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9 ABSTRACT

Presents the Northeast Regional Model (NEREGON), part of a project conducted jointly by the Thai Division of Agricultural Economics and Iowa State University to develop a demographic and economic data base for analyzing Thai agricultural policy. NEREGON, the first in a series of six Thai regional planning models, is a normative supply study which focuses on the adjustment potential and socio-economic significance of four major crops (rice, kenaf, cassava, and maize) in the relatively poor northeastern region of Thailand. The purpose of this linear programming model, which was developed and validated against cross-sectional survey data, is twofold. First, it estimates the production response of each of the four crops under a wide range of assumed prices. Secondly, it assesses the impact that different market prices and production levels for each crop would have on employment, capital requirements, income, and the production of other crops. Each crop is examined individually, while all other factors are held constant. The report includes a mathematical description of the model and an analysis of the results for each crop.

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AGRICULTURAL SUPPLY RESPONSE IN NORTHEAST THAILAND:

Production, Resources, Income, and Policy Implications

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AGRICULTURAL SUPPLY RESPONSE IN NORTHEAST THAILAND: PRODUCTION, RESOURCE, INCOME AND POLICY IMPLICATIONS

by

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FOREWORD

This study presents the Northeast Regional Model (NEREGON) for northeast Thailand. It is the first in a series of regional models to be constructed and applied for Thailand. For the Northeast, the model is of the "first generation" and further model work will continue. Also, a larger demographic and economic data base is being built up in the region to facilitate improved models and analytical work.

Northeast Thailand was selected as the region for initiating regional studies because income in this agricultural region lags behind that of other regions. This fact has been recognized in the national interregional programming model developed in the Division of Agricultural Economics (DAE). The national model has been applied to develop five-year plans that focus special attention on the Northeast and in raising income of the region relative to other regions.

Other members of the DAE staff and the ISU research team also made large contributions to the research reported.

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INTRODUCTION[1]

Agricultural production response holds the key to economic development in Northeast Thailand--a region with 43.5 percent of the agricultural land, 43.3 percent of the nation's agricultural population, and 35.9 percent of the incomes below the national average. The plight of the Northeast farmer has long been recognized, but the solution to his problem has been much more elusive. Previous national plans have set targets and even identified specific crops for special promotion programs. A land reform program is currently underway. Economic incentives have been introduced and withdrawn via fluctuations in world demand and the potential export market. Proposals are now being considered to expand production so agriculture can absorb its own surplus, as well as projected surpluses from other sectors. The key to evaluating whether any or all of these programs are feasible lies in understanding what potential there is for adjustments, and simultaneously, how these adjustment might affect the rest of the agricultural sector and economy [5].

Scope and Limitations

This study is a normative supply study which focuses specifically on the adjustment potential and impact of four major crops in the Northeast

[1]The research reported in this paper was supported by the Royal Thai Government, Iowa State University, and USOM/Thailand through the cooperative Agricultural Sector Analysis Program (AID/CM/SA-C-73-19). The authors are especially grateful for the support and assistance of Dr. Earl O. Heady, Curtiss Distinguished Professor of Economics, Iowa State University and Dr. Sommuk Sriplung, Director, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, RIG.

and Thai economy--rice, kenaf, cassava, and maize. Much of the rice in the Northeast is consumed within the region, but kenaf, cassava, and maize are primarily exported through the central port at Bangkok. The study focuses on these four crops not only because of their importance in the economy, but also because of their apparent adaptability to the rainfed agriculture of the Northeast. The study is designed to examine potential production adjustment and impact of one commodity at a time, while holding all other factors constant. The linear programming model contains a finite number of production activities, each with fixed technology. The model is specified with a given resource base and that base remains constant throughout the study. For many crops the model contains several production activities reflecting different levels of technology. Consequently, the model is free to make some technical substitutions by selecting alternative production activities for the same commodity.

This study is not an examination of historic producer response. The model was developed and validated against cross-sectional survey data. The optimization procedure used in this model contains 110 lagged adjustments, so the desired level of production is reached immediately. From a development standpoint, immediate adjustment is not realistic, but that does not detract from the value of the analysis. It simply implies that if production response does hold a potential key for solving some of the problems of Northeast agriculture, additional studies will be needed to determine a reasonable adjustment schedule. Numerous other development studies have been conducted and are available as references on rate of producer response. The focus of this study is upon the end to which the

producer would strive if he optimized income subject to his resource contraints. There is sufficient evidence in Thailand to support the hypothesis that farmers do basically optimize income (home consumption plus cash income).

The primary objective of this study is to estimate production response of the four selected crops under a wide range of assumed prices. The secondary objective is to examine the impact on resource use, production patterns of other commodities, and on employment and income potential in the Northeast.

Model, Methodology and Assumptions

The Northeast Regional Model (NEREGON) is the first in a series of regional planning models to be constructed in Thailand [6]. The region under study includes the 15 Changwats (provinces) of Northeast Thailand which have been aggregated into five agroeconomic zones for agricultural planning purposes by the Ministry of Agriculture and Cooperatives [3]. The Northeast covers an area of approximately 99.3 million rai [1] of which 35.9 million rai is forest area and 25.9 million rai is agricultural land holdings [3, pp. 9-12]. Rainfall for the individual zones in the region ranges from a low of 1,112 millimeters per year to a high of 1,656 millimeters, but the seasonal distribution is uneven. About 22 percent of the annual rainfall comes in August or September, depending upon the specific zone [6].

---

[1] One rai equals 0.16 hectare.

The region had a population of 11.7 million in 1970, with a total of 1.9 million households of which 1.5 million were agricultural. In 1970 there were approximately 6.1 residents per household of which 1.9 were economically active. However, significant differences are apparent between sectors. Agriculture had 3.48 economically active members per household with only 1.3 per nonag household. The average farm household in the Northeast included 6.27 members, based on an agricultural population of 9.4 million.

NEREGON is a linear programming, interzone competition model with five consuming and five producing regions. The model used for this study contained 892 activities (433 real and 459 slack or disposal) and 409 equations [6]. The activities in the model include one or more production processes in each zone for each commodity on each type of land during each season where production has been observed historically. Separate activities have been defined for the same commodity whenever a distinct production process could be identified that would affect the resource requirement costs, and(or) yields. Although this does not provide for unlimited resource substitution, it does provide for some basic substitution.

In addition to the production activities, the model contains separate supporting activities for each zone. These include: marketing activities for each commodity; subsistence demand (on farm consumption) for selected commodities; capital borrowing by month from institutions, from relatives, and from merchants; and capital transfer activities. The Northeast model has separate bound sets for each zone which include

land by type and month, labor by month, capital by month, and capital borrowing by source. In addition to the bound sets for each zone, point demand estimates have been added in the form of regional marketing bounds for each commodity. The point demand estimates serve as upper limits for onfarm consumption and off-farm marketing at the prices specified in the model. These restraints force the five zones to compete against one another for a limited regional market.

In mathematical notation, the model may be written as follows: Find a set of X's such that

$$f(x) = CX \tag{1.1}$$

is maximized subject to

$$\begin{aligned} AX &\leq B \\ X &\geq 0 \end{aligned} \tag{1.2}$$

where,

X is a column vector of production, marketing, and employment activities;

C is a row vector of unit prices for activities;

A is a matrix of input-output coefficients; and

B is a column vector of resource and demand constraints.

The objective function to be maximized in the model is the sum of off-farm sales, the value of home consumption (valued at wholesale prices), cost of production, and interest charges on borrowed capital.

$$f(x) = \sum_{i=1}^{56} \sum_{j=1}^{5} P_{ij}MK_{ij} + \sum_{i=1}^{56} \sum_{j=1}^{5} P_{ij}SD_{ij} + \sum_{i=1}^{56} \sum_{j=1}^{5} \sum_{\ell=1}^{4} \sum_{m=1}^{12} -$$

$$C_{ij\ell m}X_{ij\ell m} + \sum_{j=1}^{5} \sum_{k=1}^{3} \sum_{m=1}^{12} - I_{jkm}CB_{jkm} \qquad (1.4)$$

where,

P_{ij} is the wholesale price of the i-th commodity (see list at end of model) sold or consumed in the j-th zone (j=1 for Zone 01, 2 for Zone 02, etc.);

MK_{ij} is the marketing (off-farm) of the i-th commodity in the j-th zone;

SD_{ij} is the subsistence demand (onfarm consumption) of the i-th commodity in the j-th zone;

$C_{ij\ell m}$ is the cost of producing the i-th crop in the j-th zone on the ℓ-th land type (ℓ=1 for floating paddy, 2 for irrigated paddy, 3 for nonirrigated paddy, and 4 for upland) starting in the m-th month (m=1 for January, 2 for February, 3 for March, etc.). Crop refers to a particular commodity and cultural practice combination. Not all 56 crops are produced in any zone;

$X_{ij\ell m}$ is the rai of the i-th crop produced in the j-th zone on the ℓ-th land type starting in the m-th month,[1]

I_{jkm} is the interest charge for capital borrowed during the m-th month in the j-th zone from the k-th source (k=1,2,3 for institutions, relatives, and merchants, respectively); and

CB_{jkm} is the capital borrowing (Baht) during the m-th month in the j-th zone from the k-th source.

Crop production in a given zone is constrained by the total cropland available during a given time period in that zone.

$$L_{\ell m} \geq \sum_{i=1}^{56} X_{i\ell m} \qquad \ell = 1,2,3,4 \quad m = 1,2,3,\ldots 12 \tag{1.5}$$

where,

$L_{\ell m}$ is the amount of the ℓ-th land type available in the m-th month; and

$X_{j\ m}$ is as defined earlier.

Crop production in a given zone is constrained by the total labor available during a given time period in that zone.

$$LB_m \geq \sum_{i=1}^{56} H_{im} X_{im} \tag{1.6}$$

where,

LB_m is the number of hours of labor available for crop production during the m-th month;

H_{im} is the hours of labor required to produce the i-th crop during the m-th month; and

X_{im} is as defined earlier.

Crop production in a given zone is constrained by the total capital available during a given time period in that zone. Capital sources

---

[1] A detailed description of the crop activities in each zone is contained in Working Paper No. 2, Regional Agricultural Development in Thailand: Northeast Crop Model (NEREGON), DAE, MOAC, RTG, April 1975 [6].

include cash or resources on hand plus borrowing from institutions, relatives, or merchants. The constraint is summarized in Equation 1.7:

$$C_m \geq \sum_{i=1}^{56} A_{im}X_{im} - \sum_{k=1}^{3} CB_{km} \qquad m = 1,2,3,\ldots,12 \qquad (1.7)$$

where,

C_m is the capital (Baht) available for agricultural production in the m-th month;

A_{im} is the number of Baht required to produce the i-th crop during the m-th month; and

X_{im} and CB_{km} are as defined earlier.

However, capital available for borrowing from institutions and relatives is limited as follows:

$$B_k \geq \sum_{m=1}^{12} CB_{km} \qquad k = 1,2 \qquad (1.8)$$

where,

B_k is the limit of capital supply from the k-th source which can be borrowed during a given year; and

CB_{km} is as defined earlier.

In addition to land, labor, and capital constraints, sericulture activities in a given zone are constrained by the availability of silkworms in that zone.

$$COC_i \geq Z_iX_i \qquad i = 50,51 \qquad (1.9)$$

where,

COC_i is the available supply of silkworms of the i-th type;

Z_i is the number of silkworms of the i-th type which can be supported on one rai of mulberry; and

X_i is the number of rai of mulberry produced for the i-th type of silkworms.

Home consumption and sale of commodities from a given zone is constrained by the amount of commodity produced in that zone.

$$RT_i \geq \sum_{i=1}^{56} \sum_{\ell=1}^{4} \sum_{m=1}^{12} - Y_{i\ell m} X_{i\ell m} + SD_i + MK_i \qquad (1.10)$$

where,

RT_i is the transfer row for the i-th commodity;

$Y_{i\ell m}$ is the yield coefficient for the i-th crop produced on the ℓ-th type land starting in the m-th month; and

$X_{i\ell m}$, SD_i, and MK_i are as defined earlier.

Sales are further bounded by a regional market constraint which fixes an upper bound on the total home consumption and sales in the region.

$$RMKB_i \geq \sum_{j=1}^{5} SD_{ij} + \sum_{j=1}^{5} MK_{ij}$$

where,

$RMKB_i$ is the upper bound on the total regional home consumption and sales of the i-th commodity; and

SD_{ij} and MK_{ij} are as defined earlier.

Subsistence demand for a given commodity in a given zone must be met by production in that zone. Column bounds are used to insure that

subsistence demand requirements are met before resources are used for production of alternative commodities. Because the same price was used for subsistence demand and marketing activities equalities were used on the subsistence demand activities to force sales above subsistence demand to pass through the marketing activities for accounting purposes. The bounds are:

$$SD_i = \sum_{\ell=1}^{4} \sum_{m=1}^{12} Y_{i\ell m} X_{i\ell m} \qquad i = 1,2,3,\ldots,56 \qquad (1.12)$$

where, SD_i, $Y_{i\ell m}$, and $X_{i\ell m}$ are defined earlier.

