A Dynamic Analysis of Thai Agricultural Growth: Some Lessons from the Past

Thailand Development Research Institute Foundation

Workshop on

"TDRI Research Activities Supported by the EPD II Project"

October 7-8, 1989, at Novotel Suriwongse Hotel, Chiang Mai

Report on

A DYNAMIC ANALYSIS OF THAI AGRICULTURAL GROWTH: SOME LESSONS FROM THE PAST

Thailand Development Research Institute

A DYNAMIC ANALYSIS OF THAI AGRICULTURAL GROWTH: SOME LESSONS FROM THE PAST

Ammar Siamwalla
Direk Patmasiriwat
Yair Mundlak
Suthad Setboonsarng

Introduction

This paper examines the factors behind the growth of agricultural production in Thailand in the period 1961 to 1985. It utilizes province-level data pulled from various sources to estimate the system supply functions both for agricultural output as a whole and for individual crops. It also examines the factors that explain the growth of the land area and of labor within individual provinces, and to that extent attempt to provide elements for a dynamic analysis of the growth of Thai agriculture. The picture is incomplete to the extent that capital accumulation in agriculture remains unexplored. This will be the subject of a future study.

The paper is divided into two parts, the first half sets out the analytical framework and the second shows the usefulness of the model employed by applying it to some specific questions at hand.

ANALYSIS

Factors Explaining Aggregate Agricultural Supply

Past changes in production are here analyzed by estimating a supply function. That function is derived from the following theoretical model. The agricultural sector in any province in any given year is supposed to be endowed with land and labor. The farmers then maximize their profits, net of variable costs from cash input items such as fertilizers. That is, they maximize:

$$\pi = p'x - w'v,$$

by varying x and v (and only these), subject to the production function:

$$x = f(w,h,n,k,z),$$

where x is the vector of all the outputs,

v is the vector of all the variable inputs (fertilizers and other chemicals),

h is the amount of land available to agriculture,

n is the amount of agricultural labor,

k is the vector of agricultural capital,

z is the vector of all other factors which shift the production function,

p is the vector of output prices, and

w is the vector of variable input prices.

The maximization process then yields the following supply equation system:

$$x = g(p,w,h,n,k,z). \quad (1)$$

We estimate (1) in two steps. In this subsection, we estimate the supply of agricultural output as a whole. In another subsection below, we estimate the supply of individual crops or subset of crops.

We have compiled aggregate production data for the following twenty crops:

Paddy (Wet Season Crop),	Mungbeans,
Paddy (Dry Season Crop),	Rubber,
Maize,	Coconuts,
Sugarcane,	Oil Palm,
Cassava,	Virginia tobacco,
Soybeans,	Sorghum,
Groundnuts,	Chilies,
Cotton,	Kenaf,
Pineapples,	Longan,
Shallot,	Garlic.

The supply function for agricultural output as a whole is as follows:

$$y/n = y(p_a/p_{na},\ w/p_{na},\ h/n,\ k/n,\ z) \quad (2)$$

where y denotes the Divisia index of production for the above twenty crops,

p_a denotes the Divisia index of agricultural goods prices,

and

p_{na} stands for the index of nonagricultural goods prices.

What are the exogenous factors z that may affect y/n? We have experimented with a large number of possible factors, mostly involving public investments of one kind or another. The variables that were tried included: irrigation, road building, schooling, expenditures on agricultural research, and extension. To take care of short-term impact on production, we included rainfall as an explanatory variable as well. Furthermore, to take account of regional variations in fertility, there are dummy variables that represent nine different areas of the country.

The functional form for (2) can be chosen from among a broad range. We have here chosen the double-log form (except for the rainfall variables, for which the actual level rather than their logarithms were put in as independent variables). This implies a Cobb-Douglas form of production function.

Estimation results: We have employed provincial-level production time series data for the twenty crops named above: labor, land and other inputs, covering all 73 provinces of the Kingdom for the period

1961 to 1985.[1] A detailed description of the data is available in Appendix A.

The result of the ordinary least squares estimation of the double-logarithmic version of equation (2), shown in Table 1, indicates that the amount of land per worker is the most powerful factor explaining the growth of labor productivity, with the value of the estimated coefficient as high as 0.56. The result indicates that a great deal of labor productivity growth is due to the expansion of the land frontier. To the extent that land expansion will slow down in the future, growth of productivity will also decline substantially unless counteracting policies are adopted.

The coefficient for capital is 0.14 and statistically significant. The results for land and capital (and of fertilizers below) imply that the share of labor in agricultural activities is about 20 per cent.

Equation (2) which we have estimated is a supply function and not a production function, although it is derivable from a production function and embodies implicitly some of the parameters from it. As a supply function, it has a price term, which in our empirical estimation is the expected price of agricultural goods relative to nonagricultural prices. The expectation is assumed to follow the

---

[1] Because the period we are studying saw a number of provinces split up, and since continuous data exist only for the older unified provinces, the number of provinces that we are examining is actually only 70. Thus, for example, "Chiang Rai" means, in modern terms, Chiang Rai and Payao.

autoregressive forecast of lagged prices.[2] The prices used are Bangkok wholesale prices of each of the commodities, because the data for these prices are more accurate, and a longer series exist. The assumption made here is that the internal marketing systems for most agricultural commodities are near-perfect, so that Bangkok prices are transmitted completely to the farm-level. Even though Bangkok prices are used, the price indices for the various provinces move differently because each province's weight is specific to its output mix. The coefficient we have obtained is significant but small (0.15). This is the short-run price elasticity of agricultural output as a whole, and as such the result is quite reasonable.

We have also estimated the responsiveness of agricultural production to the use of variable factors, for which we single out fertilizers. The results show that the responsiveness of agricultural productivity to fertilizer prices to be significant at -0.10.

Aside from the conventional inputs--land, capital, labor and fertilizers, we have introduced various variables as shifters of the productivity functions. The most surprising, but nonetheless robust, result concerns the role of schooling. This turns out to be the most significant variable after land per worker in explaining agricultural productivity, with an elasticity coefficient as high as 0.48. This is in accordance with results from earlier studies (Sussangkarn 1987) that higher schooling, at least in earlier years, does increase farmer's productivity. During the 1960s and 1970s, Thailand's

2 For the rice price, we have used the predicted rice price from a "reduced form" equation as an instrumental variable, in order to reduce the simultaneity bias.

agriculture benefits as individuals for whom the compulsory elementary education had been increased from four to seven years began to enter the labor force.

The government has expended a great many resources on agriculture. The two activities that should directly enhance the level of productivity are irrigation and agricultural research. The former is measured (imperfectly) by the command area in the various provinces, and the latter by national research expenditures. It was found that the product terms of these two variables are more significant than each individual variable. This strongly suggests that the benefits of the research have been captured by the irrigation. Anyone familiar with the way agricultural research systems work will not be surprised by the result.

We have tried to estimate the effect of rainfall on agricultural productivity. We have specified that the effect can best be captured by a piecewise linear function (Figure 1). The idea is that a province's output mix is attuned to its average rainfall level. A smaller-than-average rainfall in any given year will affect the output adversely. An excess of rainfall may or may not affect the output. We have introduced two segments into the higher-than-average part of the function, namely up to 1.5 times the standard deviation of the rainfall and beyond that. The results indicate that a shortfall affects the output more adversely (by 0.16% for every 100 mm. shortfall) than an excess. As long as the excess remains below 1.5 times the standard deviation for the province, the gain is about 0.13%

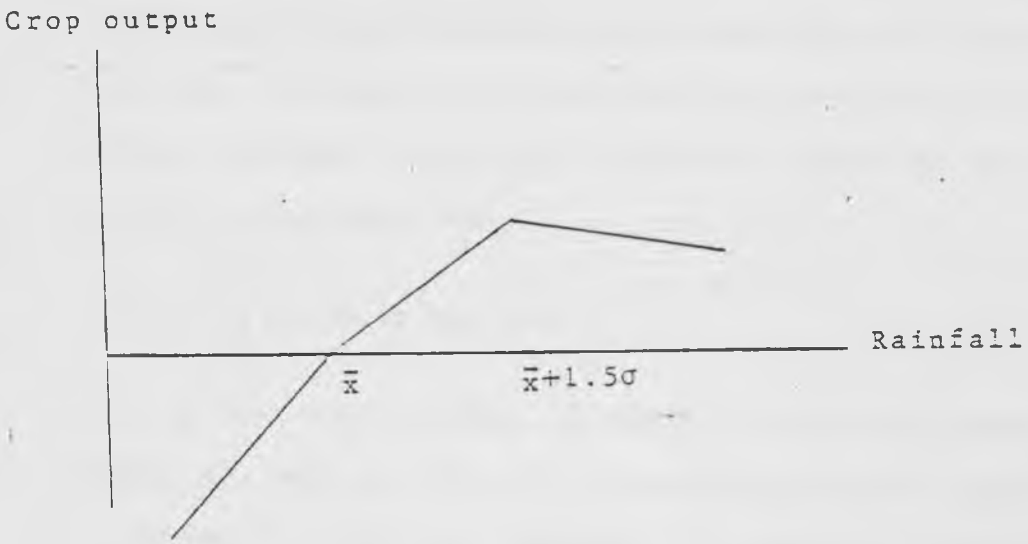

Figure 1

Hypothetical Effect of Rainfall on Crop Output per 100 mm.; beyond the limit of 1.5 times the standard deviation, the marginal gain to the extra rainfall is zero (see Figure 4).

In lieu of a variable for soil quality, we included regional dummies. Using the Lower South as the base case, we found the agricultural worker in other regions with different productivity in ascending order as follows: -26% in the Upper Northeast (i.e. workers there have a 26% lower productivity than in the Lower South, after controlling for most relevant factors other than soil quality), 21% in the Lower Northeast, 1% in the Lower North, 6% in the Central plains, 21% in the Upper South, 25% in the East, 44% in the Western region, and 55% in the Upper North.

Explaining growth in land area

In the above analysis of supply, we have been assuming that the supply of land and of labor to agriculture for any province for any given year (h and n in equations (1) and (2)) is fixed. We need, however, to explore the factors determining their changes from one year to the next. This section examines the factors explaining the use of land.

