
Maize	3	250								435	503	480	957	
Sorghum	3	811								414	509	60	1904	
Mungbean	2	375	755	367	276	1225								
Mungbean	3	211								165	124	45	661	
Soybean	3	57							162	161	16	211		
Groundnut	2	22					107	94	17	146				
Groundnut	3	8	27	22	3	54								
Cotton	3	127						217	490	332	562	134	539	518
Cassava	3	234			235	235	235	235				1009	102	481
Sugarcane	3	572	1607	1607	1856	1173	864	1798	498	241	241			1607
Sugarcane	2	43	193	193	201	54	64	221	36	12	12			193
TOTAL			7994	3340	4272	26141	8626	21925	10912	4307	2639	2648	32866	18251

LABOUR USED (EASTERN)

(MAN)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	3223					463	11107	906	882	254	278	11397	5616
Second Rice	2	407	1451	266	384	1971	295							
Maize	3	504				877	1014	957	1882					
Cotton	3	61							234	189	278	165	202	194
Cassava	3	2745			2985	2985	2985	2985				14089	1198	5641
Sugarcane	3	575	1468	1468	1719	978	858	1834	477	170	170			1468
TOTAL			2919	1734	5088	6811	5615	16893	3499	1241	702	14532	12797	12919

LABOUR USED (WESTERN)

(MAND)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	1990					203	4497	584	570	165	179	4354	2243
Second Rice	2	76	302	59	44	374	56							
Maize	3	208				362	419	399	695					
Maize	3	100								174	201	192	300	
Cotton	3	46						89	178	154	166	77	172	133
Cassava	3	293			353	353	353	353				1436	128	614
Sugarcane	3	1147	3104	3104	3619	1437	1712	5900	962	317	317			3104
TOTAL			3406	3163	4016	2526	2743	11238	2419	1215	849	1883	4954	6094

LABOUR USED (SOUTHERN)

(MAN)

Activities	Land Type	Cultivated	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Major Rice	1	3720	391	5445	18237						1362	15285	1669	1823
Second Rice	2	223				998	127	104	1459	218				
TOTAL			391	5445	18237	998	127	104	1459	218	1362	15285	1669	1823

1 = Wet Season Low Land
2 = Dry Season Low Land
3 = Upland

Appendix II

Changes in Cultivated Area by Crop by Region in Responding to 5 % Price Increases

Changes in Price

North-East

Commodities	Rice Land	Maize Land	Sorghum Land	Mungbean Land	Soybean Land	Groundnut Land	Kenaf Land	Cassava Land	Sugarcane Land
Rice	438	0	0	-21	-4	-3	0	0	0
Maize	0	66	3	-10	0	-2	-40	-54	0
Sorghum	0	0	3	-10	0	-2	-10	-10	0
Mungbean	-34	-18	-3	38	-8	-18	-18	-28	-8
Soybean	-3	0	0	-2	13	0	0	0	0
Groundnuts	-1	-4	0	-4	-1	23	-4	-4	-2
Kenaf	0	0	0	0	0	0	60	-16	0
Cassava	0	-41	0	0	0	0	0	100	0
Sugarcane	0	0	0	0	0	0	0	0	10
Sum	400	3	3	-9	0	-2	-12	-12	0

East

Commodities	Rice Land	Maize Land	Cotton Land	Cassava Land	Sugarcane Land
Rice	320	0	0	0	0
Maize	0	296	-2	-34	-20
Cotton	0	-27	1	-6	-6
Cassava	0	-245	0	55	0
Sugarcane	0	-25	0	-16	25
Sum	320	-1	-1	-1	-1

West

Commodities	Rice Land	Maize Land	Cotton Land	Cassava Land	Sugarcane Land
Rice	587	0	0	0	0
Maize	0	37	-38	-38	-40
Cotton	0	-6	34	-6	-6
Cassava	0	0	0	57	-23
Sugarcane	0	-21	-11	-28	53
Sum	587	10	-15	-15	-16

Changes in Cultivated Area by Crop by Region in Responding to 5 % Price Increases (Cont'd)