The commodity codes used in the regional model are as follows:

01	Nonglutinous rice	26	Sugarcane, fresh
05	Glutinous rice	27	Sugarcane, processing
09	Maize, feed	28	Tobacco, native
10	Maize, food	29	Tobacco, Virginia
12	Mungbean	35	Tobacco, Turkish
14	Soybean	40	Watermelon
18	Groundnut	50	Sericulture, native
21	Kenaf	51	Sericulture, hybrid
22	Jute	54	Silk cloth, native
23	Cotton	55	Silk cloth, hybrid
24	Castor seed	56	Sericulture, Japanese
25	Cassava		

Normative supply curves were derived for each of the four selected commodities through a series of solutions over a wide range of prices. As each commodity was studied individually, the upper bound on market demand was released for that commodity. It is not assumed or implied that this is a realistic market assumption. In fact, both domestic and export demand appear to be quite price responsive. Whether or not a demand exists at each price analyzed depends on the national setting, world market, and export policy. The study is designed to analyze what

would happen to agricultural production, employment, income, resource use, etc., if the demand did exist at the specified prices. If the resulting impacts are desirable, then policy makers can examine ways of expanding demand and(or) supporting prices to achieve the desired production response. This study focuses on the impact of higher prices rather than the means to achieve those price levels.

The primary objective of the study is to estimate a normative supply curve for each of the four commodities, given the general resource base, technology, and specified demand for other commodities in the model. Prices of all other commodities are held constant as the price of the commodity in question is varied. The secondary objective of the study is to estimate the impact which changes in the price structure have on income and employment levels, as well as production and resource use patterns. Although the direct impact on the production of a given commodity may be important to policy makers, the secondary impacts on other subsectors may be equally important. Only when studied within the general competitive framework of the regional model can the policy maker assess the net impact of a specific action such as supporting a given commodity price.

SUPPLY RESPONSE STUDIES

Rice Subsector

Rice dominates the economy and welfare of farmers in Northeast Thailand, as it does much of the Kingdom. Over the last 15 years, planted area has ranged from a low of 35 million rai to a high of 47 million rai for the whole Kingdom (Table 1). Northeast Thailand has roughly 45 percent of the total planted area [1] and produces 4 to 5 million tons of paddy rice annually for 30 to 40 percent of the total production. Based on preliminary solutions to NEREGON, rice generated roughly 65 percent of the total value of crop production in the Northeast in the 1971-72 base year [6, Table 12]. Consequently, although the Northeast is basically a rainfed area, paddy rice is the main backbone of the Northeast agricultural economy. Thailand has consistently exported 1 to 2 million tons of rice annually which generates 15 to 20 percent of the total foreign earnings. Rice premiums collected on exports have ranged from just under 300 million Baht[1] to over 1.3 billion Baht in the five years up to 1972. This makes rice a key factor in the agricultural economy as well as a major source of government revenue.

Rice Supply Response

Eight solutions were obtained for the rice model at 500 Baht increments from 500 Baht to 4,000 Baht per ton, wholesale paddy price [8].

---

[1] One Baht equals about US $0.05, an exchange of approximately 20 Baht per US $1.00.

As the price was increased from 500 Baht to 4,000 Baht per ton, planted area increased from 25.0 million rai to almost 29.4 million rai, or a 17.6 percent increase (Figure 1). The increase in planting was very rapid from 500 to 1,500 Baht. From 1,500 to 3,500 Baht, the increase was relatively steady, but much smaller. Above 3,500 Baht, the area again takes another sharp increase on up to 4,000 Baht.

Table 1. Area, yield, and wholesale price of rice in Thailand[a]

Crop Year	Planted Area	Average Yield	Wholesale Price
	(1,000 rai)	(Kg/rai)	(Baht/ton)[b]
1958/59	35,887	240	830.77
1959/60	37,909	223	850.96
1960/61	37,012	256	910.81
1961/62	38,619	256	1,097.17
1962/63	41,168	267	955.08
1963/64	41,229	281	770.01
1964/65	40,872	278	839.16
1965/66	40,961	268	1,210.44
1966/67	46,454	257	1,232.72
1967/68	41,612	231	1,158.25
1968/69	45,173	229	1,100.00
1969/70	47,400	283	1,024.01
1970/71	46,840	290	992.83
1971/72	47,043	292	851.15
1972/73	44,620	262	1,099.61

[a]SOURCE: Agricultural Statistics of Thailand, Crop Year 1972-73 [2].

[b]Wholesale paddy price delivered to mill in Bangkok.

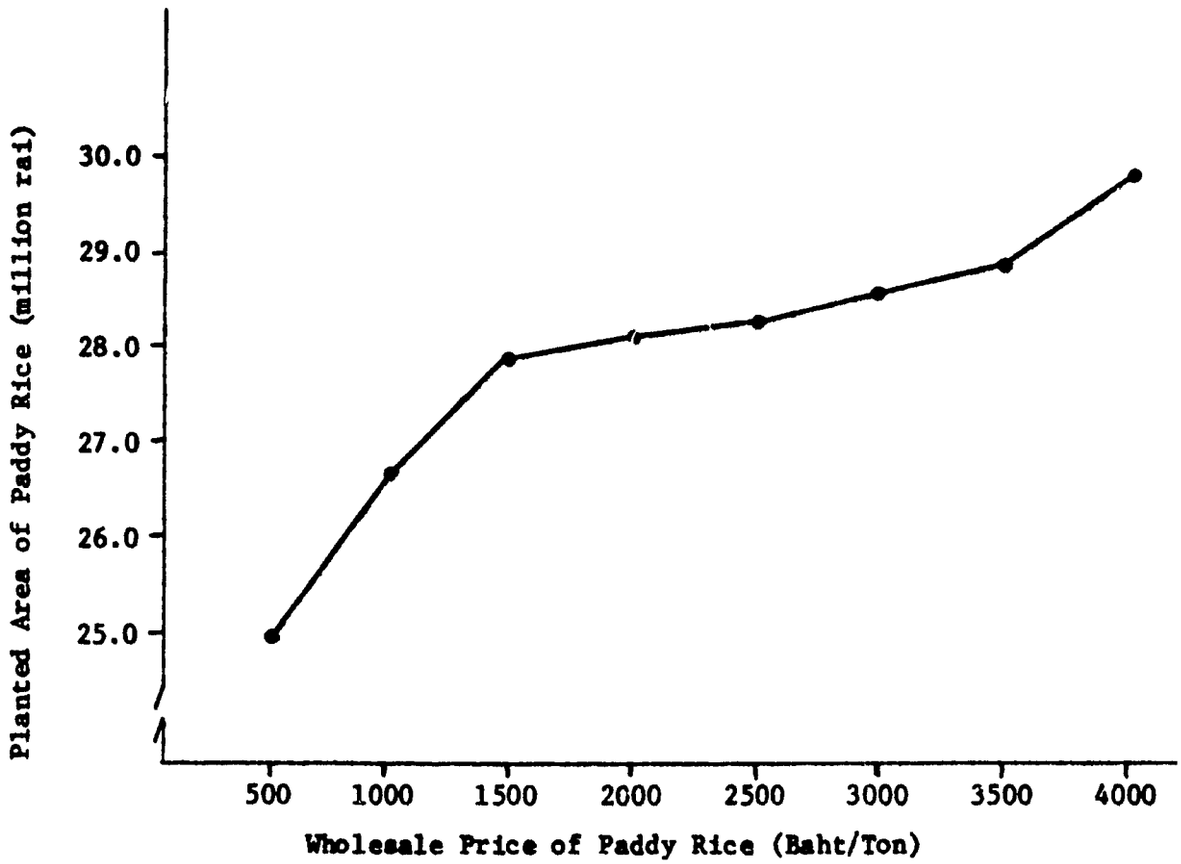

Figure 1. Normative rice planting response to varied paddy price in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 16.

Although technology is fixed in the model, resource substitution can take place through the numerous activities which have been defined, especially for rice. To some extent, the resource substitution is reflected in the comparison between Figures 1 and 2. The normative supply curve, in Figure 2, shows relatively steady response to price increases up to 2,000 Baht. From 2,000 to 2,500 Baht, there is virtually no impact.

Then, from 2,500 on up to 4,000 Baht, the response is significant again. The production increase from 5.5 million tons at 500 Baht to 6.4 million tons at 4,000 Baht represents about a 16-percent increase. An increase of 900,000 tons of paddy production would have a significant impact upon the export potential for Thailand.

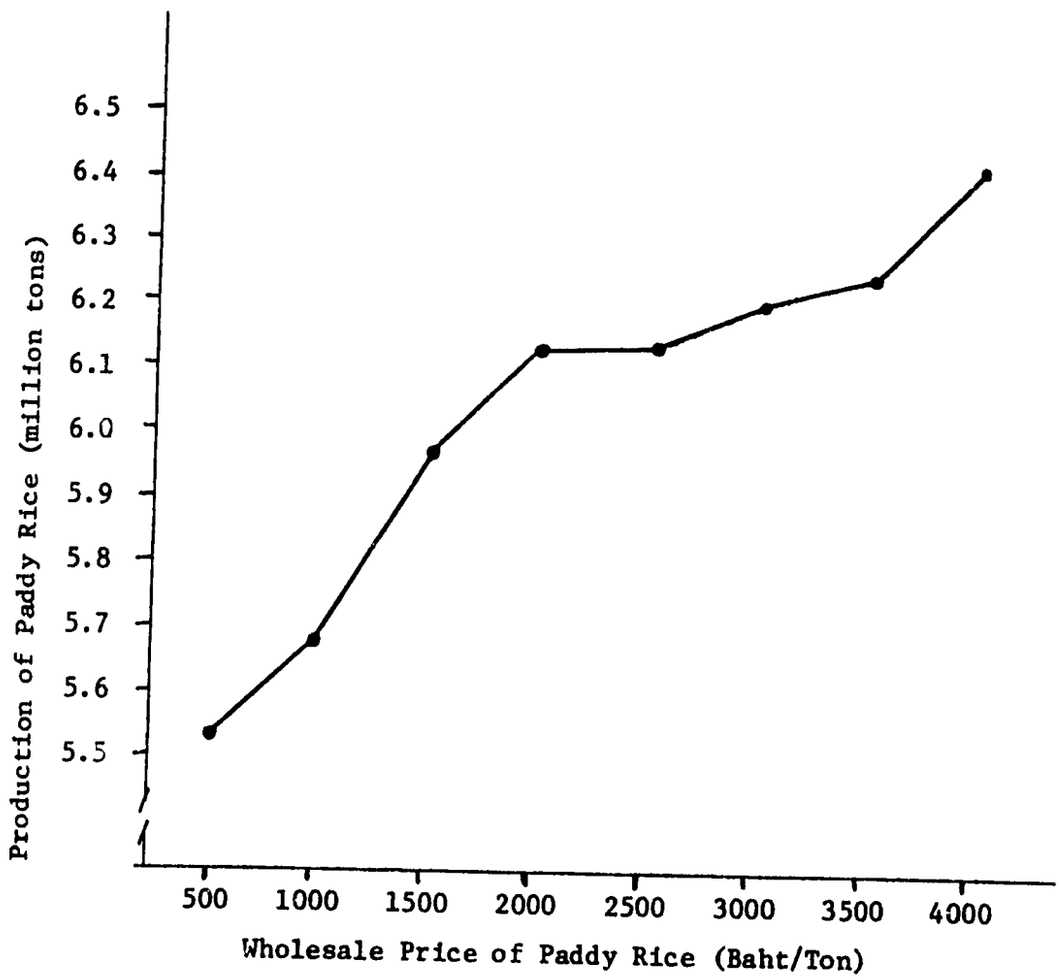

Figure 2. Normative rice supply response to varied paddy price in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 16.

Rice Impacts on Other Crops

Higher prices of rice definitely provide an economic incentive for farmers to expand rice production, even when other crops have to be given up. Summarizing the crop production patterns into five major crop groups simplifies the analysis. The initial impact of higher rice prices was to increase the total area under cultivation but also to induce production of all commodity groups except rice. Rice prices up to 2,500 Baht were competitive with the food and feed group and caused steady reductions to approximately 635,000 rai at the 2,500 Baht level. Above that price, food and feed production remained constant (Table 2). Increasing rice prices from 500 to 1,000 Baht caused production of oil crops to decline. The same was true when the price was raised to 1,500 Baht, but above 1,500 Baht oil crop production remained unchanged.

Fiber crops show the most significant response to changes in rice prices. As rice prices varied from 500 Baht to 4,000 Baht, fiber crops decreased by just over 1 million rai or about 27 percent. No significant adjustments resulted until rice price reached 2,000 Baht. Again from 2,500 Baht to 3,500 Baht, the changes were relatively small. Nearly 900,000 rai of the fiber crops were replaced when rice price was increased from 3,500 to 4,000 Baht. The remaining crop group, Other Crops, showed a slight reduction when the rice price increased from 500 Baht to 1,000 Baht, but remained constant from that point up to 2,500 Baht. Above 2,500 Baht, the area of other crops gradually decreased at each price level up to the 4,000 Baht levels.