The land expansion equation posits that farmers decide to expand the area under cultivation for economic reasons. It should therefore be possible to explain their behavior in economic terms. In particular, their decision whether and by how much to extend cultivated land is the outcome of an optimization process in which the choice to use (or not to use) existing land more intensively is considered. If it is possible for farmers to intensify, they will do so, otherwise they will move to clear new lands. Consequently, we would expect all of the variables that appear on the right hand side of (2) to explain the extent of land expansion in any given year also.

$$\delta h/h = h(p_a/p_{na}, w/p_{na}, h/n, k/n, z) \qquad (3)$$

where δh is the change in the land area under cultivation.

Estimation results: As good time-series data on land utilization in Thailand do not exist, the approach adopted in this paper is to employ the data for the combined cultivation of the seventeen crops. The land "frontier" for any given year is then defined as the maximum acreage under cultivation up to and including that year. An increase in the land frontier, our proxy for δh above is then defined as the change in this maximum acreage. This dependent variable cannot be negative. We have therefore chosen the censored regression model to estimate the equation whose results are reported on the right hand side of Table 2.

The most important term of this equation is the product of the indicator of the amount of land available in the province and the productivity per worker in the province./ We expect that the larger the amount of land available in a province, and the more productive the province, the higher the speed of expansion.

The surprising result is that the level of education and our proxy for capital, the per capita income of the province, and road building turn out to have a negative impact on the speed of expansion, indicating that the alternative to land expansion, namely an intensification of production, is intensive in both human and physical capital. Where these are available in smaller amounts, the tendency is for farmers to expand into newer areas as a solution to their income-earning problems, even though, in a sense, the act of clearing new lands is itself a major investment on the part of the farmers.

We have included a price variable as an explanation for the speed of land expansion. The price variable used here is a two-period autoregressive (AR(2)) forecast of the province-specific price index. The reason for using this instead of the simple one-year lag of the first equation is because land expansion is a long-term exercise and therefore farmers tend to take a somewhat longer view of the price before expanding their land. In the event, this variable turns out to have an insignificant impact on the rate of land expansion.

Explaining Migration

In practically every country where similar research has been conducted, agricultural wages are below those in the nonagricultural sector. Over time, for reasons which have been extensively analysed (Mundlak 1979; Mundlak and Cavallo 1982), forces are at work that tend to maintain the intersectoral disparity. Since an important motive for migration is to earn better wages, the result of this continuing disparity in the two sectors' wages is a secular migration of labor out of the agricultural to the nonagricultural sector. We should not expect Thailand to be an exception in this respect.

To document this movement, however, we focus, not on the intersectoral movement of labor, but on the interprovincial movement. The major problem that faces every researcher on labor market problems is the absence of wage data. Luckily, the estimate of the supply function (2) can be differentiated to obtain an estimate of the wage rate in agriculture for each province. The estimate for the province's nonagricultural wage rate are based on: a) the wage wage share in value added by sector from the Input-Output table, 1980; b) the relative importance of sectors in the gross provincial product (i.e., the share in value added of individual sector in gross provincial product accounts). These together with additional assumption that the wage coefficient for the particular industry are equal across provinces made the estimate for nonagricultural wage possible. In symbols,

$$S = \Sigma \alpha_i \cdot VA_i \text{ , for all provinces}$$

$$w_j = S_j / Ln_j$$

S_j = wage compensation for the jth province

VA_i = value added of the ith sector in gross provincial product (GPP)

α_i = the wage-value added ratio by industry taken from the Input-Output table, 1980

Ln = nonagricultural labor force

Subscript i refers to the nonagricultural sectors

Subscript j refers to province

The province's wage rate, the weighted average of the agricultural and the nonagricultural wage rates, in relative term is used as explanatory variable explaining the interprovincial movement of population.

The data on migration come from the 1980 Population and Housing Census, which gives the pairwise flow of population between provinces during the previous five years.[3] From these data we obtain the net migration of the population between provinces which we put as a dependent variable in the regression.

Aside from the relative wages whose estimation we have described, we have other explanatory variables as listed in Tables 3A-3C. The first two regressions are based on all observations (3306); the remaining are the results from controlling migration distance (over 100 kilometers for the third and the fourth, and over 300 kilometers for the fifth and the sixth). Dummy for Bangkok is alternately put in the specification to reflect the migration flow toward the Greater Bangkok area which might be significantly different from other provinces. The impact on the parameter estimates was surprisingly minor.

The results of the exercise indicates, apart from obvious points such as that shorter distances induce more migration than longer distances, that:

(a) The response of migration to relative wage difference is quite strong with an elasticity of the rate of migration to the wage ratio between receiving and sending provinces of about 0.5;

---

3 Specifically, respondents were asked in which province they were residing 5 years prior to the census date.

(b) Education and irrigation investments in a given province tend to encourage emigration rather than immigration. On the other hand, provinces with better roads and with more land per capita tend to attract migrants. In assessing these somewhat anomalous results, bear in mind that many of these variables explain partly the relative wage rates which are included as one of the variables in the equation. The effect of the four mentioned variables that work through relative wages have thus already been taken into account. The presence of these variables in the equation therefore reflects their impact over and above what works through the relative wages.

The results suggest the following hypotheses, that migration is affected not only by current income levels, as captured by the relative-wage term in the equation, but by wealth and capital-market considerations. Thus to take an example, the benefits from irrigation are captured by farmers through the consequent increase in land prices, which accrue to them regardless of whether they stay in the province or not. This increase in land prices no doubt enables them to finance their migration. To the extent that irrigation leads to an increase in the demand for labor, this effect is already captured in the relative wage term. The same argument applies in the case of education.

(c) Land per capita and road building attract immigration as expected. For land per capita, the argument presented in the previous paragraph for other types of wealth do not quite apply, because the land titling procedure in Thailand is hedged about with great difficulties (Feder, et al. 1988), farmers who have acquired the land have to stay on the land to maintain a claim. It would have been better to distinguish between titled land, which is a negotiable asset for its holders and untitled land, which is not. Unfortunately, province-level data on these two categories of land-holding are not available. Impact of road-building on migration flow can be ambiguous. On one hand it increased wealth through higher land prices similarly to the case of irrigation. On the other hand it makes farm products easily accessed to markets which attracts immigrants. It is possible that the negative wealth effect might be smaller than the latter effect.

Output of Individual Crops

The above analysis by itself is, as we shall see below, useful when analysing the impact of various factors on aggregate crop output. However the research method and data obtained allow us to probe the determinants of the individual crop output as well.

To obtain a set of estimates consistent with the estimate of (1), we will examine the value share of the particular crop in the aggregate output of the seventeen crops. The equation for crop i is as follows:

$$s_i = s_i((p/p_{na}, w/p_{na}, h/n, k/n, z); \quad i = 1,2..,n \qquad (4)$$

where s_i is the share of crop i or subset of crop i in the aggregate value of output,

and

p is the vector of all output prices.

For the share equation (4), however, our choice is restricted by the following econometric consideration. A consistent supply system, like the consistent demand system, has to meet certain theoretical restrictions. The trivial one of course is that the share of the value of all crops should add up to unity. The second is that the supply system should be homogeneous of degree zero in all prices, which we have allowed in equation (4) by making restriction that all price coefficients sum up to zero. The third and most complex requirement is the symmetry condition, which states that the derivative of the supply of crop i with respect to changes in crop j's price should be equal the supply of crop j with respect to crop i's price. This requirement ensures that the transformation surface in the output space is continuous. This condition can be imposed on our estimates of the parameter in an econometrically tractable way only by specifying firstly that equation (4) is semi-logarithmic in form, and secondly that the derivative of s_i with respect to the logarithm of the price of the j-th crop is the same as the derivative of s_j with respect to the logarith of of the i-th crop price. In other words, the symmetry of the supply equation system is ensured by specifying that $[\beta_{ij}]$ in the following system be symmetric:

$$s_i = \alpha_i + \Sigma_j \beta_{ij}.\ln p_j + \beta_{ih}.\ln(h/n) + \beta_{ik}.\ln(k/n) + \text{other terms} \ldots \qquad i = 1,2,.. \qquad (5)$$

A bonus of this specification is that the positive sign of β_{ih} and β_{ik} would indicate that the crop i is relatively land-intensive or capital-intensive and vice versa. This is a useful information to have when examining long-term developments when the availability of the various factors of production will evolve.

Estimation results: Equation (5) is separately estimated for each of the regions. Because a system of equations for all crops would be too large for us to handle, so we group them into a manageable system. In the first approach, crops are grouped into 4 categories, namely, rice, upland, tree, and vegetables. Their estimates are presented in Tables 4A-4G. In the second approach we selects 5 most important crops for the particular region and lump all the remaining crops into a single "composite" crop making a system of six equations. The estimates along the second approach are provided in Appendix B. Table 5 extracts from the estimated parameters of equation system (5) the matrix of own and cross-price elasticities, aggregated across regions. The formula used to derive these elasticities is:

$$\xi_{ij} = s_j.(1 + \alpha) + (1/s_i).\beta_{ij} - \delta_{ij}$$

where ξ_{ij} is the elasticity of supply of crop i with respect to the price of crop j;

α is the elasticity of the aggregate crop output with respect to price; and

δ_{ij} is the Kronecker delta, i.e. it takes the value of 1 when i = j and 0 otherwise.

The estimated parameters, β_{ii} and β_{ik} in Tables 4A-4G, are significant and conform in sign for most regions, except for the

Upper-North. Increased land availability and capital tend to enhance the role of the upland crop at the expense of paddy.

As for the other variables shown in Tables 4a-4g, to be particularly noted is the role of irrigation. We observe that from our earlier analysis that irrigation has a minor impact on aggregate agricultural output, but in the share equations, the impact is quite strongly to enhance the share of paddy at the expense of upland crops. Thus it appears that the net return to this heavy investment is quite small, the increase in paddy output being negated by the slower shift towards upland crops. Research on the other hand appears to have the opposite impact. These two results on irrigation and research combined now explain the result we have obtained earlier that the two variables can explain the growth of output only in tandem. The one helps paddy production mostly at the expense of upland crops, while the other does the reverse.

APPLICATIONS

Growth Accounting

We know from our estimate of equation (2) which factors are significant in explaining past growth in crop output per head. How important is each of the factors relative to the others? Table 6 presents the results of the growth accounting exercise employing the estimates of equation (2).