Changes in Price

Central

Commodities	Rice Land	Maize Land	Sorghum Land	Mungbean Land	Soybean Land	Groundnut Land	Cotton Land	Cassava Land	Sugarcane Land
Rice	73	0	0	-177	0	0	0	0	0
Maize	0	242	-2	-41	-3	0	-11	-1	-31
Sorghum	0	39	39	0	0	0	0	0	0
Mungbean	-72	-51	-2	217	-2	-1	-2	-1	-2
Soybean	0	-10	0	0	4	0	0	0	0
Groundnut	-1	-2	0	-1	0	1	0	0	0
Cotton	0	-12	0	0	0	0	8	0	0
Cassava	0	-5	0	0	0	0	0	2	0
Sugarcane	0	-62	-16	-18	0	0	0	0	18
Sum	0	139	19	-20	-1	0	-5	0	-15

North

Commodities	Rice Land	Maize Land	Sorghum Land	Mungbean Land	Soybean Land	Groundnut Land	Cotton Land	Cassava Land	Sugarcane Land
Rice	1095	0	0	-67	-67	-6	0	0	0
Maize	0	611	39	0	-109	-219	-39	-21	-21
Sorghum	0	-2	98	0	-12	-12	0	0	0
Mungbean	-59	-63	0	137	-113	0	0	0	0
Soybean	-30	-107	0	-50	463	-31	-27	0	0
Groundnuts	-5	-258	-2	-20	-78	352	-4	-2	0
Cotton	0	-78	-28	0	-28	-28	132	-28	-17
Cassava	0	-6	0	0	0	0	0	51	0
Sugarcane	0	-62	-28	0	-62	-62	-62	0	38
Sum	1001	35	79	0	-6	-6	0	0	0

South

Commodities	Rice Land
Rice	781
Sum	781

Appendix III

Table III.1 Effect of 5 Percent Changes in Price of Rice on The Area and Output

CULTIVATED, PRODUCTION (WESTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	1,958	753,279
SECOND RICE	95	51,496
MAIZE	308	119,386
COTTON	46	6,262
CASSAVA	293	684,336
SUGARCANE	1,147	7,846,623

Table III.2 Effect of 5 Percent Change in Price of Maize on the Area and Output

CULTIVATED,PRODUCTION (WESTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	1,390	536,961
SECOND RICE	76	41,212
MAIZE	345	134,109
COTTON	40	5,449
CASSAVA	293	684,336
SUGARCANE	1,126	7,730,084

Table III.3 Effect of 5 Percent Changes in Price of Cotton on the Area and Output

CULTIVATED,PRODUCTION (WESTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	1,390	536,961
SECOND RICE	76	41,212
MAIZE	270	105,332
COTTON	80	10,848
CASSAVA	293	684,336
SUGARCANE	1,136	7,785,754

Table III.4 Effect of 5 Percent Changes in Price of Cassava on the Area and Output

CULTIVATED, PRODUCTION (WESTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	1,390	536,961
SECOND RICE	76	41,212
MAIZE	270	105,732
COTTON	40	5,449
CASSAVA	350	304,986
SUGARCANE	1,119	7,691,115

Table III.5 Effect of 5 Percent Changes in Price of Sugarcane on the Area and Output

CULTIVATED,PRODUCTION (WESTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	1,390	536,961
SECOND RICE	76	41,212
MAIZE	268	104,693
COTTON	40	5,449
CASSAVA	270	634,017
SUGARCANE	1,200	8,134,187

Table III.6 Effect of 5 Percent Changes in Price of Rice on the Area and Output

CULTIVATEC,PRODUCTION (EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	3,500	1,096,095
SECOND RICE	450	222,734
MAIZE	504	135,999
COTTON	61	6,249
CASSAVA	2,745	5,722,931
SUGARCANE	575	3,476,726

Table III.7 Effect of 5 Percent Changes in Price of Maize on the Area and Output

CULTIVATED,PRODUCTION (EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	3,223	1,010,027
SECOND RICE	407	201,482
MAIZE	800	214,647
COTTON	34	3,518
CASSAVA	2,500	5,377,067
SUGARCANE	550	3,364,818

Table III.8 Effect of 5 Percent Changes in Price of Cotton on the Area and Output