Table 2. Normative planting response in Northeast Thailand to varied paddy rice prices--base year 1971-72

Price of Paddy	Area Planted by Major Crop Groups					
	Rice[a]	Food and Feed[b]	Oil[c]	Fiber[d]	Other[e]	Total
(Baht/ton)			(rai)			
500	26,021,325	846,885	92,247	3,795,819	488,377	31,244,653
1,000	26,703,064	776,236	81,242	3,767,447	482,661	31,810,650
1,500	27,967,618	755,624	80,273	3,761,146	482,661	33,047,322
2,000	28,191,198	755,624	80,273	3,761,146	482,661	33,270,902
2,500	28,257,911	633,310	80,273	3,693,704	482,661	33,147,859
3,000	28,363,538	637,766	80,273	3,643,959	451,418	33,176,954
3,500	29,020,914	637,766	80,273	3,643,959	421,853	33,804,765
4,000	29,371,898	637,766	80,273	2,762,886	416,491	33,269,314

SOURCE: NEREGON - Solution 16.

[a]Including both paddy and upland rice.

[b]Including maize, mungbeans, cassava, and sugarcane.

[c]Including castor seed, groundnut, and soybean.

[d]Including cotton, kenaf, and jute.

[e]Including tobacco, mulberry, and watermelon.

Increased rice prices do provide sufficient economic incentive to increase rice production at every price increment studied. The two sharpest increases come in the 500-1,000 range, and the other in the 3,500-4,000 range. At the lower end, most of the change in rice area is due to an increase in total cultivated area. At the upper end, the reduction represents a conversion from fiber crops to rice production. Throughout the rest of the price range, there is some competition with almost every crop group at every level. These adjustments raise questions about the impact on employment opportunities.

Rice Impact on Employment

The impact of various levels of rice price on rice production and production of other crops has already been discussed. Just as changes in price level would affect production patterns, they would also affect employment patterns. The overall impact is to reduce employment by about 8.4 percent as price increased from 500 Baht to 4,000 Baht per ton and crop production adjusted accordingly. The least adjustment takes place between 2,000 Baht and 3,500 Baht where employment stabilizes at about 4.3 billion hours (Table 3). Above 3,500 Baht there is another reduction of 55 million hours as price increased to 4,000 Baht.

Differential impacts can be observed in the five zones. In Zone 01 the only changes in employment are the reductions in the 1,000-1,5000 range and the 3,500-4,000 range. Zone 02 employment drops only when price raises from 500 to 1,000 Baht and remains constant thereafter. Zone 03 has a unique employment pattern. Employment drops as each 500

Baht increment is added up to 2,000 Baht. Above 2,000 Baht employment increases by 8 and 9 million hours, respectively, until the price reaches 3,000 Baht. Employment holds steady in the 3,000-3,500 Baht range, and then drops again from 3,500 to 4,000 Baht. Zone 04 employment drops about 7.2 percent in the 1,000-1,500 range and then remains relatively constant. Zone 05 shows a steady decrease in employment up to 2,500 Baht and then remains constant.

Table 3. Agricultural employment in Northeast Thailand under various rice price assumptions--base year 1971-72

Price of Paddy	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million hours)			
500	963	550	1,267	1,049	829	4,658
1,000	963	499	1,251	1,051	829	4,593
1,500	865	499	1,248	975	828	4,415
2,000	865	499	1,199	975	785	4,323
2,500	865	499	1,208	975	771	4,318
3,000	865	499	1,217	974	770	4,325
3,500	865	499	1,217	969	770	4,320
4,000	815	499	1,215	966	770	4,265

SOURCE: NEREGON - Solution 16.

Rice Impact on Capital Requirements

Capital utilization is an aggregate measure of resource requirements in production agriculture. The type of crops produced and the technology level used directly affects the land, labor, and capital mix required. Discussion in the previous section shows employment going down, in general,

as rice prices and production increases. The data in Table 4 reflect the significance of resource substitution in production. The capital utilization patterns are almost exactly opposite the employment patterns. Capital requirements increase throughout the price range up to 3,000 Baht with the total requirement increasing by 12.9 percent. Above 3,000 Baht the capital requirement drops again by 6.6 percent.

In Zones 01, 02, and 04, the capital requirements remain remain relatively constant above 1,500 Baht paddy price. In Zone 03 the capital requirement increases up to 3,000 Baht and then remains constant. In Zone 05 the capital requirements increase up to 3,000 Baht, remain constant to 3,500, and then drop sharply as price goes to 4,000 Baht.

Table 4. Agricultural capital requirements in Northeast Thailand under various rice price assumptions--base year 1971-72

Price of Paddy	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million baht)			
500	158.8	71.6	343.2	223.9	169.9	967.4
1,000	159.4	74.0	363.1	225.2	173.9	995.6
1,500	172.8	74.0	362.8	241.9	173.2	1,024.7
2,000	172.8	74.0	397.3	241.9	179.6	1,065.6
2,500	172.8	74.0	397.3	241.9	189.4	1,075.4
3,000	172.8	74.0	414.3	240.3	191.1	1,092.5
3,500	172.8	74.0	414.3	239.9	191.1	1,092.1
4,000	124.6	74.0	414.3	233.0	173.9	1,019.8

SOURCE: NEREGON - Solution 16.

Rice Impact on Income

At each solution level, the value of the program (net income) was recorded and used to calculate per capita net income estimates for the 9.579 million people living in rural households in Northeast Thailand [8]. Net income in this calculation includes gross value of sales, plus onfarm consumption valued at market price, minus cost of production. This is not a measure of cash income, but rather a measure of net value of production. As indicated in Figure 3, per capita income increases at almost a perfectly linear or constant rate. More specifically, it increases from 572 Baht per person when rice is 500 Baht per ton to 2,780 Baht per person when rice is 4,000 Baht per ton. This increase represents nearly a 500 percent increase in per capita income level for all residents, not just the labor force. Applied to the labor force, of course, the increase would be much greater on a per capita basis.

The steady increase in per capita income apparently reflects two major factors. First, because rice is so dominant in both the general economy and in the home consumption package, price increases have a dramatic impact upon the income and welfare of the paddy farmers. Second, the steady growth in income, in constrast to the nonlinear planting and production patterns in Figures 1 and 2, indicate that income and production of other crops are being given up in order to increase rice production, as already discussed.

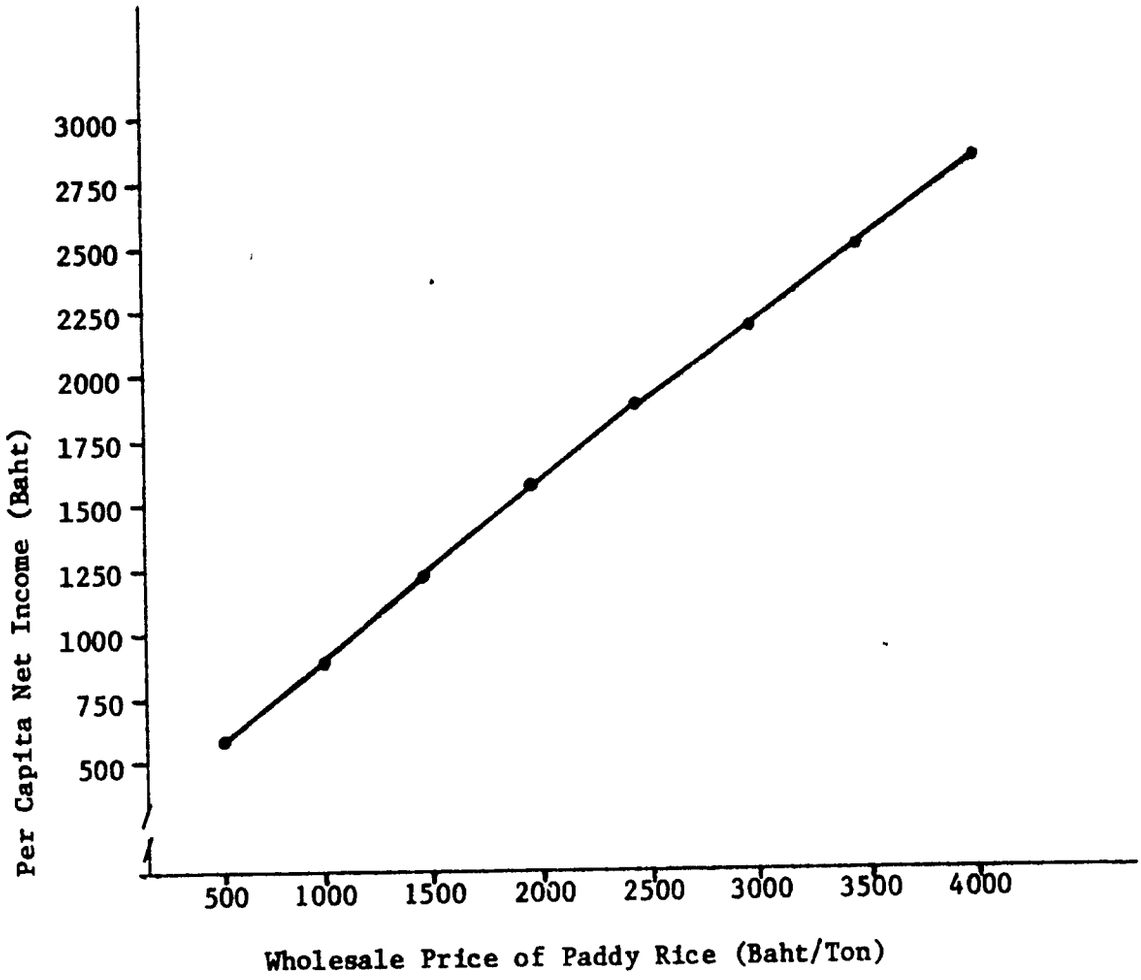

Figure 3. Normative net income response to varied paddy prices in Northeast Thailand--base year 1971-72[a,b]

[a]SOURCE: NEREGON - Solution 16.

[b]Net income measured as net cash income plus onfarm consumption valued at market price.

Kenaf Subsector

Kenaf production does not dominate the economy of Thailand like rice, but it is an important cash crop. For the whole Kingdom, planted area has ranged from a low of about .127 million rai to a high of about 2.95 million

rai over the last 15 years (Table 5). Among the upland crops for the whole Kingdom, average planted area of kenaf ranked third behind maize and rubber in 1971-72 [4, p. 3]. Northeast Thailand had about 83 percent, or nearly 2.4 million rai, of the total planted area in the 1971-72 crop year. Based on preliminary solutions to NEREGON, fiber crops generated roughly 25.2 percent of the total value of crop production in the Northeast [6, Table 12]. Kenaf produced over 97 percent of the fiber income. Kenaf is particularly important to Thailand because of its contribution to foreign trade and exchange earnings. In 1972 kenaf exports exceeded 1,076 million Baht, or nearly 5 percent of the total domestic exports [2, pp. 94 and 103].

Kenaf Supply Response

Six solutions were obtained for the kenaf model at 1,000 Baht increments from 500 Baht to 5,500 Baht per ton, wholesale retted kenaf price [9]. As the price was increased from 500 Baht to 5,500 Baht per ton, planted area increased from 1.0 million rai to just over 4.0 million rai, or a 400 percent increase (Figure 4). The increase in planting was very responsive from 500 to 2,500 Baht. From 2,500 Baht to 3,500 Baht, area increased by 8.3 percent; but above 3,500 Baht there was practically no increase in planted area.

Although technology is fixed in the model some resource substitution can take place through the various activities which have been defined. Only a limited amount of resource substitution is reflected in the kenaf response by comparing Figures 4 and 5. The normative supply curve, in

Figure 5, shows relatively steady response to price increase up to 2,500 Baht. Above 2,500 Baht supply is relatively unresponsive to further price increases.

Table 5. Area, yield, and wholesale price of kenaf in Thailand[a]

Crop Year	Planted Area	Average Yield	Wholesale Price
	(1,000 rai)	(Kg/rai)	(Baht/ton)[b]
1958/59	127	233.1	2.30
1959/60	278	180.5	2.24
1960/61	877	208.4	3.17
1961/62	1,190	201.8	3.57
1962/63	712	192.0	2.34
1963/64	957	222.9	2.73
1964/65	1,365	225.2	2.85
1965/66	2,401	227.0	3.02
1966/67	3,314	213.0	3.30
1967/68	2,177	[illegible]07.0	1.98
1968/69	1,585	204.0	2.42
1969/70	2,358	166.7	2.66
1970/71	2,631	156.4	2.81
1971/72	2,891	145.0	2.66
1972/73	2.951	145.0	4.45

[a]SOURCE: [2].

[b]Wholesale price in Bangkok; 1958-67 retted kenaf (good), 1968-72 retted kenaf (average grade A, B, and C).