The results for the entire period (between the triennia 1961/63 and 1983/85) turns up a number of surprises, none more striking than the role of education. Its contribution is far bigger than that for any other variable, explaining as much as 39% of the total increment in output, its role outshining even that of land expansion, the conventional explanator for the postwar Thai agricultural growth. Coming well after education as a factor explaining growth, are the increased capital, land expansion, and (in tandem) research and irrigation, each contributing between one fifth and one seventh to the increment in output per agricultural worker.

We have divided the period under study into two sub-periods, with the break point being the triennium 1976/78. The first point to observe is that the growth in output per worker has declined substantially between the first and the second sub-periods, the villains of the piece being both the decline in the amount of land per capita and in the decline in prices mostly taking place in the period after 1981, both of which by themselves would have made for a negative growth rate. Indeed all the other factors seem to have made for a deceleration in growth. It thus appears from the analysis that the roots of the decline in agricultural productivity growth appear to begin much earlier than as a consequence of the decline of crop prices in the 1980s.

Growth accounting by region is presented in Table 6.

Long-run Supply Response for Agriculture

The estimate of price responsiveness for agriculture estimated shown in Table 1, shows only the short-run elasticity and does not indicate the full supply response for agriculture, because it assumes given levels of land, labor and capital. In the long run, these will change in response to price changes, and if we take these changes into account, the responsiveness will be much larger. To illustrate this phenomenon, we have tracked the impact of a flat 10% increase in all crop prices since 1970, in order to indicate the longer-range impact of the price increase. This section indicates the results of that exercise.

Table 7 shows the simulated response of crop supply by region. On the average the supply shifted by 8.5 percent in response to 10% permanent increase in prices; indicating fairly strong response to price incentives. The magnitude of supply response, as expected, varies from region to region in accordance to different resource endowments (particularly agricultural land). In the Central Plain, where the potential to expand cultivated land is most limited, the supply increase was only 4%. Supply responses for the Upper-South and the lower-South were 7.3% and 6.8% respectively. The results for

Upper-North and the Lower-North show a marked contrast as supply increased by 7.3% and 13% respectively. This, we feel, is understandable because the former region is most limited in term of cultivable land. A marked contrast also observed in the cases of the Eastern and the Western regions where supply increased by 6.6% and 10.8% respectively. For the Upper-Northeast and the Lower-Northeast, the simulated supply increases were about the same, i.e., 8.9% and 8.5% respectively.

Forecasting Future Growth in Productivity

The following is a tentative forecast of the course of agricultural productivity to the year 1995, or the end of the Seventh Plan period. The assumptions made here are:

(i) The real price of agricultural commodities will increase by 0.139 per cent per year, the source for this forecast being the World Bank Commodities Division. The selected crop price forecasts by the World Bank is presented in Table 8.

(ii) Agricultural land in each province is assumed to remain the same, as their 1985 levels, implying that land per worker will decline by 1.28 per cent per year.

(iii) The level of schooling is expected to increase at 3 per cent per year, in accordance with the trend from 1961 onwards.

(iv) Government expenditure in irrigation is assumed to increase by 8 percent per year, the rates are assumed to vary from region to region based on the past experience. Agricultural research expenditure is assumed to be increased by 5 percent per year.

(v) The figure for our proxy for capital is expected to increase at the rate of 1 percent per year.

The simulation result suggests that agricultural productivity tend to decline at the rate of 1 percent per year, a considerable decline from the rate of 2.4 percent per year chalked up between 1961 and 1985. The main culprit for this change is, of course, the slowing down in the pace of land expansion. Given the barrier to any acceleration to that rate, it appears therefore that the only major option that the government has in promoting the growth of that productivity is to push forward on intensification of technology, which will necessarily imply an increase in research and irrigation investments.

Failing a successful drive to increase its productivity, agriculture will become a gigantic pool of labor that will feed the expansion of the nonagricultural sector. If the latter sector fails to grow, then there is a prospect of a slower rate of economic expansion of the overall economy.

Table 1 : Estimates of The Aggregate Supply Equation

	Coefficient	t-statistics
Dependent Variable : Output-value per agr. worker (1972 Baht)		
Explanatory Variable :		
- Constant term	5.1894	47.73
- Education	0.4844	9.66
- Capital stock	0.1407	8.54
- Land per labor	0.5588	24.26
- Rainfall (1 st category)	-0.000165	-7.46
- Rainfall (2 nd category)	0.000125	2.30
- Fertilizer price	-0.0985	-1.90
- Crop price expectation	0.1521	2.37
- Research and irrigation	0.0047	3.13
- Regional dummies :		
Upper north	0.5533	11.82
Lower north	0.0100	0.22
Upper northeast	-0.2645	-6.30
Lower northeast	-0.2087	-4.75
Central plain	0.0628	1.48
Eastern	0.2467	6.09
Western	0.4365	9.30
Upper south	0.2129	5.13
Lower south	-	-
Goodness of fit statistics :		
- R2	0.70	
- F-statistics	242.70	

Source : TDRI estimate

Table 2 : Estimates of The Land Expansion Equations

Variables	Equations (1)	Equations (2)* reject if distance < 30 Km
Dependent Variable : d ln (D) ; censored = 0 in case d ln (d) < 0		
Explanatory Variable :		
- Constant term	-0.2669 (-2.57)	-0.3178 (-2.79)
- Interaction between ldav and vperl(-1)	0.0331 (4.82)	0.0341 (4.90)
- Crop price expectation	0.0277 (0.82)	0.0303 (0.89)
- Capital stock	-0.0097 (-1.06)	-0.0096 (-1.03)
- Education	-0.1320 (-4.66)	-0.1337 (-4.66)
- Irrigation	-0.0042 (-1.52)	-0.0040 (-1.41)
- Research budget	-0.0154 (-3.62)	-0.0148 (-3.45)
- Change in road	-0.0052 (-1.81)	-0.0050 (-1.71)
- Distance from Bangkok	0.0298 (2.82)	0.0357 (2.94)
- Regional dummies :		
Upper north		
Lower north	0.0665 (3.11)	0.0698 (3.19)
Upper northeast	0.0675 (3.41)	0.0700 (3.49)
Lower northeast	0.0571 (2.64)	0.0613 (2.76)
Central plain	0.0543 (1.85)	0.0621 (2.02)
Eastern	0.0487 (1.86)	0.0566 (2.03)
Western	0.0783 (2.97)	0.0863 (3.08)
Upper south	0.0030 (0.01)	-0.0005 (-0.02)
Lower south	-0.0074 (-0.37)	-0.0109 (-0.54)
Log-likelihood	-114.25	-110.64

Estimation technique : TOBIT

Note : d denotes the cultivated area.
: ldav denotes the percentage of land availability.
: vperl denotes 1-yr lagged of output per agricultural worker.
: Figures in parentheses are t-statistic.
: * Excluding Bangkok sample.

Table 3A : Estimate of The Net Migration between Provinces, 1976-1980

Variables	equations (1) Coefficient	T-ratio	(2) Coefficient	T-ratio
Dependent Variables : The rate of net migration from province i to province j , mij / (ni x nj)0.5				
Explanatory Variables :				
- Constant term	0.2727	(0.83)	0.2644	(0.81)
- Education	-1.0384	(-4.39)	-0.9619	(-4.03)
- Distance	-1.8248	(-36.73)	-1.8238	(-36.73)
- Irrigation	-0.0759	(-2.46)	-0.0772	(-2.50)
- Road	0.1610	(3.25)	0.1589	(3.21)
- Size of population	-0.1033	(-2.25)	-0.1566	(-3.08)
- Proportion of agr. workers	-1.4635	(-12.45)	-1.2769	(-9.11)
- Provincial growth rate	3.1282	(2.83)	3.0701	(2.78)
- Relative wages	0.5154	(3.30)	0.5607	(3.57)
- Capital stock	0.1171	(2.19)	0.1088	(2.03)
- Land per labor	0.4129	(5.47)	0.4250	(5.63)
- Dummy (Bangkok)	-	-	1.0458	(2.44)
Goodness of fit statistics:				
- R2	0.3989		0.4000	
- F-test	218.66		199.62	
- Log-likelihood	-7370.9		-7368.0	
- Number of observations	3306			

Source : TDRI estimate

Estimation technique : OLS

Table 3B : Estimate of The Net Migration between Provinces, 1976-1980
Controlling distance must be > 100 km.

Variables	Equations (1) Coefficient	(1) T-ratio	(2) Coefficient	(2) T-ratio
Dependent Variables : The rate of net migration from province i to province j , $\frac{m_{ij}}{(n_i \times n_j)^{0.5}}$				
Explanatory Variables :				
- Constant term	0.3034	(0.80)	0.1621	(1.21)
- Education	-1.0915	(-4.55)	-0.4519	(-1.91)
- Distance	-1.8310	(-31.83)	-1.3486	(-31.87)
- Irrigation	-0.0764	(-2.44)	-0.0790	(-2.79)
- Road	0.1621	(3.22)	0.1755	(3.46)
- Size of population	-0.0895	(-1.90)	-0.1686	(-3.26)
- Proportion of agr. workers	-1.5246	(-12.60)	-1.0321	(-8.58)
- Provincial growth rate	3.1567	(2.81)	5.1890	(4.71)
- Relative wages	0.4951	(3.14)	0.7362	(4.63)
- Capital stock	0.1223	(2.26)	-	-
- Land per labor	0.4138	(5.42)	-	-
- Dummy (Bangkok)	-	-	0.9760	(2.14)
Goodness of fit statistics:				
- R^2	0.3663		0.3531	
- F-test	185.38		194.56	
- Log-likelihood	-7189.1		-7222.3	
- Number of observations	3218			

Source : TDRI estimate

Estimation technique : OLS

Table 3C : Estimate of The Net Migration between Provinces , 1976-1980
Controlling distance must be >300 km.