CULTIVATED,PRODUCTION (EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	3,223	1,010,027
SECOND RICE	407	201,482
MAIZE	502	135,598
COTTON	62	6,403
CASSAVA	2,745	5,722,931
SUGARCANE	575	3,476,726

Table III.9 Effect of 5 Percent Changes in Price of Cassava on the Area and Output

CULTIVATED, PRODUCTION (EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	3,223	1,010,027
SECOND RICE	407	201,482
MAIZE	470	126,960
COTTON	55	5,684
CASSAVA	2,800	5,799,306
SUGARCANE	559	3,418,165

Table III.10 Effect of 5 Percent Changes in Price of Sugarcane on the Area and Output

CULTIVATED,PRODUCTION (EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	3,223	1,010,027
SECOND RICE	407	201,482
MAIZE	484	130,698
COTTON	55	5,684
CASSAVA	2,745	5,722,931
SUGARCANE	600	3,565,849

Table III.11 Effect of 5 Percent Changes in Price of Rice on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	2[illegible],400	8,804,811
SECOND RICE	424	184,937
MAIZE	2,886	1,040,592
SORGHUM	180	36,557
MUNGBEAN	258	26,615
SOYBEAN	121	[illegible],136
GROUNNUTS	184	37,876
KENAF	1,000	166,176
CASSAVA	5,100	13,335,554
SUGARCANE	490	3,501,396

Table III.12 Effect of 5 Percent Changes in Price of Maize on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	386	169,175
MAIZE	2,952	1,062,829
SORGHUM	180	36,557
MUNGBEAN	274	27,305
SOYBEAN	124	22,593
GROUNDNUTS	181	37,263
KENAF	1,000	166,176
CASSAVA	5,059	17,269,998
SUGARCANE	490	3,501,396

Table III.13 Effect of 5 Percent Changes in Price of Sorghum on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	386	169,175
MAIZE	2,889	1,041,406
SORGHUM	183	37,036
MUNGBEAN	289	28,870
SOYBEAN	124	22,593
GROUNNUTS	185	38,065
KENAF	1,000	106,176
CASSAVA	5,100	13,335,554
SUGARCANE	490	3,501,396

Table III.14 Effect of 5 Percent Changes in Price of Mungbean on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	365	159,922
MAIZE	2,876	1,037,846
SORGHUM	170	34,945
MUNGBEAN	330	32,305
SOYBEAN	12[illegible]	22,290
GROUNDNUTS	181	37,263
KENAF	1,000	166,176
CASSAVA	5,100	13,375,554
SUGARCANE	400	3,561,396

Table III.15 Effect of 5 Percent Changes in Price of Soybean on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	382	167,396
MAIZE	2,886	1,040,592
SORGHUM	180	36,557
MUNGBEAN	284	28,336
SOYBEAN	137	24,618
GROUNNUTS	184	37,907
KENAF	1,000	167,176
CASSAVA	5,100	17,335,554
SUGARCANE	490	3,501,396

Table III.16 Effect of 5 Percent Changes in Price of Groundnut on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	383	167,860
MAIZE	2,894	1,040,095
SORGHUM	176	36,266
MUNGBEAN	274	27,305
SOYBEAN	124	22,593
GROUNNUTS	208	47,530
KENAF	1,000	166,176
CASSAVA	5,100	17,335,554
SUGARCANE	490	3,561,396

Table III.17 Effect of 5 Percent Changes in Price of Kenaf on the Area and Output

CULTIVATED, PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	386	169,175
MAIZE	2,846	1,027,673
SORGHUM	170	34,945
MUNGBEAN	274	27,305
SOYBEAN	124	22,593
GROUNNUTS	181	37,263
KENAF	1,060	173,576
CASSAVA	5,100	13,335,554
SUGARCANE	490	3,501,396

Table III.18 Effect of 5 Percent Changes in Price of Cassava on the Area and Output

CULTIVATED,PRODUCTION (NORTH_EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,392
SECOND RICE	386	169,175
MAIZE	2,832	1,022,697
SORGHUM	170	76,945
MUNGBEAN	264	26,270
SOYBEAN	124	22,593
GROUNDNUTS	181	37,267
KENAF	984	164,176
CASSAVA	5,206	13,492,225
SUGARCANE	490	3,501,396