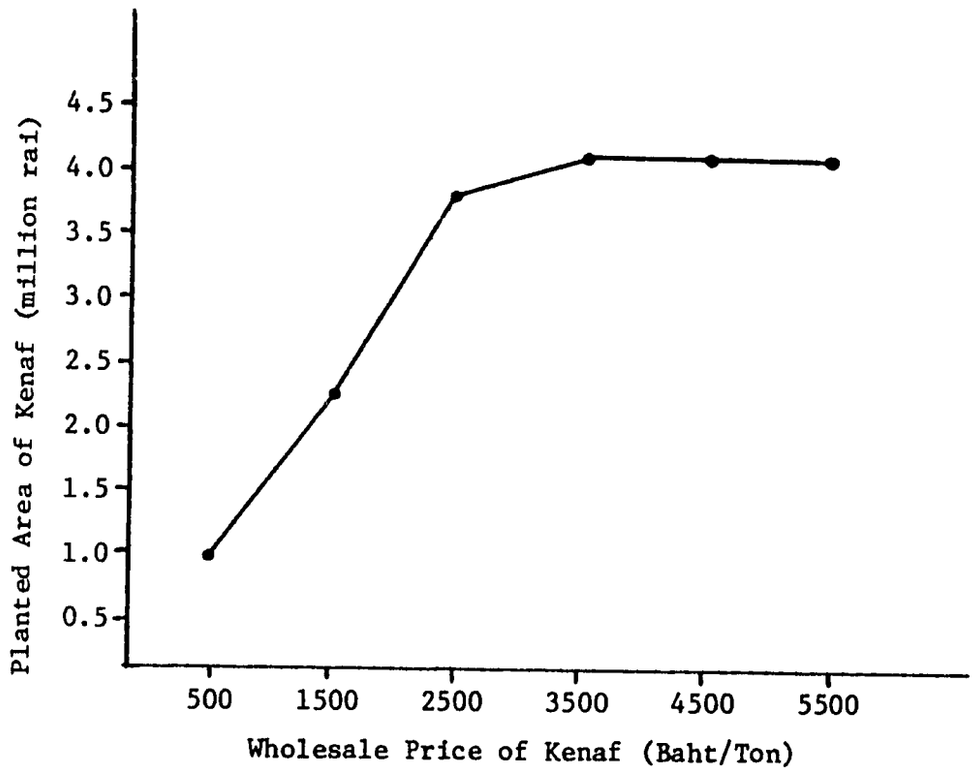

Figure 4. Normative kenaf planting response to varied kenaf prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 17.

Kenaf Impact on Other Crops

At least within some limits, higher kenaf prices definitely provide an economic incentive for farmers to expand kenaf production, even when other crops have to be given up. To analyze changes in the crop production patterns the crops have been summarized into five major crop groups (Table 6). Starting from the lowest price level, the initial impact of price change is to increase total planted area. The increase continues up to the 2,500 Baht price level and then total planted area drops very slightly as price increases.

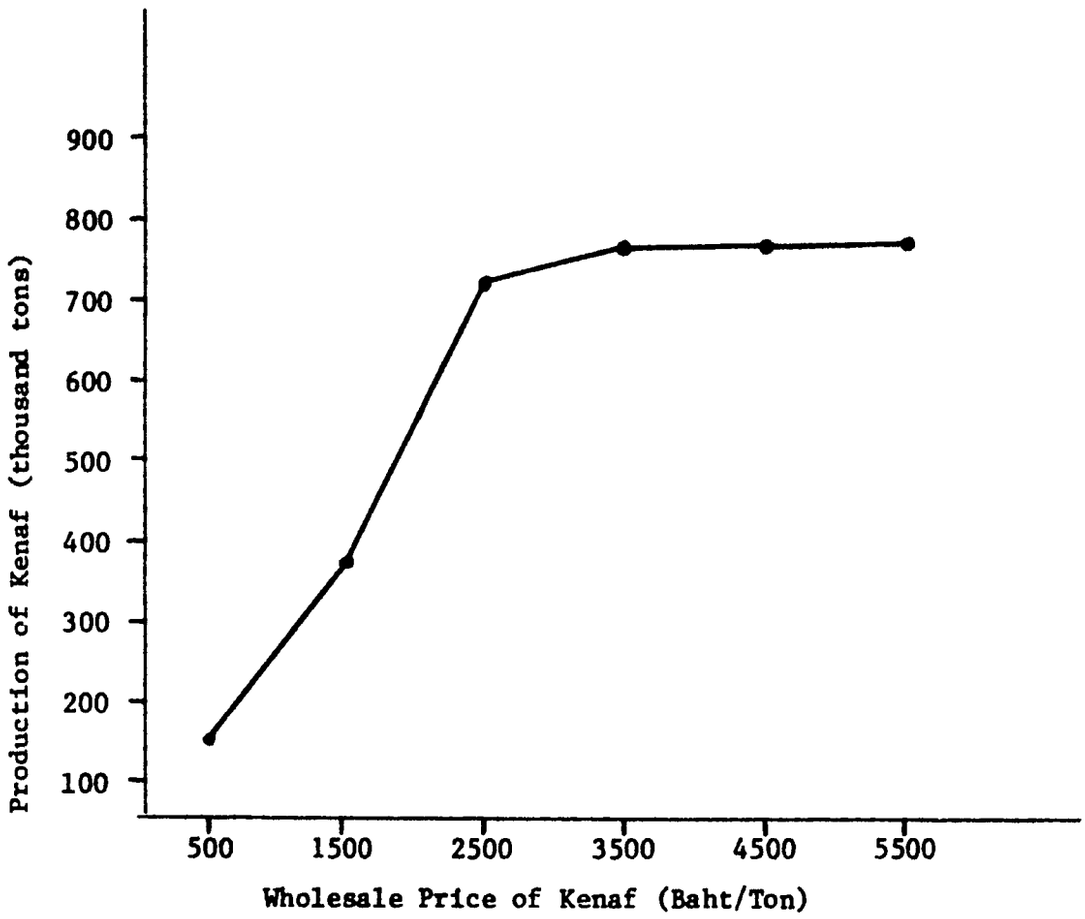

Figure 5. Normative kenaf supply response to varied kenaf prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 17.

Table 6. Normative planting response in Northeast Thailand to varied kenaf prices--base year 1971-72

Price of Kenaf	Area Planted by Major Crop Groups						
	Kenaf	Rice[a]	Food and Feed[b]	Oil[c]	Fiber[d]	Other[e]	Total
(Baht/ton)				(rai)			
500	1,006,410	27,205,675	658,474	92,249	1,431,080	539,444	29,926,922
1,500	2,225,840	26,662,846	627,585	92,135	2,358,299	487,012	30,227,877
2,500	3,776,443	26,120,029	609,881	100,484	3,778,829	483,906	31,093,129
3,500	4,089,780	26,143,159	263,134	88,717	4,092,166	483,906	31,071,082
4,500	4,096,713	26,139,019	256,201	88,717	4,099,099	486,712	31,069,748
5,500	4,097,497	26,139,280	256,201	87,933	4,099,883	483,906	31,067,203

SOURCE: NEREGON - Solution 17.

[a]Including both paddy and upland rice.

[b]Including maize, mungbean, cassava, and sugarcane.

[c]Including castor seed, groundnut, and soybean.

[d]Including cotton, kenaf, and jute.

[e]Including tobacco, mulberry, and watermelon.

The impact of the changing kenaf prices and production causes some reduction in each of the other four groups. Rice production drops as kenaf increases up to the 2,500 Baht price level, and then rice increases by about 20,000 rai and stabilizes at that level. Up to 2,500 Baht kenaf increases result in some reduction in food and feed grains. From 2,500 to 3,500 Baht virtually all of the kenaf increases are at the expense of food and feed grains production. Oil crops experience adjustment only in the 1,500 to 3,500 Baht range. From 1,500 to 2,500 Baht, oil crop area actually increases. From 2,500 to 3,500 Baht the oil crops fall back to about 3.7 percent below original levels. Within the fiber crop group, substitution takes place as well. Initially, kenaf area constitutes just under 70 percent of the fiber crops. At the high price level kenaf constitutes essentially all of the fiber crop area. Most of the substitution takes place below 2,500 Baht. Kenaf price and production has the least impact on the "Other Crops" group. Here, kenaf replaces some of the area as price increases to 2,500 Baht, but has little impact above that price level.

Kenaf Impact on Employment

Changing production patterns often signal significant changes in employment opportunities. In contrast to the rice situation, increasing production of kenaf results in moderate increases in employment (Table 7). However, the total impact is less than 4 percent even when price is increased over the wide range from 500 to 5,500 Baht.

Table 7. Agricultural employment in Northeast Thailand under various kenaf price assumptions--base year 1971-72

Price of Kenaf	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million hours)			
500	924	594	1,102	1,045	814	4,479
1,500	977	547	---[a]	---[a]	---[a]	---[a]
2,500	969	549	1,236	1,048	825	4,627
3,500	---[a]	---[a]	1,263	1,048	825	---[a]
4,500	969	550	1,262	1,048	825	4,654
5,500	969	550	1,262	1,048	825	4,654

SOURCE: NEREGON - Solution 17.

[a]Data not available.

Employment increases in all five zones except Zone 02 where employment dropped as price increased from 500 to 1,500 Baht. In Zones 01, 04, and 05, employment increased up to 2,500 Baht level and then stabilized. In Zone 03 employment increased to the 3,500 Baht level and then remained constant. Given the historic price and production levels for kenaf, increasing kenaf production offers little promise for increasing employment opportunities in agriculture with the current resource and technology bases.

Kenaf Impact on Capital Requirements

Capital requirements are affected by the level of kenaf production. As kenaf price was raised from 500 Baht to 2,500 Baht, the capital requirements increased from 828.8 million Baht to 988.6 million Baht (Table 8), or about 19 percent. Above 2,500 the requirements appear to

fall slightly reflecting the reallocation of crop patterns as discussed earlier. However, the production patterns at the higher kenaf prices still require 18.8 percent more capital than at the lowest price level.

Zone 02 reflects a unique pattern of capital use when the capital requirement increases up to the 2,500 Baht price level and then falls back and stabilizes. Capital requirements in Zone 05 drop as kenaf production in the region increases up to the 2,500 Baht price. The other three zones all have increasing capital requirements up to the 2,500 Baht price level, and then constant requirements above that level.

Table 8. Agricultural capital requirements in Northeast Thailand under various kenaf price assumptions--base year 1971-72

Price of kenaf	Zone 01	Zone 02	Zone 03	Zone 4	Zone 05	Total
(Baht/ton)			(million Baht)			
500	130.1	54.0	275.0	185.1	184.6	828.8
1,500	154.4	70.8	---[a]	---[a]	---[a]	---[a]
2,500	161.7	76.1	361.3	221.7	167.8	988.6
3,500	---[a]	71.6	363.7	221.7	167.8	---[a]
4,500	160.1	71.6	363.7	221.7	167.8	984.9
5,500	160.1	71.6	363.7	221.7	167.8	984.9

SOURCE: NEREGON - Solution 17.

[a]Data not available due to malfunction of computer printer.

Kenaf Impact on Income

At each solution level the value of the program (net income) was recorded and used to calculate per capita net income estimates for the 9.579 million people living in rural households in Northeast Thailand [9].

Net income in this calculation includes gross value of sales, plus onfarm consumption valued at market price, minus cost of production. As indicated in Figure 6, per capita income increases at almost a linear or constant rate. More specifically, it increases from 664 Baht per person when kenaf is 500 Baht per ton to 1,008 Baht when kenaf is 5,500 Baht per ton. This increase represents slightly over a 50 percent increase in per capita income level for all residents, not just the labor force. Applied to the labor force, of course, the increase would be much greater on a per capita basis.

The increase in per capita income associated with the alternative price levels reflects a positive impact on farmers, but not a dramatic impact considering the wide range of prices analyzed. The steady growth in per capita income, in contrast to the nonlinear patterns in Figures 4 and 5, indicates that income and production of other crops are being given up in order to increase kenaf, as discussed earlier.

Cassava Subsector

Cassava production is a large and growing activity in Thailand. Over the last 13 years, planted area for the Kingdom has ranged from a low of about .447 million rai to a high of about 2.039 million rai (Table 9). The range of production only tells part of the story, however, as cassava production has been steadily increasing over time. In fact, the preliminary 1973-74 crop year data show another significant increase from just over 2 million rai to 2.67 million rai [13, p. 25]. Cassava production utilized the fourth largest crop area in Northeast Thailand

in the 1971-72 crop year, about .156 million rai [6, Table 9]. This accounts for a little over 11 percent of the national total.