Variables	Equations (1) Coefficient	T-ratio	(2) Coefficient	T-ratio
Dependent Variables : The rate of net migration from province i to province j , mij / (ni x nj) 0.5				
Independent Variables :				
- Constant term	-0.6487	(-1.17)	-0.6327	(-1.15)
- Education	-1.0645	(-4.22)	-0.9438	(-3.70)
- Distance	-1.6939	(-20.75)	-1.6966	(-20.81)
- irrigation	-0.0545	(-1.64)	-0.0569	(-1.72)
- Road	0.1566	(2.95)	0.1507	(2.84)
- Size of population	-0.0769	(-1.52)	-0.1528	(-2.73)
- Proportion for agr. worker	-1.5400	(-11.79)	-1.2616	(-7.99)
- Provincial growth rate	3.2405	(2.65)	3.1817	(2.61)
- Relative wages	0.4735	(2.86)	0.5454	(3.26)
- Capital stock	0.1086	(1.91)	0.0994	(1.75)
- Land per labor	0.4310	(5.45)	0.4466	(5.64)
- Dummy (Bangkok)	-	-	1.6129	(3.13)
Goodness-of-fit statistics:				
- R2	0.2894		0.2919	
- F-test	114.12		104.96	
- Log-likelihood	-6298.1		-6293.2	
- Number of observations	2813			

Source : TDRI estimate

Estimation technique : TOBIT

Table 4A : Estimate of The Share Supply Equation for Upper North (include Tak)

Variable	Crop		
	Upland	Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-0.3388 (-1.16)	0.1737 (0.07)	1.3317 (4.43)
Price :			
- Upland	-0.0493 (-0.94)	0.0332 (0.69)	-0.0006 (-0.02)
- Rice	0.0332 (0.69)	0.1167 (1.98)	-0.1634 (-5.66)
- Tree	0.1091 (3.82)	0.1383 (5.03)	-0.2018 (-6.93)
- Vegetable	-0.0006 (-0.02)	-0.1634 (-5.66)	0.1927 (6.24)
- Fertilizer	-0.0924 (-3.03)	-0.1248 (-4.18)	0.1730 (5.86)
- Education	0.2984 (4.25)	-1.0462(-15.51)	0.6347 (9.06)
- Capital stock	0.0426 (1.05)	0.2011 (5.18)	-0.2377 (-5.72)
- Irrigation	-0.0142 (-2.66)	0.0267 (5.20)	-0.0091 (-1.72)
- Research	-0.0487 (-3.79)	0.0257 (2.08)	0.0296 (2.27)
- Land availability	0.0318 (0.68)	-0.1109 (-2.46)	0.0769 (1.60)
- Road	0.0117 (1.23)	-0.0205 (-2.25)	0.0088 (0.90)
- Rainfall, 1 st	-0.0023 (-0.47)	0.0008 (0.17)	0.0026 (0.53)
- Rainfall, 2 nd	-0.0009 (-0.18)	-0.0016 (-0.35)	0.0034 (0.71)

Source : TDRI estimate

Estimation method : SURE with the adding-up and the symmetry restrictions

Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4B : Estimate of The Share Supply Equation for Lower North (exclude Tak)

Variable	Crop		
	Upland	Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-0.4678 (-1.81)	0.1564 (0.58)	1.2878 (8.86)
Price :			
- Upland	0.2833 (3.65)	-0.2430 (-3.16)	-0.0387 (-1.33)
- Rice	-0.2430 (-3.16)	0.2267 (2.62)	0.0197 (0.62)
- Tree	0.0338 (0.88)	-0.0347 (-0.86)	-0.0054 (-0.25)
- Vegetable	-0.0387 (-1.33)	0.0197 (0.62)	0.0200 (0.93)
- Fertilizer	-0.0354 (-0.92)	0.0314 (0.78)	0.0044 (0.20)
- Education	0.0701 (0.87)	0.1114 (1.32)	-0.1909 (-4.18)
- Capital stock	0.0665 (1.78)	0.0763 (1.94)	-0.1409 (-6.67)
- Irrigation	-0.0339 (-4.51)	0.0112 (1.31)	0.0233 (5.47)
- Research	0.0371 (2.80)	-0.0532 (-3.89)	0.0191 (2.57)
- Land availability	0.0342 (1.02)	-0.0473 (-1.34)	0.0114 (0.60)
- Road	0.0511 (2.59)	-0.0802 (-3.85)	0.0295 (2.67)
- Rainfall, 1 st	0.0107 (1.54)	-0.0116 (-1.58)	0.0007 (0.18)
- Rainfall, 2 nd	0.0044 (0.67)	-0.0009 (-0.12)	-0.0035 (-0.93)

Source : TDRI estimate
Estimation method : SURE with the adding-up and the symmetry restrictions
Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4C : Estimate of The Share Supply Equation for Northeast

Variable	Crop Upland	Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-1.4898 (-5.85)	2.6425 (10.00)	-0.1328 (-1.58)
Price :			
- Upland	0.2349 (5.62)	-0.2342 (-5.58)	0.0140 (1.07)
- Rice	-0.2341 (-5.58)	0.2708 (5.88)	-0.0294 (-2.00)
- Tree	0.0325 (0.99)	-0.0620 (-1.81)	0.0171 (1.57)
- Vegetable	0.0140 (1.07)	-0.0294 (-2.00)	0.0132 (1.23)
- Fertilizer	-0.0472 (-1.43)	0.0547 (1.60)	-0.0149 (-1.38)
- Education	0.1645 (1.47)	0.0342 (0.30)	-0.1467 (-4.00)
- Capital stock	0.2364 (6.25)	-0.2914 (-7.43)	0.0429 (3.44)
- Irrigation	-0.0184 (-2.75)	0.0215 (3.09)	-0.0032 (-1.44)
- Research	-0.0165 (-1.47)	0.0118 (1.01)	0.0059 (1.53)
- Land availability	-0.1480 (-3.01)	0.1574 (3.09)	-0.0076 (-0.46)
- Road	-0.0218 (-1.24)	0.0146 (0.80)	0.0075 (1.29)
- Rainfall, 1 st	-0.0042 (-0.80)	0.0005 (0.09)	0.0035 (2.02)
- Rainfall, 2 nd	-0.0103 (-2.03)	0.0080 (1.51)	0.0023 (1.36)

Source : TDRI estimate
Estimation method : SURE with the adding-up and the symmetry restrictions
Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4D : Estimate of The Share Supply Equation for Central Plain

Variable	Upland	Crop Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	0.9543 (9.10)	-1.7508(-14.20)	0.6423 (12.46)
Price :			
- Upland	0.1797 (3.39)	-0.2391 (-4.34)	-0.0030 (-0.17)
- Rice	-0.2391 (-4.84)	0.3357 (5.00)	-0.0213 (-0.97)
- Tree	0.0394 (1.31)	-0.1282 (-3.46)	0.0058 (0.38)
- Vegetable	-0.0030 (-0.17)	-0.0219 (-0.97)	0.0266 (1.95)
- Fertilizer	0.0229 (0.75)	0.0529 (1.43)	-0.0082 (-0.54)
- Education	-0.0081 (-0.15)	0.1152 (1.84)	-0.1147 (-4.40)
- Capital stock	0.0091 (1.15)	0.1838 (19.72)	-0.0578(-14.82)
- Irrigation	-0.1373(-13.57)	0.1462 (12.31)	-0.0112 (-2.24)
- Research	0.0991 (10.48)	-0.1385(-12.53)	0.0146 (3.04)
- Land availability	0.0171 (7.18)	-0.0178 (-6.37)	-0.0029 (-2.47)
- Road	-0.0702 (-6.15)	0.0718 (5.36)	0.0121 (2.17)
- Rainfall, 1 st	0.0017 (0.35)	0.0022 (0.39)	-0.0012 (-0.49)
- Rainfall, 2 nd	0.0042 (0.91)	0.0011 (0.21)	-0.0013 (-0.56)

Source : TDRI estimate
Estimation method : SURE with the adding-up and the symnetry restrictions
Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4E : Estimate of The Share Supply Equation for Eastern

Variable	Crop Upland	Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-0.2984 (-0.56)	-2.0359 (-3.64)	0.5362 (6.90)
Price :			
- Upland	0.1064 (1.10)	0.0529 (0.55)	0.0121 (0.83)
- Rice	0.0529 (0.55)	-0.0425 (-0.39)	-0.0009 (-0.06)
- Tree	-0.0844 (-1.19)	-0.0731 (-0.97)	-0.0056 (-0.47)
- Vegetable	0.0121 (0.83)	-0.0009 (-0.06)	-0.0007 (-0.08)
- Fertilizer	-0.0871 (-1.13)	0.0637 (0.82)	-0.0049 (-0.35)
- Education	0.0463 (1.72)	-0.3753 (-1.33)	0.0593 (1.46)
- Capital stock	0.0664 (0.90)	0.3593 (4.66)	-0.0781 (-7.17)
- Irrigation	-0.0849 (-4.75)	0.0950 (5.06)	0.0119 (4.52)
- Research	0.0369 (1.68)	-0.8040 (-3.48)	0.0023 (0.65)
- Land availability	-0.0522 (-3.56)	0.0406 (2.65)	-0.0036 (-1.69)
- Road	-0.0768 (-2.00)	-0.0016 (-0.04)	-0.0056 (-1.00)
- Rainfall, 1 st	-0.0091 (-0.96)	0.0084 (0.85)	-0.0000 (-0.00)
- Rainfall, 2 nd	-0.0054 (-0.58)	0.0047 (0.48)	0.0003 (0.23)

Source : TDRI estimate

Estimation method : SURE with the adding-up and the symnetry restrictions

Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.

The group of tree crops include rubber, oilplam, coconut, and longan.