Table III.19 Effect of 5 Percent Changes in Price of Sugarcane on the Area and Output

CULTIVATED,PRODUCTION (NORTH-EASTERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	29,000	8,704,397
SECOND RICE	386	169,175
MAIZE	2,388	1,046,59[illegible]
SORGHUM	180	76,557
MUNGBEAN	284	28,336
SOYBEAN	124	22,597
GROUNDNUTS	183	37,70[illegible]
KENAF	1,000	166,178
CASSAVA	5,100	13,355,554
SUGARCANE	500	3,545,257

Table III.20 Effect of 5 Percent Changes in Price of Rice on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,950	1,660,179
MAIZE	1,998	693,079
SORGHUM	811	141,496
MUNGBEAN	262	27,038
SOYBEAN	57	8,943
GROUNDNUTS	30	6,477
COTTON	127	20,965
CASSAVA	234	613,119
SUGARCANE	615	4,234,781

Table III.21 Effect of 5 Percent Changes in Price of Maize on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	2,240	764,031
SORGHUM	850	147,611
MUNGBEAN	283	27,959
SOYBEAN	47	7,556
GROUNDNUTS	29	6,162
COTTON	115	19,426
CASSAVA	229	604,577
SUGARCANE	553	3,943,454

Table III.22 Effect of 5 Percent Changes in Price of Sorghum on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	1,996	692,183
SORGHUM	850	147,611
MUNGBEAN	332	33,087
SOYBEAN	57	8,943
GROUNDNUTS	31	6,521
COTTON	127	20,985
CASSAVA	234	613,119
SUGARCANE	599	4,160,732

Table III.23 Effect of 5 Percent Changes in Price of Mungbean on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,700	1,548,077
MAIZE	1,957	680,861
SORGHUM	811	141,496
MUNGBEAN	551	52,356
SOYBEAN	57	8,943
GROUNDNUTS	30	6,411
COTTON	127	20,985
CASSAVA	234	613,119
SUGARCANE	597	4,151,334

Table III.24 Effect of 5 Percent Changes in Price of Soybean on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	1,995	692,185
SORGHUM	811	141,496
MUNGBEAN	332	33,087
SOYBEAN	61	9,490
GROUNDNUTS	31	6,521
COTTON	127	20,985
CASSAVA	234	613,119
SUGARCANE	615	4,234,781

Table III.25 Effect of 5 Percent Changes in Price of Groundnut on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	1,998	693,079
SORGHUM	811	141,496
MUNGBEAN	333	33,180
SOYBEAN	57	8,943
GROUNDNUTS	32	6,732
COTTON	127	20,985
CASSAVA	234	613,119
SUGARCANE	615	4,234,781

Table III.26 Effect of 5 Percent Changes in Price of Cotton on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,731
MAIZE	1,987	689,600
SORGHUM	811	141,496
MUNGBEAN	332	33,087
SOYBEAN	57	8,943
GROUNDNUTS	31	6,521
COTTON	135	22,089
CASSAVA	234	613,118
SUGARCANE	615	4,234,781

Table III.27 Effect of 5 Percent Change in Price of Cassava on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	1,997	692,631
SORGHUM	811	141,496
MUNGBEAN	333	33,185
SOYBEAN	57	8,943
GROUNDNUTS	31	6,521
COTTON	127	20,985
CASSAVA	236	616,768
SUGARCANE	615	4,234,781

Table III.28 Effect of 5 Percent Changes in Price of Sugarcane on the Area and Output

CULTIVATED,PRODUCTION (CENTRAL PLAIN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	7,587	2,882,662
SECOND RICE	2,877	1,627,931
MAIZE	1,967	683,960
SORGHUM	811	141,496
MUNGBEAN	332	33,087
SOYBEAN	57	8,943
GROUNDNUTS	31	6,521
COTTON	127	20,985
CASSAVA	234	613,119
SUGARCANE	633	4,317,057