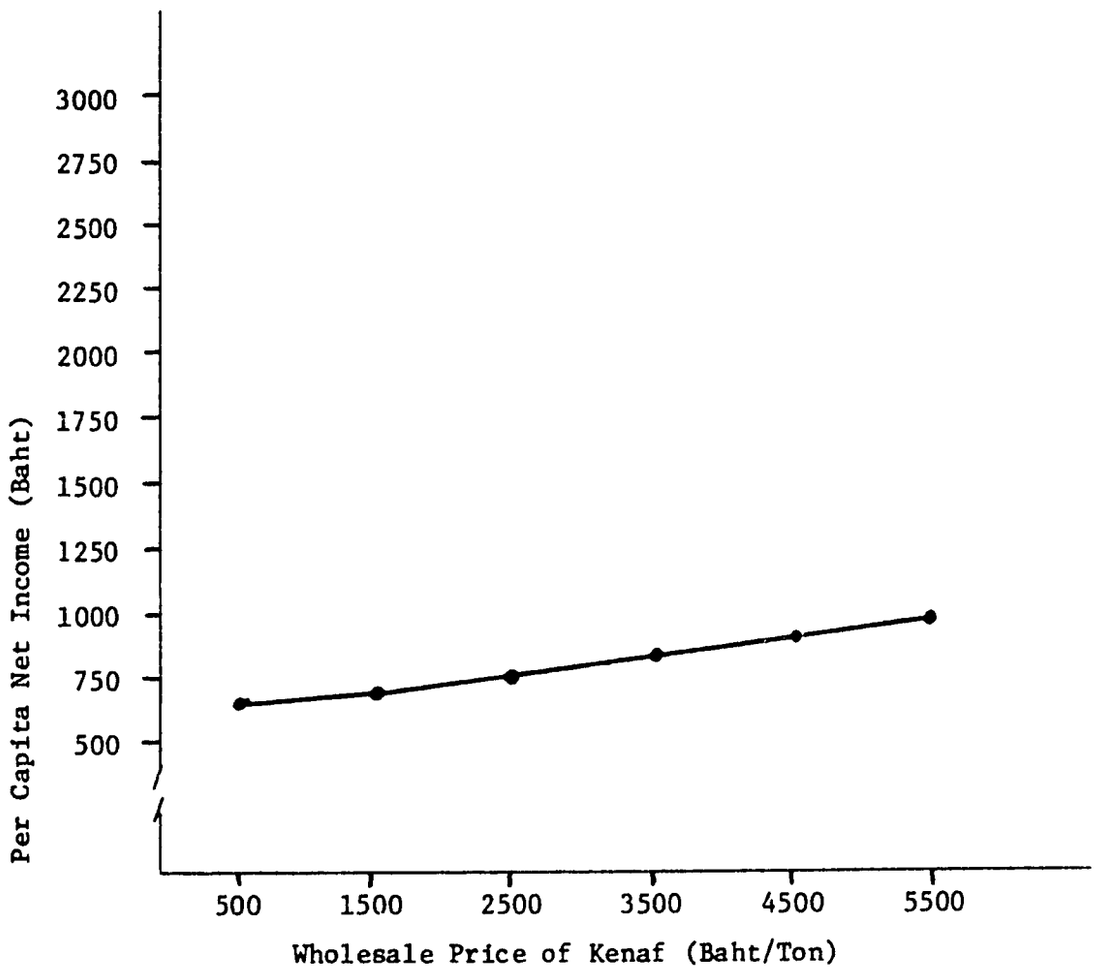

Figure 6. Normative net income response to varied kenaf prices in Northeast Thailand--base year 1971-72[a,b]

[a]SOURCE: NEREGON - Solution 17.

[b]Net income measured as net cash income plus onfarm consumption at market price.

A strong export market has been a key factor in the rapid expansion of cassava production. Exports have increased from 443 million tons of processed cassava (shredded, flour, pellets, and waste) in 1961 to 1,311 million tons in 1972 [2, p. 98]. In 1972 cassava exports exceeded 1,546 million Baht, or just over 7 percent of the total domestic exports [2, pp. 94 and 98].

Table 9. Area, yield, and wholesale price of cassava in Thailand[a]

Crop Year	Planted Area	Average Yield	Wholesale Price
	(1,000 rai)	(Kg/rai)	(Baht/ton)[b]
1960/61	447	2,733.8	0.63
1961/62	621	2,779.4	0.65
1962/63	767	2,708.0	0.73
1963/64	875	2,412.6	0.62
1964/65	656	2,373.5	0.55
1965/66	637	2,315.5	0.70
1966/67	814	2,324.3	0.72
1967/68	880	2,343.2	0.59
1968/69	1,666	2,449.3	0.58
1969/70	1,193	2,580.9	0.65
1970/71	1,403	2,445.5	0.71
1971/72	1,384	2,250.0	2.14
1972/73	2,039	2,072.0	2.34

[a]SOURCE: [2].

[b]Wholesale price in Bangkok; 1960-68, 1971-72 cassava meal; 1969-70 cassava pellets converted to meal price (conversion: one ton roots = 392 kgs of meal = 365.5 kgs of pellets).

Cassava Supply Response

Six solutions were obtained for the cassava model at 300 Baht increments from 100 Baht per ton to 1,600 Baht per ton, wholesale cassava price [10]. As price increased from 100 Baht to 1,600 Baht per ton planted area increased from no production to almost 3.8 million rai (Figure 7). For practical purposes, all of the increase came between 100 and 400 Baht per ton. Above 400 Baht there was a very slight increase in area, but the total increase in planted area from 400 to 1,600 Baht was only 45.8 thousand rai, or about 1 percent of the production level at 400 Baht. This suggests that policies designed to manipulate price above 400 Baht would not be effective in stimulating production.

The normative supply curve (Figure 8) shows a sharp response between 100 and 400 Baht per ton, as observed with area planted. Beyond 400 Baht per ton there was very little supply response. The close correlation between area planted and production, and the lack of response to prices above 400 Baht, suggest that very little resource substitution is taking place in cassava production. Although technology is fixed in the model, some resource substitution could take place through selection of alternative activities which have been defined in the model.

Cassava Impact on Other Crops

Prices do provide an economic incentive to farmers to increase cassava production even when other crops have to be given up. Because the cassava response is so distinct, it is relatively easy to describe. Increased prices do increase total area cultivated by a little over 2.5

percent but the big adjustment comes in crop substitution (Table 10). In the 100-400 range when cassava increased by 3.7 million rai, 3.4 million rai of the total was given up in the fiber crops. The other unique circumstance is that the change in cropping patterns changed the resource demand pattern sufficiently to allow oil crops to increase by 41,000 rai also. At all other price levels production remained nearly constant, reflecting the small change in cassava area above the 400 Baht price level.

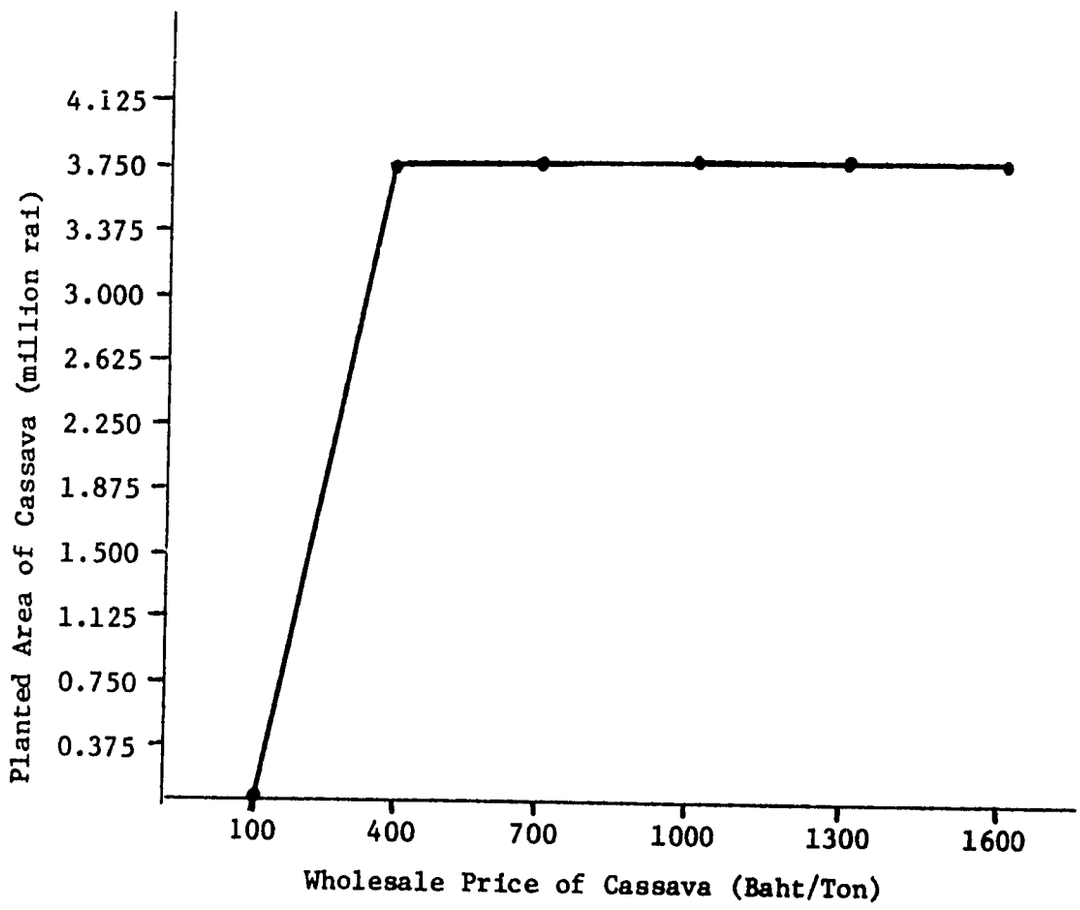

Figure 7. Normative cassava planting response to varied prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 18.

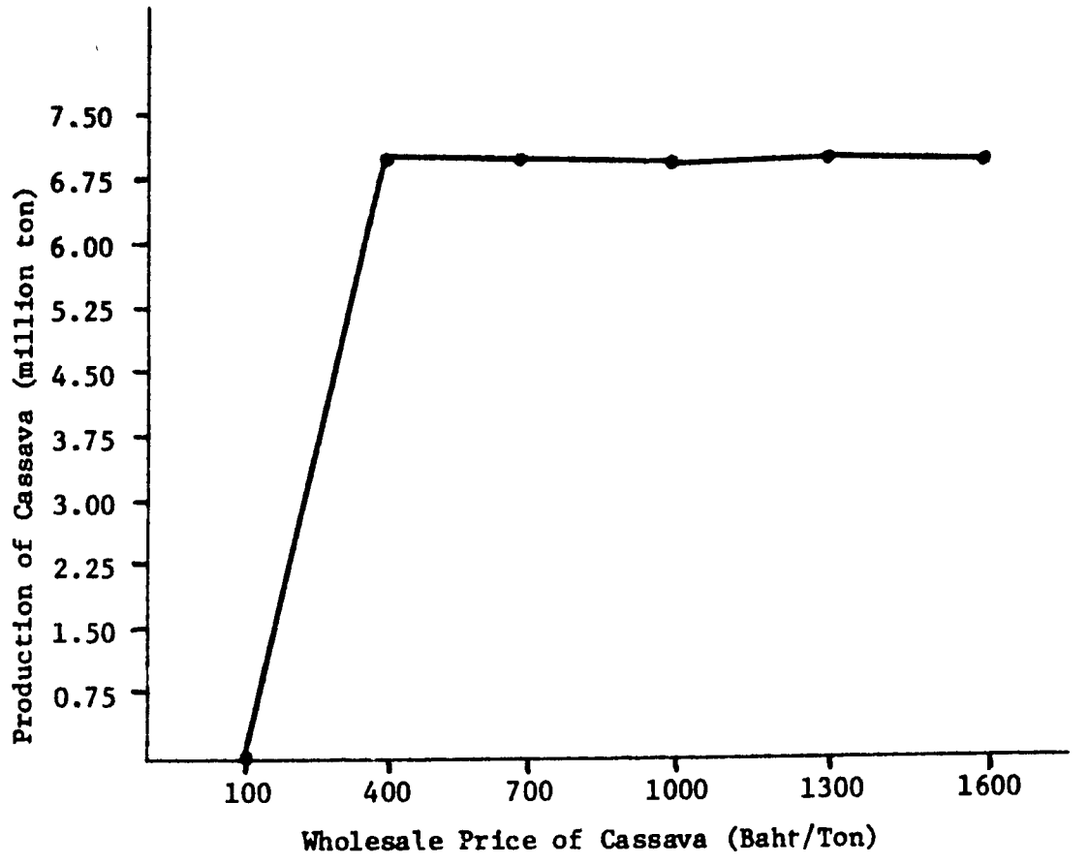

Figure 8. Normative cassava supply response to varied cassave prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 18.

Cassava Impact on Employment

Changes in crop production patterns resulting from changes in cassava price do effect the employment pattern in the Northeast (Table 11). Total employment decreased from 4,631 million hours when no cassava was produced to 4,568 million hours when the price of cassava was between 400 and 1,000 Baht (Table 11). Above 1,000 Baht employment increased again to 4,603 million hours. The total change in employment is less than 2 percent.

Table 10. Normative planting response in Northeast Thailand to varied cassava prices--base year 1971-72

Price of Cassava	Area Planted by Major Crop Groups						
	Cassava	Rice[a]	Food and Feed[b]	Oil[c]	Fiber[d]	Other[e]	Total
(Baht/ton)				(rai)			
100	0	25,803,719	444,881	56,729	3,920,340	483,906	30,709,575
400	3,746,384	26,596,225	3,858,393	97,857	524,547	483,906	31,560,928
700	3,754,102	26,594,685	3,859,178	97,073	524,547	483,906	31,559,389
1,000	3,755,023	26,595,086	3,860,099	97,073	523,625	482,984	31,558,867
1,300	3,792,064	26,596,185	3,897,140	97,073	523,625	447,658	31,561,681
1,600	3,792,064	26,596,185	3,897,140	97,073	523,625	447,658	31,561,681

SOURCE: NEREGON - Solution 18.

[a]Including both paddy and upland rice.

[b]Including maize, mungbean, cassava, and sugarcane.

[c]Including castor seed, groundnut, and soybean.

[d]Including cotton, kenaf, and jute.