The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4F : Estimate of The Share Supply Equation for Western

Variable	Crop		
	Upland	Rice	Vegetable
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-1.5253 (-4.39)	3.9425 (10.79)	0.2978 (4.11)
Price :			
- Upland	0.4368 (6.27)	-0.1653 (-2.56)	-0.0063 (-0.42)
- Rice	-0.1653 (-2.56)	0.0910 (1.03)	-0.0048 (-0.27)
- Tree	-0.0070 (-0.15)	0.0376 (0.74)	-0.0070 (-0.62)
- Vegetable	-0.0063 (-0.42)	-0.0048 (-0.27)	0.0165 (1.79)
- Fertilizer	-0.2581 (-5.55)	0.0415 (0.79)	0.0016 (0.14)
- Education	1.4065 (10.61)	-1.7750(-12.96)	-0.0529 (-1.85)
- Capital stock	0.1348 (3.14)	-0.3213 (-7.14)	-0.0226 (-2.57)
- Irrigation	0.0143 (1.23)	0.0437 (3.57)	-0.0108 (-4.51)
- Research	0.0735 (4.76)	-0.0376 (-2.32)	0.0165 (5.08)
- Land availability	0.1470 (3.94)	-0.2154 (-5.49)	0.0148 (1.93)
- Road	-0.3110(-11.69)	0.3156 (11.35)	-0.0013 (-0.24)
- Rainfall, 1 st	-0.0126 (-1.64)	0.0073 (0.90)	0.0027 (1.75)
- Rainfall, 2 nd	-0.0070 (-0.98)	0.0013 (0.17)	0.0024 (1.66)

Source : TDRI estimate
Estimation method : SURE with the adding-up and the symnetry restrictions
Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 4G : Estimate of The Share Supply Equation for South

Variable	Crop Upland	Rice	Tree
Dependent Variable : Value share of crop in the total value of 20 crops			
Constant term	-0.0428 (-0.49)	-0.0378 (-0.37)	1.0265 (7.59)
Price :			
- Upland	0.0927 (3.01)	0.0093 (0.37)	-0.1035 (-3.52)
- Rice	0.0093 (0.37)	0.2292 (6.08)	-0.2080 (-5.99)
- Tree	-0.1035 (-3.52)	-0.2080 (-5.99)	0.3122 (6.47)
- Vegetable	-0.0058 (-0.39)	-0.0264 (-1.51)	0.0191 (0.85)
- Fertilizer	0.0072 (0.44)	-0.0041 (-0.22)	-0.0198 (-0.86)
- Education	-0.0065 (-0.32)	-0.0441 (-1.87)	0.0559 (1.81)
- Capital stock	0.0253 (1.92)	0.0693 (4.44)	-0.0916 (-4.47)
- Irrigation	-0.0214 (-7.63)	0.0446 (13.40)	-0.0214 (-4.90)
- Research	-0.0060 (-0.79)	-0.0191 (-2.20)	0.0180 (1.54)
- Land availability	0.0056 (2.56)	0.0144 (5.49)	-0.0222 (-6.48)
- Road	0.0225 (3.14)	-0.0325 (-3.81)	0.0143 (1.28)
- Rainfall, 1 st	-0.0051 (-1.82)	-0.0040 (-1.19)	0.0092 (2.12)
- Rainfall, 2 nd	-0.0041 (-1.52)	-0.0037 (-1.15)	0.0074 (1.77)

Source : TDRI estimate
Estimation method : SURE with the adding-up and the symmetry restrictions
Note : The group of upland crops include cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum and pineapple.
The group of tree crops include rubber, oilplam, coconut, and longan.
The group of vegetable crops include tabacco, chili, shallot and garlic.

Table 5A : Own-and Cross-Price Elasticities of Crop Supply Whole Kingdom

	Upland	Rice	Tree	Vegtable
Upland	0.2449	-0.1589	0.2449	-0.1589
Rice	0.0424	0.1280	0.0424	0.1280
Tree	2.3309	-2.8736	2.3309	-2.8736
Vegetable	0.1764	0.0832	0.1764	0.0832

Note : Elasticities for Upland and rice are the weighted coefficients.
: Elasticities for Trees are based on the Southern region only.
: Elasticities for Vegetables based on the Upper North region only.

Table 5B : Own- and Cross-Price Supply Elasticities of Crops --Upper North

	groundnut	paddy	tobacco	shallot	garlic	composite
groundnut	-1.22906	0.85565	-0.35040	-0.17705	0.21801	0.27040
paddy	0.11533	0.05036	0.21235	-0.02526	0.02284	-0.45906
tobacco	-0.13351	0.60170	0.20142	-0.09030	0.16123	0.52895
shallot	-0.27699	-0.29321	-0.37076	-0.12529	-0.23672	0.90458
garlic	0.07930	0.06164	0.15393	-0.05504	-0.21452	0.61018
composite	0.06964	-0.87719	0.35754	0.14891	0.43202	0.04087

Table 5C : Own- and Cross-Price Supply Elasticities of Crops --Lower North

	mungbean	maize	paddy	soybean	sugarcane	composite
mungbean	-0.50572	-0.82120	-0.35066	0.29072	0.51698	0.42197
maize	-0.25978	0.72581	-0.01497	0.12995	0.12042	0.41195
paddy	-0.04227	-0.00570	0.04581	-0.03434	0.00478	-0.14359
soybean	0.70367	0.99428	-0.68943	-1.13194	0.60744	-0.32357
sugarcane	0.76469	0.56309	0.05867	0.37121	0.22886	0.37277
composite	0.20062	0.61914	-0.56633	-0.06356	0.11982	-0.13790

Table 5D : Own- and Cross-Price Supply Elasticities of Crops --Northeast

	cassava	groundnut	kenaf	paddy	sugarcane	composite
cassava	1.04509	-0.12889	0.30361	1.29613	0.04125	-0.14152
groundnut	-0.91858	0.42746	0.12849	-0.19885	-0.06609	0.11365
kenaf	0.22130	0.01314	-0.43112	0.06973	0.12024	-0.06174
paddy	0.17727	-0.00382	0.01308	-0.19877	-0.02037	0.12703
sugarcane	0.20468	-0.04601	0.81840	-0.73888	1.32508	0.28257
composite	-0.12747	0.01436	-0.07630	0.83661	0.05130	-0.52670

Table 5E : Own- and Cross-Price Supply Elasticities of Crops --Central Plain

	mungbean	maize	paddy	sugarcane	chili	composite
mungbean	0.03382	-0.01705	0.86671	-0.22723	-0.23126	-0.10860
maize	-0.00209	-0.09349	-0.82707	-0.38781	0.05338	0.27527
paddy	0.00946	-0.07366	0.16954	-0.01526	0.09099	-0.01493
sugarcane	-0.08573	-1.19340	-0.52738	0.68942	0.93928	0.05416
chili	-0.01728	0.03253	0.62258	0.18600	-0.58808	0.07108
composite	-0.02936	0.60702	-0.36978	0.03881	0.25722	-0.33210

Table 5F : Own- and Cross-Price Supply Elasticities of Crops --Eastern

	cassava	groundnut	paddy	sugarcane	coconut	composite
cassava	0.31879	-0.02125	-0.11427	0.07079	-0.13460	-0.10885
groundnut	-0.26815	0.10017	-0.14537	0.06826	0.16004	0.41026
paddy	-0.05664	-0.00571	-0.28590	-0.00194	0.05511	0.76212
sugarcane	0.24916	0.01904	-0.01374	-0.81671	0.00361	-1.61346
coconut	-0.75489	0.07113	0.62357	0.00576	-0.60259	-0.15097
composite	-0.11540	0.03447	1.63010	-0.48596	-0.02854	-0.86286

Table 5G : Own- and Cross-Price Supply Elasticities of Crops --Western

	paddy	sugarcane	coconut	pineapple	chili	composite
paddy	-0.14457	-0.32214	0.23217	0.24657	0.08099	0.13589
sugarcane	-0.57798	0.25071	0.09615	0.50019	0.01930	0.86598
coconut	1.40212	0.32364	-1.53063	0.00093	-0.46565	-1.23783
pineapple	0.59814	0.67630	0.00037	-0.69075	0.01347	-0.33620
chili	1.06140	0.14098	-1.01043	0.07278	-0.58506	-1.03075
composite	0.48138	1.70978	-0.72608	-0.49093	-0.27863	-0.52371

Table 5H : Own- and Cross-Price Supply Elasticities of Crops --South

	paddy	rubber	oilpalm	coconut	pineapple	composite
paddy	0.58142	-0.13227	-0.01721	-0.09850	-0.00380	-0.03497
rubber	-0.06515	0.18844	0.02054	0.03312	0.01326	-0.02232
oilpalm	-0.37102	0.89934	-0.99484	0.13688	0.43467	-0.18964
coconut	-0.18913	0.12912	0.01219	0.01318	0.07323	0.47264
pineapple	-0.01675	0.11852	0.08875	0.16794	0.11077	-0.04613
composite	-0.25136	-0.32573	-0.06321	1.76936	-0.07531	-0.88195

Table 6 : Growth of Crop Supply and Its Sources during 1961-1985

	1961/63 and 1976/78	1976/78 and 1983/85	1961/63 and 1983/85
WHOLE KINGDOM			
Growth of output over the period	0.5868 (100.00)	0.1004 (100.00)	0.6872 (100.00)
Source of growth:			
- Education	0.1899 (32.36)	0.0813 (80.98)	0.2712 (39.46)
- Capital stock	0.0919 (15.66)	0.0308 (30.68)	0.1227 (17.86)
- Research and irrigation	0.0794 (13.53)	0.0005 (0.50)	0.0891 (12.97)
- Land per labor	0.1437 (24.49)	-0.0342 (-34.06)	0.1095 (15.93)
- Fertilizer price	0.0415 (7.07)	0.0116 (11.55)	0.0531 (7.73)
- Crop prices	0.0290 (4.94)	-0.0422 (-42.03)	-0.0132 (-1.92)
UPPER NORTH			
Growth of output over the period	0.8335 (100.00)	0.0395 (100.00)	0.8730 (100.00)
Source of growth:			
- Education	0.2627 (31.52)	0.0995 (251.90)	0.3622 (41.49)
- Capital stock	0.0943 (11.31)	0.0248 (62.78)	0.1190 (13.63)
- Research and irrigation	0.0801 (9.61)	0.0010 (2.53)	0.1008 (11.55)
- Land per labour	0.0353 (4.24)	-0.0326 (-82.53)	0.0027 (0.31)
- Fertilizer price	0.0415 (4.98)	0.0116 (29.37)	0.0531 (6.08)
- Crop price	0.0313 (3.76)	-0.0280 (-70.89)	0.0033 (0.38)
LOWER NORTH			
Growth of output over the period	0.5028 (100.00)	0.2287 (100.00)	0.7315 (100.00)
Source of growth:			
- Education	0.1832 (36.44)	0.0781 (34.15)	0.2613 (35.72)
- Capital stock	0.0537 (10.68)	0.0376 (16.44)	0.0913 (12.49)
- Research and irrigation	0.0652 (12.97)	0.0010 (0.44)	0.0854 (11.68)
- Land per labour	0.2988 (59.43)	0.0144 (6.30)	0.3131 (42.81)
- Fertilizer price	0.0415 (8.25)	0.0116 (5.07)	0.0531 (7.26)
- Crop price	0.0343 (6.82)	-0.0431 (-18.85)	-0.0088 (-1.21)
UPPER NORTHEAST			
Growth of output over the period	0.4822 (100.00)	0.1706 (100.00)	0.6528 (100.00)
Source of growth:			
- Education	0.1533 (31.80)	0.0654 (38.36)	0.2188 (33.51)
- Capital stock	0.0944 (19.58)	0.0379 (22.22)	0.1323 (20.27)
- Research and irrigation	0.0785 (16.28)	0.0004 (0.21)	0.0893 (13.68)
- Land per labour	0.0937 (19.43)	-0.0375 (-21.98)	0.0562 (8.61)
- Fertilizer price	0.0415 (8.60)	0.0116 (6.81)	0.0531 (8.13)
- Crop price	0.0303 (6.29)	-0.0445 (-26.08)	-0.0142 (-2.17)