Table III.29 Effect of 5 Percent Changes in Price of R
on the Area and Output

CULTIVATED, PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	14,001	5,577,472
SECOND RICE	657	376,504
MAIZE	5,629	2,357,117
SORGHUM	803	147,977
MUNGBEAN	2,494	325,703
SOYBEAN	1,007	172,280
GROUNDNUTS	443	90,521
COTTON	268	42,958
CASSAVA	399	919,429
SUGARCANE	542	4,301,862

Table III.30 Effect of 5 Percent Changes in Price of Maize on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	559	324,117
MAIZE	6,240	2,613,825
SORGHUM	800	144,455
MUNGBEAN	2,490	324,213
SOYBEAN	930	158,328
GROUNDNUTS	190	77,814
COTTON	190	20,504
CASSAVA	393	907,588
SUGARCANE	500	3,991,862

Table III.31 Effect of 5 Percent Changes in Price of Sorghum on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	559	724,117
MAIZE	5,648	2,367,781
SORGHUM	900	140,787
MUNGBEAN	2,553	771,437
SOYBEAN	1,077	176,954
GROUNDNUTS	446	91,036
COTTON	240	38,497
CASSAVA	399	919,429
SUGARCANE	534	4,160,242

Table III.32 Effect of 5 Percent Changes in Price of Mungbean on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,006	5,136,201
SECOND RICE	492	229,828
MAIZE	5,629	2,357,117
SORGHUM	802	143,933
MUNGBEAN	2,690	345,060
SOYBEAN	987	169,147
GROUNDNUTS	428	87,728
COTTON	268	42,958
CASSAVA	399	919,429
SUGARCANE	562	4,301,862

Table III.33 Effect of 5 Percent Changes in Price of Soybean on the Area and Output

CULTIVATED, PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	492	249,828
MAIZE	5,520	2,309,274
SORGHUM	790	141,975
MUNGBEAN	2,440	320,326
SOYBEAN	1,500	252,286
GROUNDNUTS	370	75,701
COTTON	240	38,492
CASSAVA	399	919,429
SUGARCANE	500	3,991,862

Table III.34 Effect of 5 Percent Changes in Price of Groundnut on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	553	320,824
MAIZE	5,410	2,260,968
SORGHUM	790	141,975
MUNGBEAN	2,553	331,637
SOYBEAN	1,006	171,591
GROUNDNUTS	800	163,659
COTTON	240	38,492
CASSAVA	399	919,429
SUGARCANE	500	3,991,862

Table III.35 Effect of 5 Percent Changes in Price of Cotton on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	15,000	5,126,201
SECOND RICE	559	324,117
MAIZE	5,590	2,340,007
SORGHUM	802	143,933
MUNGBEAN	2,553	331,637
SOYBEAN	1,010	172,260
GROUNDNUTS	444	90,621
COTTON	406	63,891
CASSAVA	399	919,429
SUGARCANE	500	3,991,862

Table III.36 Effect of 5 Percent Changes in Price of Cassava on the Area and Output

CULTIVATED, PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	559	324,117
MAIZE	5,608	2,348,049
SORGHUM	802	143,933
MUNGBEAN	2,553	331,637
SOYBEAN	1,037	176,954
GROUNDNUTS	446	91,036
COTTON	240	38,492
CASSAVA	450	1,016,324
SUGARCANE	562	4,300,242

Table III.37 Effect of 5 Percent Changes in Price of Sugarcane on the Area and Output

CULTIVATED,PRODUCTION (NORTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	13,000	5,126,201
SECOND RICE	559	324,117
MAIZE	5,608	2,348,049
SORGHUM	802	143,933
MUNGBEAN	2,553	331,637
SOYBEAN	1,037	176,954
GROUNDNUTS	448	91,450
COTTON	251	40,195
CASSAVA	399	919,429
SUGARCANE	600	4,488,613

Table III.38 Effect of 5 Percent Changes in Price of Rice on the Area and Output

CULTIVATED,PRODUCTION (SOUTHERN)

COMMODITIES	CULTIVATED (1000 RAIS)	PRODUCTION (TONS)
MAJOR RICE	4,500	1,233,106
SECOND RICE	224	91,235