[e]Including tobacco, mulberry, and watermelon.

The impact in individual zones of the region differs slightly. In Zones 01, 04, and 05, employment declined as price increased from 100 to 400 Baht and then remained constant. In Zones 02 and 03 the employment increased as price increased to 400 Baht and then, in Zone 02, remained constant. In Zone 03 employment increased again above 1,000 Baht.

Table 11. Agricultural employment in Northeast Thailand under various cassava price assumptions--base year 1971-72

Price of Cassava	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million hours)			
100	963	547	1,234	1,062	825	4,631
400	958	550	1,238	1,016	806	4,568
700	958	550	1,238	1,016	806	4,568
1,000	958	550	1,238	1,016	806	4,568
1,300	958	550	1,273	1,016	806	4,603
1,600	958	550	1,273	1,016	806	4,603

SOURCE: NEREGON - Solution 18.

Cassava Impact on Capital Requirements

Basically the impact of expanded cassava production on capital requirements is exactly opposite the employment response. The total capital requirement increased from 972.7 million Baht at 100 Baht per ton for cassava to a high of 1,118.5 million Baht at 700 Baht per ton (Table 12). Above 700 Baht, capital utilization declined to 1,115.6 million Baht at the 1,600 Baht price. The total change represents just under 15 percent.

Table 12. Agricultural capital requirements in Northeast Thailand under various cassava price assumptions--base year 1971-72

Price of Cassava	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million Baht)			
100	159.4	69.4	361.1	214.0	168.8	972.7
400	182.8	71.6	362.2	246.8	210.0	1,073.4
700	181.6	71.6	362.2	246.9	256.2	1,118.5
1,000	181.3	71.6	362.2	246.9	256.2	1,118.2
1,300	181.3	71.6	359.8	246.9	256.0	1,115.6
1,600	181.3	71.6	359.8	246.9	256.0	1,115.6

SOURCE: NEREGON - Solution 18.

In each of the five zones capital requirements increased when price increased from 100 Baht to 400 Baht. Capital use remained nearly constant after that with one exception. In Zone 05 capital utilization increased by 22 percent from 400 Baht to 700 Baht.

Cassava Impact on Income

At each solution level the value of the program (net income) was recorded and used to calculate per capita income estimates for the 9.579 million people living in rural households in Northeast Thailand [10]. Net income in this calculation includes gross value of sales, plus onfarm consumption valued at market price, minus cost of production. This is not a measure of cash income but rather a measure of net value of production. As indicated in Figure 9, per capita income increases almost at a linear or constant rate as prices are increased. More specifically,

it increases from 779 Baht per person when cassava is 100 Baht per ton to 1,781 Baht per person when cassava is 1,600 Baht per ton. This increase respresents a little over a 200 percent increase in per capita income level for all residents, not just the labor force. Applied to the labor force, of course, the increase would be much greater on a per capita basis.

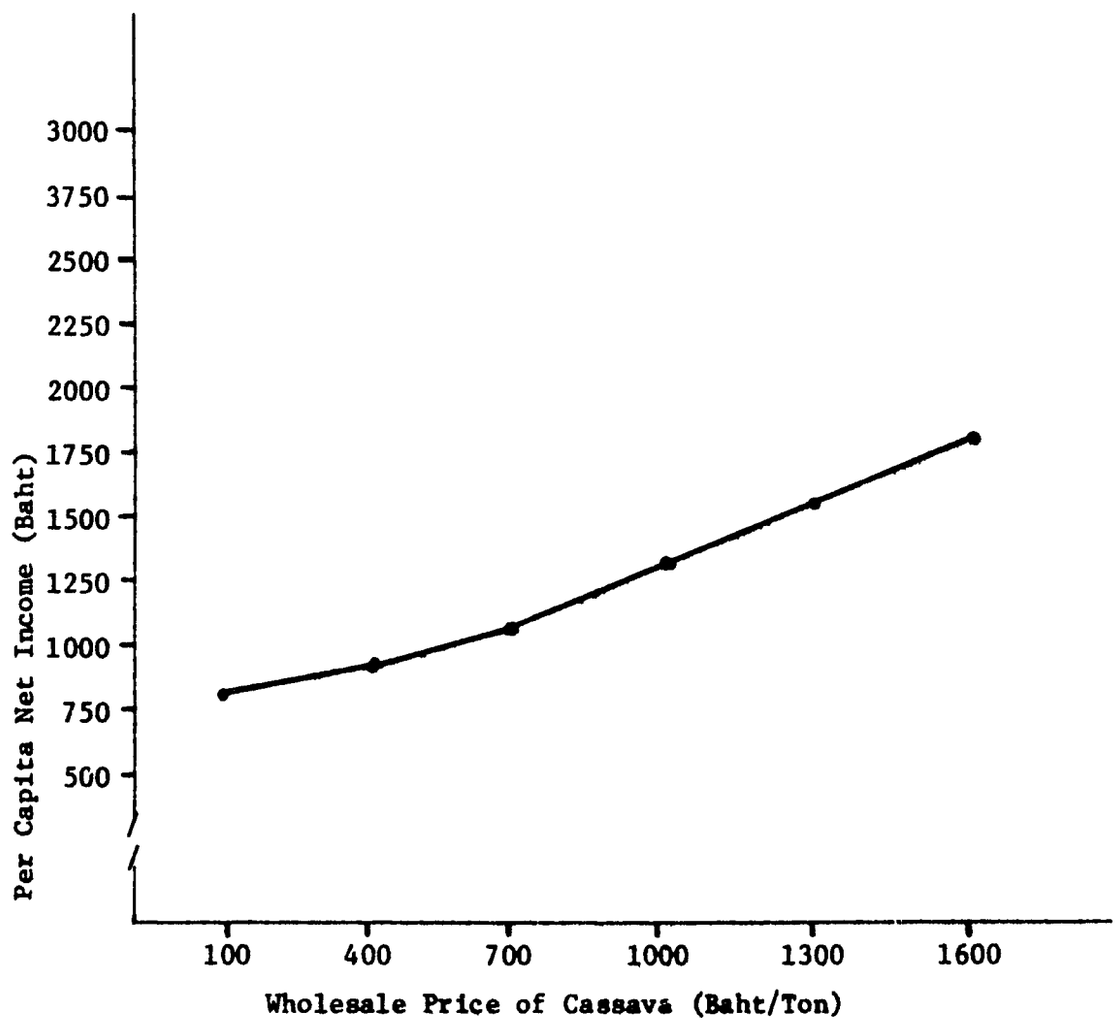

Figure 9. Normative net income response to varied cassava prices in Northeast Thailand--base year 1971-72[a,b]

[a]SOURCE: NEREGON - Solution 18.

[b]Net income measured as net cash income plus onfarm consumption valued at market prices.

The steady increase in per capita income apparently reflects two major factors. First, although the area planted to cassava is not extremely large in Northeast Thailand, the volume of production (approximatekly 7.0 million tons) is significant when price policies are considered. At this level of production every 100 Baht per ton increase in price would change per capita income by approximately 73 Baht. Second, the steady growth in income, in contrast to the nonlinear production patterns, indicates that production and income of other crops are being given up in order to increase cassava production.

Maize Subsector

Maize is the dominant upland food crop in Thailand, with the 1971-72 crop representing 67.5 percent of the area planted to the principal upland food crops [1, p. 52]. Production has expanded steadily from less than 300,000 rai in 1953-54 to over 6.2 million rai in 1972-73 (Table 13). Preliminary data for crop year 1973-74 indicate that the trend in production is continuing with the planted area exceeding 6.8 million rai [13, p. 23]. During the 1971-72 crop year, maize production utilized the third largest crop area in Northeast Thailand, about 522,000 rai [6, Table 9]. This accounts for about 8.2 percent of the national total.

A strong export market has been a key factor in rapid expansion of maize production. Exports have increased from about 34,700 tons of maize in 1953 to 1.93 million tons of maize and 86,500 tons of meal in 1972 [2, p. 97]. In 1972 maize exports exceeded 2,086 million Baht, or

Table 13. Area, yield, and wholesale price of maize in Thailand[a]

Crop Year	Planted Area (1,000 rai)	Average Yield (kg/rai)	Wholesale Price (Baht/kg)[b]
1953/54	298	173	1.50
1954/55	331	191	1.30
1955/56	347	196	1.20
1956/57	514	225	1.16
1957/58	606	229	0.96
1958/59	792	238	1.04
1959/60	1,249	256	1.01
1960/61	1,785	306	1.02
1961/62	1,916	321	1.12
1962/63	2,050	331	1.01
1963/64	2,612	353	1.06
1964/65	3,449	276	1.04
1965/66	3,605	291	1.22
1966/67	4,083	304	1.12
1967/68	4,138	352	1.17
1968/69	4,193	398	0.97
1969/70	4,248	400	1.10
1970/71	5,180	380	1.23
1971/72	6,368	360	1.19
1972/73	6,231	211	1.14

[a]SOURCE: [2].

[b]Wholesale price for shelled, yellow maize (including gunny bags) delivered in Bangkok.

about 9.65 percent of the total domestic exports [2, pp. 94 and 97]. The 1972 volume of exports placed maize second behind rice.

Maize Supply Response

The maize model was solved seven times at 250 increments from 500 to 2,000 Baht per ton, wholesale maize price [11]. As the price was increased from 500 Baht to 2,000 Baht per ton, area planted increased from 91,000 rai to over 5.0 million rai (Figure 10). The increase in planting was relatively small from 500 to 750 Baht, but considerably larger from 750 to 1,000 Baht. From 1,000 to 1,250 Baht the planted area increased by more than 3.1 million rai. Nearly another million rai was added when the price increased to 1,500 Baht. Beyond 2,500 Baht the response to further price increases was relatively small.

Although technology is fixed in the model, resource substitution can take place through the various activities which have been defined. To some extent, the resource substitution is reflected in the comparison between Figures 10 and 11. The normative supply curve, in Figure 11, shows supply response breaking into three distinct segments. The response from 500 to 1,000 Baht and 1,500 to 2,000 is relatively small, while significant response is experienced from 1,000 to 1,500. This suggests that policies designed to manipulate price below 1,000 Baht or above 1,500 Baht per ton would have much less impact on supply than in the range from 1,000 to 1,500 Baht. The observed supply response is particularly significant when it is noted from Table 13 that the prevailing price of maize has consistently been at or just over 1 000 Baht per ton.

Thus, it appears that only a small amount of support for the maize price would produce a large response.

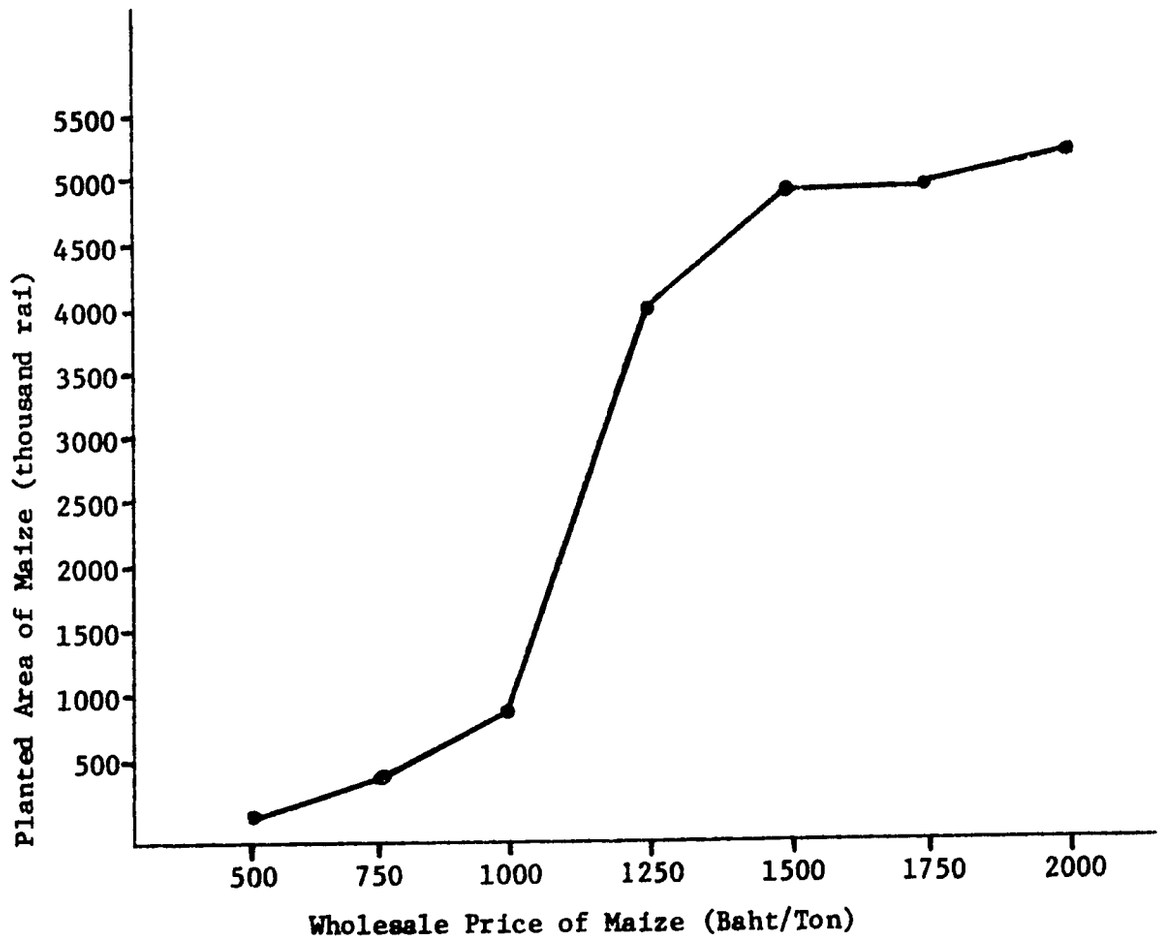

Figure 10. Normative maize planting response to varied maize prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 19.