Table 6 : Growth of Crop Supply and Its Sources during 1961-1985 (continue)

	1961/63 and 1976/78	1976/78 and 1983/85	1961/63 and 1983/85
LOWER NORTHEAST			
Growth of output over the period	0.4544 (100.00)	0.2838 (100.00)	0.7382 (100.00)
Source of growth:			
- Education	0.1497 (32.94)	0.0660 (23.25)	0.2157 (29.22)
- Capital stock	0.0975 (21.46)	0.0364 (12.83)	0.1339 (18.14)
- Research and irrigation	0.0691 (15.20)	0.0004 (0.14)	0.0799 (10.82)
- Land per labour	0.0970 (21.34)	-0.0108 (-3.81)	0.0862 (11.67)
- Fertilizer price	0.0415 (9.12)	0.0116 (4.09)	0.0531 (7.19)
- Crop price	0.0292 (6.42)	-0.0452 (-15.92)	-0.0160 (-2.17)
CENTRAL PLAIN			
Growth of output over the period	0.5133 (100.00)	-0.0118 (100.00)	0.5016 (100.00)
Source of growth:			
- Education	0.1840 (35.84)	0.0869 (-738.95)	0.2709 (54.01)
- Capital stock	0.1057 (20.59)	0.0400 (-340.14)	0.1457 (29.05)
- Research and irrigation	0.0974 (18.97)	0.0000 (-0.26)	0.1046 (20.86)
- Land per labour	0.0956 (18.62)	-0.0622 (529.25)	0.0333 (6.65)
- Fertilizer price	0.0415 (8.08)	0.0116 (-98.81)	0.0531 (10.58)
- Crop price	0.0371 (7.22)	-0.0395 (335.71)	-0.0024 (-0.48)
EASTERN			
Growth of output over the period	0.5301 (100.00)	0.0197 (100.00)	0.5498 (100.00)
Source of growth:			
- Eduacation	0.1730 (32.63)	0.0789 (401.27)	0.2519 (45.82)
- Capital stock	0.1138 (21.47)	0.0250 (127.05)	0.1388 (25.25)
- Research and irrigation	0.0795 (14.99)	0.0006 (2.90)	0.0937 (17.05)
- Land per labour	0.0899 (16.96)	-0.0449 (-228.42)	0.0450 (8.18)
- Fertilizer price	0.0415 (7.82)	0.0116 (59.07)	0.0531 (9.65)
- Crop price	0.0288 (5.44)	-0.0522 (-265.33)	-0.0234 (-4.25)
WESTERN			
Growth of output over the period	1.1902 (100.00)	-0.1369 (100.00)	1.0532 (100.00)
Source of growth:			
- Education	0.1961 (16.47)	0.0853 (-62.30)	0.2814 (26.71)
- Capital stock	0.0922 (7.75)	0.0144 (-10.48)	0.1066 (10.12)
- Research and irrigation	0.1121 (9.41)	0.0004 (-0.26)	0.1253 (11.90)
- Land per labour	0.2712 (22.79)	-0.0679 (49.58)	0.2033 (19.31)
- Fertilizer price	0.0415 (3.48)	0.0116 (-8.49)	0.0531 (5.04)
- Crop price	0.0417 (3.50)	-0.0514 (37.53)	-0.0097 (-0.92)

Table 6 : Growth of Crop Supply and Its Sources during 1961-1985
(continue)

	1961/63 and 1976/78	1976/78 and 1983/85	1961/63 and 1983/85
UPPER SOUTH			
Growth of output over the period	0.2258 (100.00)	0.0467 (100.00)	0.2725 (100.00)
Source of growth:			
- Education	0.1926 (85.29)	0.0861 (184.47)	0.2787 (102.29)
- Capital stock	0.0862 (38.17)	0.0254 (54.34)	0.1116 (40.94)
- Research and irrigation	0.0514 (22.78)	0.0004 (0.84)	0.0610 (22.39)
- Land per labour	0.1226 (54.29)	-0.0642 (-137.44)	0.0584 (21.44)
- Fertilizer price	0.0415 (18.37)	0.0116 (24.89)	0.0531 (19.48)
- Crop price	0.0015 (0.66)	-0.0330 (-70.61)	-0.0315 (-11.56)
LOWER SOUTH			
Growth of output over the period	0.4663 (100.00)	0.0732 (100.00)	0.5395 (100.00)
Source of growth:			
- Education	0.3178 (68.16)	0.1218 (166.33)	0.4396 (81.48)
- Capital stock	0.1141 (24.46)	0.0146 (19.94)	0.1287 (23.85)
- Research and irrigation	0.0792 (16.98)	0.0006 (0.85)	0.0942 (17.47)
- Land per labour	0.1757 (37.67)	-0.0588 (-80.31)	0.1169 (21.66)
- Fertilizer price	0.0415 (8.89)	0.0116 (15.87)	0.0531 (9.84)
- Crop price	-0.0123 (-2.63)	-0.0348 (-47.47)	-0.0470 (-8.72)

Source : TDRI estimate

Table 7 : Simulated Supply of Agriculture in Response to 10 % Increase in Price, 1970-1985
(As the ratio of actual figure)

Year/Region	Upper Northeast	Lower Northeast	Upper South	Lower South	Upper North	Lower North	Central Plain	Eastern	Western
1970	1.0039	1.0055	1.0526	1.0253	1.0117	1.0445	1.0158	0.9845	1.0275
1971	1.0358	1.0367	1.0534	1.0432	1.0340	1.0726	1.0077	1.0209	1.0527
1972	1.0209	1.0248	1.0574	1.0425	1.0260	1.0604	0.9267	1.0099	1.0442
1973	1.0541	1.0533	1.0724	1.0604	1.0464	1.0964	1.0199	1.0376	1.0694
1974	1.1132	1.1112	1.0612	1.0463	1.0865	1.1587	1.0623	1.0944	1.1299
1975	1.1434	1.1310	1.1029	1.1016	1.1031	1.1756	1.0688	1.1009	1.1431
1976	1.0998	1.0940	1.0549	1.0473	1.0724	1.1435	1.0519	1.0711	1.1199
1977	1.1030	1.0980	1.0745	1.0708	1.0764	1.1498	1.0543	1.0765	1.1319
1978	1.0886	1.0879	1.0455	1.0393	1.0694	1.1209	1.0515	1.0623	1.1536
1979	1.1144	1.1101	1.0960	1.0967	1.0904	1.1600	1.0670	1.0909	1.1429
1980	1.1063	1.1027	1.0757	1.0740	1.0887	1.1474	1.0662	1.0834	1.1282
1981	1.1255	1.1169	1.0859	1.0901	1.0985	1.1769	1.0768	1.1022	1.1211
1982	1.1313	1.1237	1.0965	1.1013	1.1022	1.1801	1.0754	1.1089	1.1335
1983	1.0891	1.0841	1.0720	1.0713	1.0792	1.1255	1.0597	1.0675	1.0889
1984	1.0944	1.0915	1.0834	1.0856	1.0860	1.1323	1.0638	1.0752	1.1220
1985	1.0941	1.0923	1.0805	1.0890	1.0885	1.1294	1.0701	1.0737	1.1130
Mean	1.0889	1.0852	1.0728	1.0678	1.0725	1.1296	1.0402	1.0663	1.1079

Note : Price expectation in aggregate supply equation was constructed by each crop price expectation.

Table 8 : Commodity Agriculture Price Forecast

(at 1985 price ,unit : US $)

	Actual			Forecast		
	1970	1980	1987	1995	2000	
Paddy*	396	416	177	173	166	US $ / MT
Maize	161	120	58	68	73	US $ / MT
Sugarcane	223	606	115	224	254	US $ / MT
Sorghum	143	124	56	62	68	US $ / MT
Soybean	322	284	166	196	148	US $ / MT
Soybean oil	845	572	257	316	371	US $ / MT
Rubber	127	156	86	115	106	US $ / KG
Palm oil	716	559	264	327	296	US $ / MT
Coconut	619	434	238	266	266	US $ / MT
Cotton	174	196	127	116	116	US $ / KG
Kenaf	754	295	248	243	236	US $ / MT
Tobacco	2717	2205	1471	1492	1439	US $ / MT

Source : World Bank, Commodity Price Forecast, October 17,1988

Table 9A : Estimate of The Share Supply Equation for Upper North

	Groundnut		Paddy		Tobacco		Shallot		Garlic	
Constant term	-0.1914	(-1.134)	-1.3429	(-4.024)	0.0761	(.211)	0.3781	(2.906)	1.0723	(2.423)
Price :										
Groundnut	-0.0160	(-.668)	0.0208	(.604)	-0.0283	(-1.207)	-0.0119	(-1.640)	0.0023	(.195)
Paddy	0.0208	(.598)	0.2332	(2.130)	0.0182	(.302)	-0.0268	(-1.222)	-0.0620	(-.551)
Tobacco	-0.0283	(-1.011)	0.0132	(***)	0.1481	(2.076)	-0.0188	(-1.073)	-0.0021	(***)
Shallot	-0.0119	(-1.065)	-0.0268	(***)	-0.0138	(-.688)	0.0231	(2.977)	-0.0144	(-.533)
Garlic	0.0023	(.240)	-0.0620	(-2.121)	-0.0021	(-.104)	-0.0144	(-1.957)	0.0915	(3.393)
Composite	0.0012	(.094)	-0.2366	(-3.675)	0.0402	(1.577)	0.0229	(2.317)	0.0543	(1.606)
Fertilizer	0.0214	(.954)	-0.1893	(-2.312)	0.0793	(1.774)	0.0082	(.463)	-0.0791	(-1.221)
Education	0.1682	(7.122)	0.4019	(5.374)	0.9634	(***)	0.0164	(.463)	0.2340	(3.428)
Capital stock	0.0427	(1.828)	0.3789	(5.112)	-0.8829	(-148.183)	-0.0501	(-2.640)	-0.1966	(-2.309)
Road	-0.0261	(-3.574)	0.0430	(1.921)	0.3736	(***)	0.0132	(2.121)	0.0475	(2.313)
Irrigation	-0.0073	(-3.340)	-0.0172	(-2.490)	0.0099	(2.192)	-0.0037	(-2.086)	-0.0039	(-.617)
Research	-0.0127	(-2.583)	-0.0827	(-5.452)	0.0464	(4.715)	0.0087	(2.236)	-0.0129	(-.918)
Land available	0.0174	(.678)	0.0631	(.801)	0.0331	(.628)	0.0369	(1.784)	-0.0338	(-.463)

Source : TDRI estimate
Estimation technique : SURE

Table 9B : Estimate of The Share Supply Equation for Lower North

	Mungbean		Maize		Paddy		Soybean		Sugarcane	
Constant term	-0.1670	(-1.680)	2.6329	(7.151)	-2.6995	(-7.577)	0.1325	(.319)	0.0226	(.146)
Price :										
Mungbean	0.0268	(1.528)	-0.0676	(-1.615)	-0.0621	(***)	0.0166	(1.300)	0.0238	(4.054)
Maize	-0.0676	(-4.254)	0.3003	(***)	-0.1285	(***)	0.0200	(.704)	0.0141	(.342)
Paddy	-0.0621	(-2.376)	-0.1235	(-2.496)	0.2251	(2.397)	-0.0346	(-1.002)	-0.0243	(-.722)
Soybean	0.0116	(***)	0.0200	(***)	-0.0346	(***)	-0.0043	(-.147)	0.0147	(.507)
Sugarcane	0.0238	(1.343)	0.0141	(.168)	-0.0243	(-.456)	0.0147	(.536)	0.0509	(1.577)
Composite	0.0169	(1.788)	0.0514	(2.004)	-0.1596	(-4.969)	-0.0127	(-1.010)	0.0093	(.751)
Fertilizer	-0.0037	(-.187)	0.0940	(1.646)	-0.2003	(-5.829)	0.0059	(.205)	-0.0065	(-.196)
Education	0.0338	(-.851)	-1.3075	(-10.900)	1.6273	(19.986)	0.0578	(1.124)	-0.0204	(-.394)
Capital stock	0.0239	(2.435)	-0.1491	(-4.962)	0.2190	(***)	-0.0179	(-1.418)	0.0144	(1.130)
Road	0.0011	(.282)	-0.0747	(-6.215)	0.0026	(.232)	0.0086	(1.723)	0.0169	(3.344)
Irrigation	-0.0010	(-.425)	0.0362	(5.134)	-0.0046	(-.519)	-0.0107	(-3.656)	-0.0155	(-5.249)
Research	0.0040	(1.135)	0.1185	(12.397)	-0.1354	(-11.578)	0.0036	(.762)	-0.0061	(-1.273)
Land available	-0.0127	(-1.317)	-0.1369	(-4.594)	0.0121	(.324)	-0.0006	(-.049)	0.0805	(6.413)

Source :TDRI estimate
Estimation technique : SURE

Table 3C : Estimate of The Share Supply Equation for Northeast

	Cassava		Groundnut		Kenaf		Paddy		Sugarcane	
Constant term	-0.7777	(-4.709)	-0.0067	(-.214)	0.5070	(.514)	2.3221	(8.206)	0.0734	(.881)
Price :										
Cassava	0.1742	(7.545)	-0.0129	(-2.773)	0.0143	(***)	0.0473	(2.502)	0.0018	(.143)
Groundnut	-0.0129	(-2.341)	0.0176	(3.159)	-0.0002	(***)	-0.0122	(***)	-0.0011	(-.067)
Kenaf	0.0143	(.630)	-0.0002	(-.045)	0.0523	(.418)	-0.0862	(-1.313)	0.0122	(1.021)
Paddy	0.0473	(1.357)	-0.0122	(-1.673)	-0.0862	(-0.707)	0.0209	(.304)	-0.0273	(-1.397)
Sugarcane	0.0018	(***)	-0.0011	(-.185)	0.0122	(.083)	-0.0273	(-.519)	0.0417	(2.723)
Composite	-0.0232	(-3.005)	-0.00004	(-.028)	-0.0220	(-.504)	0.0067	(.424)	0.0030	(.815)
Fertilizer	-0.1077	(-3.946)	0.0133	(2.665)	-0.1319	(-.328)	0.0752	(1.293)	0.0047	(.352)
Education	0.0676	(1.087)	-0.0750	(-6.312)	0.3160	(***)	0.2128	(1.696)	0.0759	(2.626)
Capital stock	0.1484	(6.733)	0.0039	(2.340)	-0.0121	(-.627)	-0.3476	(-7.362)	-0.0051	(-.500)
Road	-0.0182	(-1.337)	-0.0053	(-3.093)	-0.0147	(-9.235)	0.0169	(.857)	-0.0088	(-1.937)
Irrigation	0.0049	(1.268)	0.0015	(2.268)	-0.0010	(-.048)	0.0196	(2.544)	0.0003	(.163)
Research	-0.0185	(-2.946)	0.0025	(2.204)	0.0183	(.554)	0.0068	(.536)	-0.0062	(-1.394)
Land available	-0.1249	(-4.374)	-0.0124	(-2.515)	-0.0057	(-.036)	0.1273	(2.213)	0.0302	(2.301)

Source :TDRI estimate
Estimation technique :SURE

Table 9D : Estimate of The Share Supply Equation for Central Plain

	Mungbean		Maize		Paddy		Sugarcane		Chilli	
Constant term	0.0505	(2.643)	0.6109	(***)	-1.7257	(***)	-0.0010	(-.010)	0.3759	(4.583)
Price :										
Mungbean	0.0085	(1.847)	-0.0008	(***)	-0.0002	(***)	-0.0021	(***)	-0.0030	(***)
Maize	-0.0008	(-.125)	0.0560	(2.411)	-0.1163	(***)	-0.0280	(-2.792)	-0.0052	(-.186)
Paddy	-0.0002	(-.025)	-0.1163	(-2.392)	0.2119	(2.678)	-0.0321	(-1.119)	-0.0298	(-1.259)
Sugarcane	-0.0021	(-.431)	-0.0280	(***)	-0.0312	(***)	0.0366	(1.401)	0.0178	(.896)
Chilli	-0.0030	(-.940)	-0.0052	(-.342)	-0.0298	(-2.115)	0.0178	(1.221)	0.0313	(2.587)
Composite	-0.0012	(-1.104)	0.0162	(2.072)	-0.0387	(-3.188)	0.0004	(.079)	0.0039	(.884)
Fertilizer	-0.0004	(-.078)	0.0655	(***)	-0.1553	(***)	0.0363	(1.353)	0.0039	(.170)
Education	0.0001	(.014)	0.1006	(2.265)	0.2648	(***)	-0.1208	(-4.255)	-0.0913	(-4.169)
Capital stock	0.0018	(2.366)	0.0036	(.584)	0.1224	(5.348)	0.0090	(2.272)	-0.0352	(-11.474)
Road	-0.0030	(-2.733)	-0.0633	(-7.079)	0.0881	(51.341)	0.0080	(1.412)	0.009	(2.023)
Irrigation	-0.0108	(-11.221)	-0.1194	(-15.291)	0.1491	(12.786)	0.0162	(3.240)	-0.0069	(-1.788)
Research	0.0064	(6.142)	0.0728	(8.424)	-0.1309	(-10.451)	0.0003	(.057)	0.0015	(.366)
Land available	0.0009	(4.135)	0.0116	(6.278)	-0.0174	(-6.279)	0.0026	(2.244)	-0.0023	(-3.225)

Source : TDRI estimate
Estimation technique : SURE

Table 9E : Estimate of The Share Supply Equation for Eastern

	Cassava		Groundnut		Paddy		Sugarcane		Coconut	
Constant term	0.6661	(1.320)	0.1684	(1.369)	-3.5416	(-4.456)	-0.5812	(-1.548)	0.2820	(1.870)
Price :										
Cassava	0.2351	(6.200)	-0.0093	(-1.442)	-0.1420	(-3.678)	-0.0007	(-.030)	-0.0402	(-3.347)
Groundnut	-0.0093	(***)	0.0190	(2.223)	-0.0118	(***)	-0.0001	(***)	0.0020	(***)
Paddy	-0.1420	(-14.375)	-0.0118	(-1.155)	0.0847	(1.111)	-0.0340	(-.822)	0.0039	(.225)
Sugarcane	-0.0007	(***)	-0.0001	(-.011)	-0.0340	(***)	0.0069	(.520)	-0.0027	(-.218)
Coconut	-0.0402	(***)	0.0020	(.313)	0.0039	(***)	-0.0027	(-.217)	0.0139	(1.482)
Composite	-0.0787	(-3.251)	0.0029	(.315)	0.2315	(6.949)	-0.1173	(-8.386)	-0.0157	(-2.840)
Fertilizer	-0.0461	(-.561)	0.0012	(.125)	0.1377	(1.287)	-0.0764	(-1.818)	-0.0137	(-.833)
Education	0.8132	(3.572)	0.0468	(1.309)	-1.7775	(***)	1.1206	(10.792)	0.0687	(1.683)
Capital stock	-0.0866	(-1.550)	-0.0252	(-4.673)	1.1054	(***)	0.0096	(.382)	-0.0506	(-5.285)
Road	0.0249	(.320)	-0.0147	(-5.728)	-0.1623	(***)	0.0308	(2.581)	0.0557	(12.255)
Irrigation	-0.0240	(-1.869)	-0.0020	(-1.641)	0.0194	(1.247)	-0.0134	(-2.369)	0.0006	(.270)
Research	-0.0012	(-.086)	0.0029	(1.819)	0.0496	(3.136)	-0.0587	(-9.002)	-0.0187	(-7.212)
Land available	-0.0230	(-2.456)	0.0009	(1.062)	0.0246	(2.171)	-0.0164	(-3.979)	0.0033	(2.118)