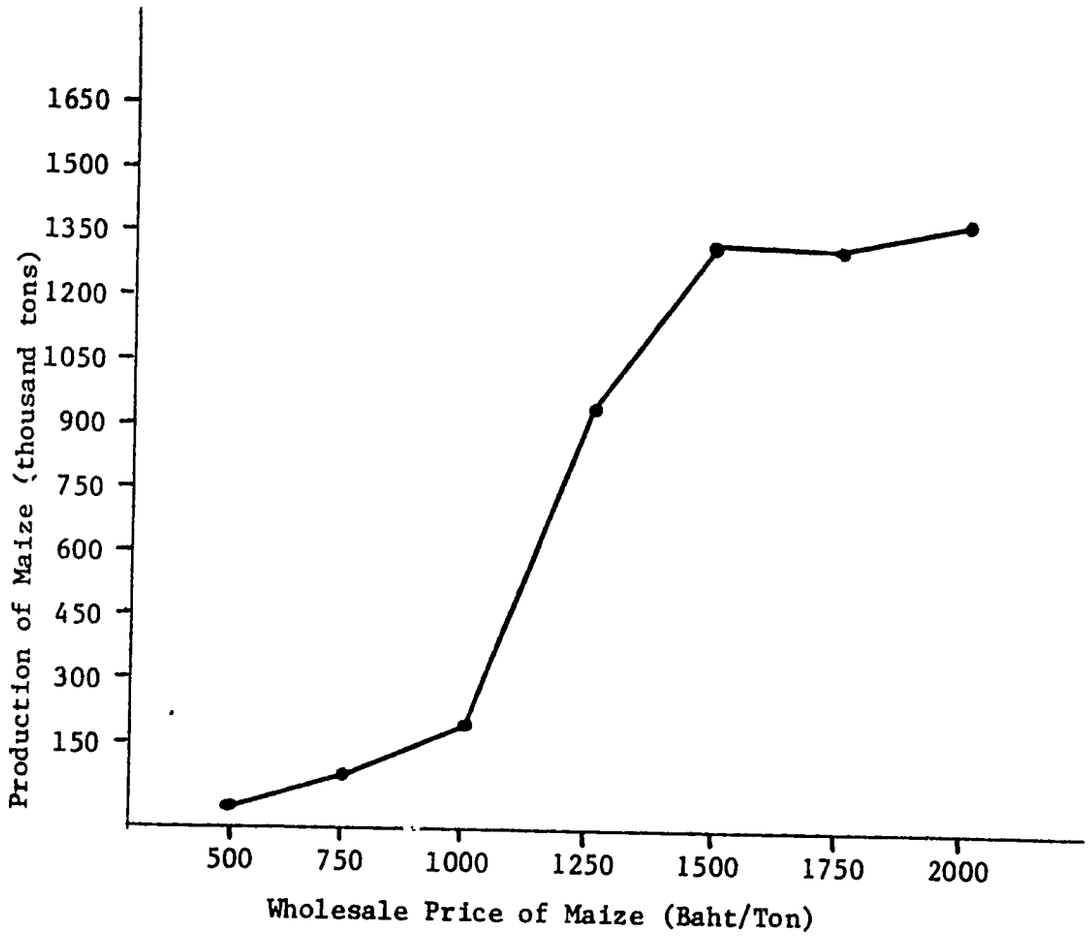

Figure 11. Normative maize supply response to varied maize prices in Northeast Thailand--base year 1971-72[a]

[a]SOURCE: NEREGON - Solution 19.

The solution level for area planted at 1,000 Baht compares favorably with the actual planting in the Northeast at a similar price. If supply would respond as indicated in the solution, supporting the price at 1,250 would result in expanded production of 772,000 tons. Assuming that domestic demand would not increase,[1] the additional supply

[1]If any demand response could be anticipated, it would be a decrease, not an increase.

would be available for export. An increased supply of 772,000 tons in the Northeast in 1971-72 would have been enough to increase national maize exports by 38 percent, assuming an export demand. Similarly, if price had been 1,500 Baht and supply in the Northeast had been 1.318 million tons, exports could have increased by more than 55 percent.

Maize Impact on Other Crops

The level of maize price does provide economic incentive for farmers to expand maize production, even if other crops must be reduced. The overall impact of the price changes studied was to increase total planted area by about 1.0 million rai while maize increased by nearly 5.0 million rai (Table 14). The maize production has very little impact on rice, other food and feed crops, or "Other Crops." It does have an impact on oil and fiber crops. As with cassava, the reorganized production pattern allows oil crop production to increase at the same time maize production increases. The real competition is between maize and fiber crops. Of the 4.97 million rai increase in maize, 3.58 million or more than 70 percent is at the expense of fiber production. The biggest adjustments come at the 1,000-1,250 and 1,250-1,500 Baht price levels, but the competition between maize and fiber crops is apparent at all levels.

Maize Impact on Employment

The overall impact of raising maize price from 500 to 2,000 Baht per ton and the subsequent changes in crop production patterns was to lower the employment in the Northeast Region by 4.5 percent. In

Table 14. Normative planting response in Northeast Thailand to varied maize prices--base year 1971-72

Price of Maize	Area Planted by Major Crop Groups						
	Maize	Rice[a]	Food and Feed[b]	Oil[c]	Fiber[d]	Other[e]	Total
(Baht/ton)				(rai)			
500	148,456	26,131,791	353,089	80,368	3,977,179	483,906	31,026,333
750	289,347	26,134,386	523,355	81,337	3,842,002	483,906	31,064,986
1,000	896,955	26,090.856	1,132,218	109,624	3,665,560	483,906	31,482,164
1,250	4,057,070	26,054,591	4,292,333	109,624	1,444,348	483,906	32,384,802
1,500	4,939,953	25,730,307	5,175,216	109,934	562,125	483,906	32,061,488
1,750	4,939,953	25,730,307	5,175,216	109,934	562,125	483,906	32,061,488
2,000	5,119,502	25.697,364	5,340,830	109,150	397,295	483,906	32,038,545

SOURCE: NEREGON - Solution 19.

[a]Including both paddy and upland rice.

[b]Including maize, mungbean, cassava, and sugarcane.

[c]Including castor seed, groundnut, and soybean.

[d]Including cotton, kenaf, and jute.

[e]Including tobacco, mulberry, and watermelon.

general, employment declines steadily as maize replaces other crops, except for the increase when price rose from 750 to 1,000 Baht (Table 15).

Table 15. Agricultural employment in Northeast Thailand under various maize price assumptions--base year 1971-72

Price of Maize	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million hours)			
500	977	547	1,253	1,050	825	4,652
750	963	548	1,243	1,051	825	4,630
1,000	975	549	1,262	1,046	832	4,664
1,250	975	547	1,142	1,047	850	4,561
1,500	975	503	1,142	990	850	4,460
1,750	975	503	1,142	990	850	4,460
2,000	970	503	1,142	977	850	4,442

SOURCE: NEREGON - Solution 19

Within individual zones, the impact on employment varies depending on the level of production. In Zone 01 employment dropped as price rose from 500 to 750 Baht, increased and remained constant from 1,000 to 1,750 Baht, and dropped again at 2,000 Baht. In Zone 02 employment remained relatively unchanged up to 1,250 Baht, and then dropped by 10 million hours at 750 Baht. It then rose by 20 million hours at 1,000 Baht and then dropped by 120 million hours at 1,250 Baht where it steadied. In Zone 04 there was an employment drop at 1,000 Baht and another drop at 1,500 Baht. Zone 05 counters the general trend by raising employment at 1,000 Baht and again at 1,250 Baht. The differences

in labor utilization reflect different resource distributions and comparative production advantages throughout the region. The impact on employment is directly related to the production patterns and the competitiveness of maize with the production of a particular zone. As with other commodities, an increase in maize production within the zone does not necessarily imply a uniform employment impact on all zones.

Maize Impact on Capital Requirements

Maize production requires significant capital inputs. Increasing price from 500 Baht to 2,000 Baht per ton increases production and, thus, the capital requirements by about 6 percent. The requirements increase at all levels of production except the 2,000 Baht level where capital requirements decline slightly (Table 16).

Table 16. Agricultural capital requirements in Northeast Thailand under various maize price assumptions--base year 1971-72

Price of Maize	Zone 01	Zone 02	Zone 03	Zone 04	Zone 05	Total
(Baht/ton)			(million Baht)			
500	154.4	69.4	362.9	225.4	168.0	980.1
750	159.4	72.6	362.0	225.2	167.8	987.0
1,000	163.7	76.1	363.7	220.6	178.9	1,003.0
1,250	163.7	73.9	352.4	223.2	206.3	1,019.5
1,500	163.7	85.4	352.4	234.3	206.3	1,042.1
1,750	163.7	85.4	352.4	234.3	206.3	1,042.1
2,000	169.3	85.4	352.4	228.1	206.3	1,041.5

SOURCE: NEREGON - Solution 19.

As with employment, the impact on individual zones differs. Zone 01 capital requirements increase up to the price level of 1,000 Baht and then remain constant until they increase again at 2,000 Baht. In Zone 02 the requirements increase to the 1,000 Baht level, drop at 1,250, and then rise to a new constant at 1,500 Baht. In Zone 03 all of the adjustment is below 1,250 Baht. The requirement decreases at 750, increases at 1,000, and decreases again at 1,250 Baht. In Zone 04 the requirement is relatively constant except for a small increase at 1,500 and 1,750 Baht. In Zone 05 the requirement increases at 1,000 and 1,250 Baht, and then remains constant. Again, the impact on capital requirements reflects the changing production patterns and comparative advantages.

Maize Impact on Income

At each solution level, the value of the program (net income) was recorded and used to calculate per capita net income estimates for the 9.579 million people living in rural households in Northeast Thailand [11]. Net income in this calculation includes gross value of sales, plus onfarm consumption valued at market price, minus cost of production. This is not a measure of cash income, but rather a measure of net value of production. As indicated in Figure 12, per capita income increases at almost a linear rate. More specifically, it increases from 785 Baht per person when price is 500 Baht per ton to 903 Baht per person when the price is 2,000 Baht per ton.

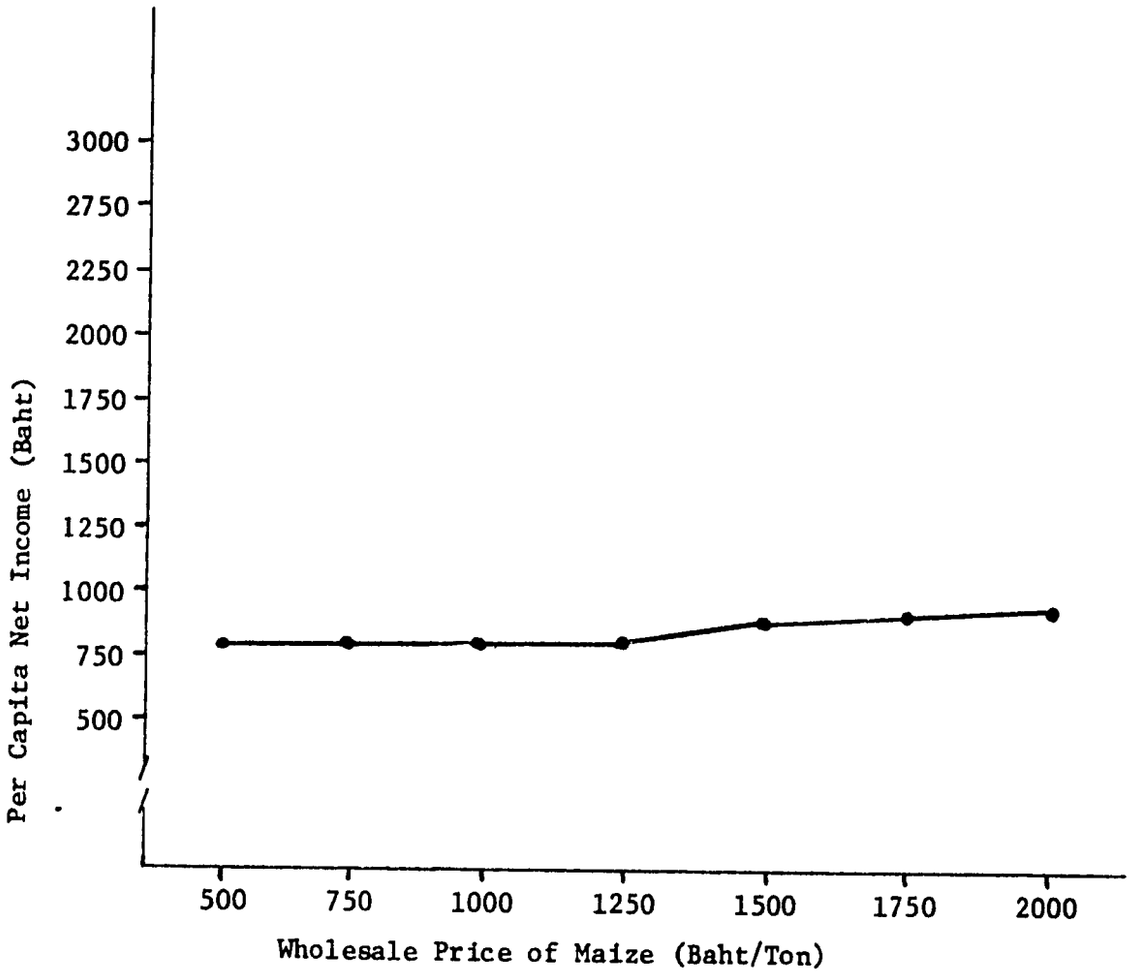

Figure 12. Normative income response to varied maize prices in Northeast Thailand--base year 1971-72[a,b]

[a]SOURCE: NEREGON - Solution 19.