Source :TDRI estimate
Estimation technique : SURE

Table 9F : Estimate of The Share Supply Equation for Western

	Paddy		Sugarcane		Coconut		Pineapple		Shallot	
Constant term	1.9779	(3.9743)	1.2214	(2.429)	-1.6342	(-6.372)	-2.2741	(-4.084)	0.8044	(2.779)
Price :										
Paddy	0.1546	(2.001)	-0.2342	(-11.216)	0.0619	(1.613)	0.0212	(***)	0.0181	(***)
Sugarcane	-0.2342	(-2.492)	0.2210	(2.840)	0.0041	(.128)	0.0685	(.932)	-0.0037	(-.061)
Coconut	0.0619	(***)	0.0041	(***)	-0.0404	(-1.148)	-0.0128	(***)	-0.0333	(***)
Pineapple	0.0212	(***)	0.0685	(2.277)	-0.0128	(-.279)	0.0191	(***)	-0.0037	(-.117)
Shallot	0.0181	(.789)	-0.0037	(-.076)	-0.0333	(-1.567)	-0.0037	(-.136)	0.0116	(.539)
Composite	0.0013	(.036)	0.1639	(4.749)	-0.0910	(-4.849)	-0.0775	(-2.015)	-0.0356	(-1.535)
Fertilizer	0.0631	(2.391)	0.2192	(3.095)	-0.1003	(-3.061)	-0.3483	(-4.280)	0.0210	(.584)
Education	-1.3758	(-8.018)	-1.4538	(-7.839)	0.8734	(***)	2.2933	(10.940)	-0.1739	(-1.319)
Capital stock	-0.1848	(-3.439)	0.0349	(1.455)	0.2102	(***)	0.1131	(1.732)	-0.0893	(-3.059)
Road	0.1519	(5.736)	0.0192	(.670)	-0.0812	(***)	-0.2618	(-8.115)	0.0856	(5.356)
Irrigation	0.0905	(6.157)	-0.0295	(-1.858)	-0.0507	(-6.819)	0.0530	(2.367)	-0.0271	(-3.389)
Research	-0.0901	(-5.566)	0.1253	(6.590)	-0.0461	(-4.120)	-0.0682	(-3.826)	0.0250	(2.290)
Land available	-0.0372	(-4.865)	0.2050	(3.936)	-0.0247	(-.985)	-0.0192	(-.323)	0.0158	(.579)

Source : TDRI estimate
Estimation technique : SURE

Table 3G : Estimate of The Share Supply Equation for South

	Paddy		Rubber		Oilpalm		Coconut		Pineapple	
Constant term	0.1968	(1.424)	0.3773	(4.052)	-0.1331	(-5.369)	-0.1605	(-1.055)	0.0239	(.255)
Price :										
Paddy	0.3244	(7.534)	-0.1848	(-2.711)	-0.0078	(xxx)	-0.0637	(-2.508)	-0.0179	(-.343)
Rubber	-0.1848	(-4.367)	0.3013	(3.964)	0.0035	(xxx)	-0.0619	(-1.541)	-0.0276	(-1.023)
Oilpalm	-0.0078	(-3.736)	0.0035	(.352)	-0.0001	(-.146)	-0.0002	(-.100)	0.0043	(2.949)
Coconut	-0.0637	(-2.514)	-0.0619	(-2.793)	-0.0002	(xxx)	0.1123	(2.740)	0.0008	(.173)
Pineapple	-0.0179	(-.255)	-0.0276	(-.191)	0.0043	(.301)	0.0008	(.016)	0.0598	(1.821)
Composite	-0.0132	(-2.097)	-0.0325	(-2.021)	-0.0027	(-.323)	0.0567	(5.195)	-0.305	(-.796)
Fertilizer	-0.0600	(-2.071)	0.0981	(2.055)	0.0535	(6.046)	-0.0426	(-1.354)	-0.0628	(-3.033)
Education	-0.0024	(-.098)	0.0139	(.321)	0.0323	(xxx)	-0.0055	(-.131)	0.0223	(1.309)
Capital stock	0.0664	(4.232)	-0.1909	(-6.324)	-0.1704	(-133.354)	0.0865	(4.677)	0.0175	(1.633)
Road	-0.0316	(-3.777)	0.0529	(3.611)	-0.0575	(-27.583)	-0.0344	(-3.494)	0.0273	(4.752)
Irrigation	0.0508	(15.266)	0.0142	(2.440)	-0.0047	(-4.049)	-0.0414	(-10.575)	-0.0159	(-6.957)
Research	-0.0078	(-.585)	0.0106	(.157)	0.0088	(3.738)	-0.0141	(-1.170)	-0.0155	(-2.047)
Land available	0.0122	(4.860)	-0.0335	(-7.564)	0.0032	(3.585)	0.0124	(4.185)	0.0017	(1.004)

Source :TDRI estimate
Estimation technique : SURE

REFERENCES

Feder, Gershon, et al (1988) Land Policy and Farm Productivity in Thailand, World Bank publication.

Cavallo, Domingo and Mundlak, Yair (1982) Agriculture and Economic Growth in an Open Economy: The Case of Argentina, Washington: International Food Policy Research Institute.

Mundlak, Yair (1979) Intersectoral Factor Mobility and Agricultural Growth, Research Report 6, Washington, D.C.: International Food Policy Research Institute.

Sussangkarn, Chalongphob. 1987. "The Thai Labor Market: A Study of Seasonality and Segmentation," TDRI (mimeo.).

Thailand Development Research Institute. 1986. Human Resources Program, Human Resources Management. Paper presented at the 1986 Year-end Conference on Resource Management, Pattaya (December 13-14).

APPENDIX A

Data Description

Crop Production

Where available production quantity by crop and by province are taken from the annually published Agricultural Statistics of Thailand by the Department of Agricultural Economics (DAE). For other crops which are not available we have to rely on other sources, for instance, the Rubber Research Institute, the Department of Agricultural Extension. In case of rubber, official data do not disaggregated into individual province we have to estimate them based on the followings: a) the planted area by province from the aerial photograph and the LANDSAT and their interpolated figures; b) rubber yield by province from the Department of Agricultural Extension (DOAE) and the expert opinions; and c) the relative importance of the matured rubber trees by province from the Agricultural Census 1978 and the Rubber Replantation. The estimated provincial figures are adjusted so that the total quantity is consistent with the Whole Kingdom production quantity. Virginia tobacco production by province is based on the Excise Department. Longan production is based on the Department of Agricultural Extension and some previous studies.

Cultivated area

Similarly to above.

Agricultural price index by province

Agricultural price index by province refers to the Divisia price index of crops, which takes into account crops composition in each province. Because spatial prices are rarely available, we assume that price movement for each crop are identical for all provinces; specifically the Bangkok wholesale price levels are employed.

Price expectation

Crop price expectation is assumed to follow the the vector autoregressive scheme, i.e., it depends on price information in the past 3 years (own prices and prices of the "relevant" crops).

Agricultural capital stock

Our estimate for agricultural capital stock for each province is the valuation of 3 items, viz., cattle and buffalo, tractors, and water pump in 1972 prices. These information are taken from Agricultural census 1978. Because time-series data are not possible, we interpolate them by assuming that the province's capital stock grew by the rate of real income per capita.

Irrigation

Irrigation inventory for the year 1960 is based on the accumulation of the government contruction budget from the 1955 onwards. This sum is normalized by size of irrigated area in each province as the measure of capital stock per rai, and this is taken as inventory. We accumulate annual government construction budget, which are identifiable according to irrigation project, to the initial stock to get the measure for irrigation stock. Because the location of irrigation project and the recipient of irrigated water are not necessarily in the same province, we have to assign this stock proportionately to the recipient provinces. There is some weaknesses; one of them may be cited that our measure as it does not cover the privately operated irrigation, most of them small-scale and most prevalent in the Upper-Northern provinces.

Road

Similarly to the measure for irrigation stock, road stock per area is the accumulation of the construction budget by province over time. Fortunately the official road inventory for 1963 is available and thus is taken as the stock at the base year.

Agricultural research

Accumulated government budget for agricultural research is taken as the measure for research activity. This expense cannot be disaggregated by province, only the break-down by crops, e.g., rice, maize, rubber, can be available but at this stage we use the aggregate expense. Research activity however follows the public goods argument, that is, the use by one farmer does not preclude the use of other farmers; accordingly, the same research expense is used for all provinces. We assume that research activity has its life and does not vanish immediately after money is exhausted.

Agricultural extension

Similarly to the case of research expense, the public good argument still applies in case of agricultural extension.

Labor migration

Interprovincial migration data is taken from the Population census 1980. From this source we know whether the respondents had moved at all, and where they lived before moving into the present location within the past 5 years.

APPENDIX B

Individual Crop Share Equation

This section explains the second approach to study supply of individual crop in each region. We select five most important crops and lump all the remaining crops into a single "composite" crop, making a system of 6 equations. Estimate and functional form follow equation (5) in the text, and the parameters are taken to infer about the own-and cross-price elasticities. Results, shown in Tables 5B-5H, may be noted as follows: a) Own-price elasticities for the "important" crops (e.g., paddy, maize, sugarcane) are significant and positive in sign, thus indicating that farmers are in general motivated by price incentives; b) The results show which pair of crops are substitute or complement, e.g., maize, sugarcane seem to compete with paddy in the Central Plain and the East, soybean and maize compete with paddy in the Lower North, and groundnut and sugarcane compete with paddy in the Northeast. We also note that the results are not consistent across regions, i.e., sugarcane seems to complement with paddy in the Lower-North and the Northeast while the opposite is indicated in the Central Plain, the East and the West. These results make it difficult to generalize; c) Again we want to note that our results for the Upper-North should be suspected as the negative supply elasticicies are indicated in cases of garlic, shallot, and groundnut; this together with earlier estimates make us feel unhappy about the fitness of our model for this particular region.

Rajapark Building, 163 Asoke, Sukhumvit Road, Bangkok 10110 Thailand
Tel. 258-9012-7, 258-9027-9 Fax. 258-9046 Telex 20666 Rajapak TH