[b]Net income measured as net cash income plus onfarm consumption valued at market price.

Two facts are conspicuous after studying Figure 12. First, the increase in per capita income from 785 to 903 Baht represents only about a 15 percent increase while maize price was increasing by 400 percent. Second, the linear growth of income in contrast to the nonlinear production response, suggests major crop substitution. The additional

production of maize does not generate a corresponding increase in income. Thus, the expanded maize production must be causing major resource transfers to maize production from other commodities.

POLICY IMPLICATIONS

Production Response

All four of the subsectors studied--rice, kenaf, cassava, and maize--confirm the hypothesis that price policy which would raise the price of that commodity relative to other commodities does provide an economic incentive to expand planted area and production of the selected crop. However, the commodities do not all respond in the same manner to various price increases. For example, rice and maize production responded to incremental price increases throughout the range of prices assumed for the studies. In contrast, kenaf responded to price increases in the lower range of prices considered, but was relatively unresponsive to prices in the upper half of the range studied. Cassava responded at very low price levels, and was virtually unresponsive at all other levels. This suggests that rice and maize have a wide range over which price policy could be used effectively to promote production while kenaf and cassava have a relatively small range in which price policy would be an effective instrument to promote production. Although these studies are normative supply response studies, there is significant evidence in Thailand that farmers do respond to price incentives. Cassava is a good case in point. A strong export market has provided strong prices. The production of cassava has responded rather dramatically with virtually no other promotion considerations.

Another aspect of the price policy question concerns the extent to which prices would have to be raised to get significant responses. The gap between current price and a level which would produce significant results obviously is related to the degree of difficulty or amount of government expenditure necessary to get desired responses. For rice, the traditional prices have been in the very responsive section of the supply curve, meaning that either increases or decreases in price could have significant impact. Kenaf prices have been in the unresponsive upper end of the price scale recently. Thus, increasing the price may not have a significant impact; but guaranteeing a base price might protect production from a major drop. Cassava prices have been high on the unresponsive section of the supply curve. Further price supports probably would prove ineffective but the historic production pattern indicates that farmers are steadily increasing their production up to levels commensurate with the current price level. Historic price levels for maize have been at the lower end of the responsive section of the supply curve. This suggests that a minimum of effort in promoting or supoorting price could produce significant increases in maize production.

A third aspect of price policy is the impact of price changes in one commodity sector on another sector. Expanded rice production competes with all other crop groups. Kenaf competes with rice, food and feed, and other fiber crops. Cassava and maize compete most directly with the fiber crops. If a specific crop is being promoted, it mat be desirable to have it compete with specific crops. For example, it may be desirable as a government policy to replace fiber production with

maize. If so, promotion of maize is totally compatible with reducing fiber. However, if it is not desirable to reduce fiber production, the maize policy could be in direct conflict with the fiber policy. The important point is that price policy for one commodity definitely is not independent of impact on other commodities.

A fourth aspect of price policy is the impact on consumers. The studies of supply response do not deal with this topic directly, but several observations can be drawn. One of the most obvious is that any type of price support or stabilization policy to promote production will almost certainly mean higher consumer prices. In the case of exports, the higher price may be to foreign buyers and relatively insignificant to the local consumers. But when the product is consumed domestically, the higher farm prices mean higher consumer prices. The exception is with subsidized farm prices, but then the subsidy must come out of tax revenue and is transmitted back to consumers indirectly. The price problem becomes even more complex when the promoted commodity is an intermediate good for further production. This is especially true in agriculture when you are trying to promote feed production and livestock at the same time. Higher maize or cassava prices mean higher feed prices for the livestock industry. An exception is with rice promotion where the by-products can be used as feed. Promotion of rice should generate larger supplies of rice bran and broken rice which could be used for food.

Employment

Labor requirements differ significantly between commodities and depending on the level of technology used. Promotion of a given commodity through price policy or related programs may change the production patterns and rural employment significantly. In a region where unemployment or underemployment is a major problem, promoting a crop plan that reduced employment further could have serious impacts.

The four commodities studied produced very different impacts. Rice and maize promotion resulted in lower employment levels. Kenaf promotion resulted in cropping changes which produced a net increase in employment. Cassava had an indifferent impact--at some levels it raised employment and at others it lowered employment. The impact is very commodity-specific and should not be generalized without careful analysis of individual commodities.

An aspect of employment which can be dealt with more effectively in the Employment Model [7, 12], is the seasonality of employment. If off-farm employment or cottage industry employment could be generated, it might be desirable to promote a crop even if it lowered agricultural employment, provided that it helped distribute employment more evenly over the year. One of the difficulties of dealing with the labor problem in the Northeast is that nearly all the labor force is employed during the rainy season and virtually none during the dry season. It is difficult to develop off-farm employment opportunities which have the same seasonality. Employing fewer people in agriculture, but for the whole year, might make the unemployment problem easier to resolve.

Capital Requirements

Land, labor, and capital are the key resources in agricultural production. Labor seems to be restricting production at some periods of the year and surplus at others. Capital is in short supply in the Northeast with large amounts being borrowed from relatives, institutions, and merchants. At best the supply is adequate, and the charges are high. If new production patterns are to be promoted with price policy or other programs, serious consideration must be given to the capital requirements which must be met to support the program. A shortage of land, labor, capital, or incentive can destroy any program.

All four of the commodities studied result in production patterns which require greater amounts of capital as the price of the commodity in question increases. The increased requirements could be as high as 12.9, 19.3, 15.0, and 6.3 percent, respectively, for rice, kenaf, cassava, and maize. It may be desirable to provide even greater amounts of capital at institutional rates to avoid high interest charges for the farmer. These estimates of increased capital requirements do not deal with any existing capital problems in the Northeast. These studies deal strictly with the additional capital that would be required as specific commodities were promoted. If the capital is not made available it could form a bottleneck which would defeat any price incentive program.

Income

The income impact of various price policy programs vary significantly. For the four commodities considered, the range of impact is from 15

percent to more than 500 percent. Maize and kenaf produce the smallest impact on per capita income by only raising it 15 and 50 percent, respectively. In contrast, cassava could raise per capita income by 200 percent. Rice is by far the most significant with an increase of 500 percent. Admittedly, paddy price probably will not reach 4,000 Baht in Thailand in the near future, but that is not far off the world price. Even if the price only went to 3,000 Baht, it would increase per capita income by more than 270 percent in the Northeast. Probably no single policy could be as effective in raising the income level of Northeast farmers as a policy which raised rice price. The impact is significant because such a large portion of the area in the Northeast is devoted to rice production. Higher rice prices would also be desirable because of the distribution effects. With a large portion of the population producing rice, the benefits would be distributed widely without further supervision. As an example, raising rice price 500 Baht from 1,500 Baht should raise income levels in the Northeast by about 27 percent. Raising 500 Baht from 2,000 should raise income more than 21 percent. Price policy could be an effective instrument to impact on income levels and distribution.

SUMMARY

Considerable literature has been written about the supply responsiveness of small farmers in developing countries. Although this study is normative in nature and offers no direct empirical evidence to quarantee farmers will respond as indicated, there is strong evidence

in Thailand that farmers do respond to economic incentives. This study has focused on potential economic opportunities that increased prices would create, given the current technology. The sharp increases in area planted, production, and value of production suggest that increasing prices could have a very significant impact on the welfare of rural people. The cost, of course, would be higher prices to consumers. However, when rural income levels are compared with urban income levels, it appears that the redistribution is economically appropriate. Whether it is politically feasible is a question that only the policy makers can answer.

This study focused only on one price change at a time. In future studies it may be useful to consider sets of price changes rather than single price changes. In some cases where one commodity competes directly with another, increasing both prices may significantly impact on income level wihtout significantly changing production patterns.

In addition to the direct supply response, an attempt was made to describe some of the secondary impacts which would result from changes in price levels. These secondary impacts were measured in terms of impact on other crop production, employment levels, capital requirements, and per capita income. From these related discussions of the secondary impacts measured by the models, it is clear that a program defined for one commodity is rarely isolated from effects on other commodities. What may be a simple and easily administered policy may have very serious side effects. Knowing these side effects should help

the policy maker choose more wisely among alternatives or to develop complimentary programs to compensate for the negative secondary effects.

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APPENDIX

Table A.1. Rice--Normative response to varied rice prices in Northeast Thailand--base year 1971-72[a]

Price (Baht/Ton)	Value Program (Million Baht)	Area Planted (Thousand Rai)	Production (Thousand Ton)	Per Capita Income[b] (Baht)	Index of Per Capita Income
500	5,482.8	25,001.9	5,523.6	573.4	100.0
1,000	8,269.9	26,703.6	5,673.2	863.3	150.6
1,500	11,197.5	27,968.2	5,986.3	1,169.0	203.9
2,000	14,216.0	28,191.8	6,130.7	1,484.1	258.8
2,500	17,281.9	28,258.5	6,136.9	1,804.1	314.6
3,000	20,366.4	28,364.1	6,209.7	2,126.2	370.8
3,500	23,470.5	28,571.5	6,253.4	2,450.2	427.3
4,000	26,630.1	29,372.5	6,432.1	2,780.1	484.8

[a]SOURCE: NEREGON - Solution 16.

[b]Based on agricultural population of 9.579 million and onfarm consumption valued at market value.

Table A.2. Kenaf--Normative response to varied kenaf prices in Northeast Thailand--base year 1971-72

Price (Baht/Ton)	Value Program (Million Baht)	Area Planted (Thousand Rai)	Production (Thousand Ton)	Per Capita Income[a] (Baht/Year)	Index of Per Capita Income
500	6,367.7	1,006.4	142.1	664.8	100.0
1,500	6,689.7	2,225.8	365.3	698.37	105.0
2,500	7,316.0	3,776.4	707.1	763.8	114.9
3,500	8,092.2	4,089.8	780.2	844.8	127.1
4,500	8,874.0	4,096.7	782.0	926.4	139.4
5,500	9,656.1	4,097.5	782.1	1,008.0	151.6

[a]Based on agricultural population of 9,579 million and onfarm consumption valued at market price.

[b]SOURCE: NEREGON - Solution 17.

Table A.3. Cassava--Normative supply response to varied cassava prices in Northeast Thailand--base year 1971-72 [a]

Price (Baht/Ton)	Value Program (Million Baht)	Area Planted (Thousand Rai)	Production (Thousand Ton)	Per Capita Income[b] (Baht)	Index of Per Capita Income
100	7,462.2	-	-	779.0	100.0
400	8,674.8	3,746.3	6,940.0	905.6	116.3
700	10,760.5	3,754.1	6,954.8	1,123.3	144.2
1,000	12,847.3	3,755.0	6,956.6	1,341.2	172.2
1,300	14,954.7	3,792.1	7,029.4	1,561.2	200.4
1,600	17,063.5	3,792.1	7,029.4	1,781.3	228.7

[a] SOURCE: NEREGON - Solution 18.

[b] Based on agricultural population of 9.579 million and onfarm consumption valued at market value.

Table A.4. Normative[a] response to varied maize prices in Northeast Thailand--base year 1971-72.

Price (Baht/Ton)	Value Program (Million Baht)	Area Planted to Maize (Thousand Rai)	Production of Maize (Thousand Ton)	Per Capita Income[b] (Baht/Year)	Index of Per Capita Income
500	7,526.5	91.2	29.6	785.7	100.0
750	7,539.7	232.1	79.6	787.1	100.2
1,000	7,570.8	839.9	174.3	790.4	100.5
1,250	7,680.2	3,999.8	946.5	801.8	102.0
1,500	7,989.3	4,882.7	1,318.5	834.0	106.1
1,750	8,318.9	4,882.7	1,318.5	868.5	110.5
2,000	8,652.2	5,062.3	1,384.0	903.2	115.0

[a]SOURCE. NEREGON - Solution 19.

[b]Based on agricultural population of 9.579 million, and onfarm consumption valued at constant price.