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Sources of Productivity Differences among Thai Rice Farmers

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ABSTRACT

Data on 214 Thai rice farmers were analyzed using production theory and regression technique. Technical and allocative efficiencies were tested, and it was revealed that types of land ownership had significant effects on allocative efficiencies of conventional inputs among owners, part owners, and tenants. Level of schooling did not explain productivity differences. That tenants were most efficient technically was attributed to externalities of farming such as mechanization.

INTRODUCTION

Thailand has long been the only developing country in Asia that has had a surplus of rice for annual export. Thai rice export was 30.8 percent of the world's market in 1983 and has been ranked only after the world's largest exporter, the United States (Division of Policy, 1985). Although rice is Thailand's most crucial staple and has been a dependable foreign exchange earner, rice production has faced a number of serious problems, among which the relatively low and stagnant paddy yields are the most striking and disappointing.

The contradictory facts--that total Thai rice production has been sustained in the face of a declining trend in yield--can easily be understood only by looking at the nature of commonly practiced rice farming techniques. First, rice production has increased in total output due primarily to increases in area planted. Second, the rate of fertilizer application in Thai rice production is among the lowest in the world (Table 1)[2] Third, although a large number of high-yielding-varieties of rice (HYV's) have been avialable, the adoption rate has been very low. In 1982 only about 12 percent of the total paddy area was in HYV's. (OAE, 1982).

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[2] This may be due partly to the unfavorable price levels (see Table 1), yield conditions (i.e., water control and irrigation), and the availability of HYV's. Nonetheless, an application of HYV's was further marred by problems related to the quatity of such inputs as fertilizer: in the mid 1970's fake fertilizer for rice (16-20-0) flooded the market and farmers have been more reluctant to use fertilizer.

Table 1 Crop/fertilizer price relationship, fertilizer use and crop yield

	Kg of paddy to buy one Kg of fertilizer	Average fertilizer use (Kg/ha)	Average yield of paddy (Kg/ha)
Korea, Rep. of	1.15	3.80	5,512
Indonesia	1.25	54	3,317
Malaysia	1.82	104	2,833
Burma	2.17	10	2,549
Pakistan	2.17	51	2,450
Sri Lanka	2.50	74	2,514
Bangladesh	4.35	45	1,977
India	4.35	30	1,890
Philippines	4.35	34	2,196
Thailand	4.55	17	1,933
Nepal	5.00	9	1,828

Source : ESCAP/FAO/UNIDO 1986, p.3.

The purpose of this article is to examine the factors influencing rice production in Thailand. It is necessary to identify these factors, to measure their relationship with output, and to understand their relative importance, if policies are to be designed to encourage higher yields. In addition to factors common to other empirical production studies, the degree of land ownership is included to investigate the relationship between the institutional aspects of land tenure and productivity.[1] The theoretical model is estimated, using observations on samples collected from central Thailand.

Theoretical Framework

In many empirical studies in the past both economic and noneconomic factors have been shown to play significant roles in determining both yield and total output. Noneconomic factors, such as improvements in infrastructure (roads, dams, etc.) and disease controls, were found significant in explaining the supply of field crops including

[1] Using Fabricant's definition of "productivity," this study utilizes the term "productivity" and "efficiency" interchangeably. Fabricant (1959) defines productivity as a measure of efficiency with which resources are converted into commodities and services.

rice and corn in Thailand (Behrman, 1968). Other research explores the roles of institutions such as land reform and ownership in agriculture. In Taiwan, for instance, land reform and levels of education were found to be crucial to Taiwan's success (Gleason and Jesdapipat, 1983). Theoretical discussions (Hsiao, 1975) and empirical studies (Land Development, 1964 and 1969, Kongkaphet, 1973 and Thani, 1974) regarding the effects of different types of land tenure on farm output have been carried out. Mixed results, however, were obtained (Ruttan, 1966). For developed economies, the degree of land ownership often correlates positively with levels of output. The contrary is mostly true for developing economies, although serious errors may exist in the methodological framework of studies of developing economies, making the results less reliable.

The production theory allows a formulation of rice production function used in this study to have this general form:

$$Y = f(L,N,K,T,E1,E2,E3,H,M1,M2,U)$$

Where

Y = total output (tang);

L = Cultivated irrigated land area (rai);

N = labor (man-days);

K = capital services (baht);

T = new inputs (expenses on fertilizer, and pesticides; baht);

E1,E2,E3 = dummy variables used as a proxy for "human capital" reflected in years of formal education; E1 = 1 for 4 years of schooling and zero otherwise; E2 = 1 for 7 years of schooling, zero otherwise; E3 = 1 for 10 years of education and zero otherwise.

H = dummy variable to account for adoption of HYV's; H = 0 = no; H = 1 = yes;

M1 and M2 = dummy variables added to differentiate types of land ownership, namely, owners, part owners, and tenants.[1]

U = stochastic term with assumed zero mean and a fixed variance.

Data used in the empirical estimations are parts of cross-sectional data gathered by stratified sampling technique in 1978 from rice farmers in two major rice producing areas in central Thailand. Two hundred and fourteen samples were sorted out and classified into three tenurial groups. From these data, 72, 72 and 70 samples were acquired for owners, part owners and tenants, respectively.[2]

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[1] According to Mundlak (1961), these dummy variables M1 and M2 (1, 0 for owners; 0, 0 for part owners; 0, 1 for tenants, respectively) show differeent "managerial abilities" of divergent tenurial groups.

[2] Part owners own 25-27 percent of their land being used; owners own 100 percent and tenants rent 100 percent of their land.

EMPIRICAL RESULTS

By goodness-of-fit criterion, Cobb-Douglas is selected to be the most appropriate functional form over linear and quadratic forms. After taking natural log, the model can be estimated in a linear fashion using Ordinary Least Square regression. The results are as follows.

$$\begin{aligned}\text{Model } 1^{1}: Y = {} & 2.812 - 0.028\ 1nH + 0.425\ 1nL \\ & \quad (8.17)\ (-0.42)\ (6.54) \\ & + 0.072\ 1nN + 0.27\ 1nK + 0.045\ 1nT \\ & \quad (2.8)\ (5.22)\ (3.66) \\ & + 0.0065E1 + 0.02E2 - 0.10E3 \\ & \quad (0.03)\ (0.08)\ (-0.43) \\ & - 0.126M1 - 1.48M2 \\ & \quad (-1.57)\ (-1.93)\end{aligned}$$

$$N = 214\ \bar{R}^2 = 0.682\ \ F = 46.70\ SD = 0.439$$

As it turns out, t-tests of coefficients of M1 and M2 reject the hypotheses that they are not significantly different form zero at alpha equals .10 and .05 respectively. This, of course, implies that among all the "conventional" factors of production (namely, land, labor, capital, and new inputs), total output of paddy does vary with different types of land tenure.

HYV's and levels of education of farmers, however, are not statistically significant at any conventional alpha level of 10 percent. The findings thus differ from studies from other countries. Nonetheless, although

> HYV's given the proper package of inputs, usually have a clear yield advantage over traditional verieties, it is difficult to measure the difference precisely. The advantages vary widely with each crop, depending on the degree to which the recommended level of inputs is used, the quality of land base, and a host of other factors (Dalrymple, 1977).

That HYV"s failed to contribute to increasing yield (or output) is very obvious for Thai rice producers who usually cannot afford the complete package of inputs required for successful application of HYV's. Indeed, the fact that both HYV's and education variables are not statistically significant appears to be more than coincident, but rather complementary. As noted by Dalrymple (1977), the distortion between realized and

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[1] (Figures in parentheses are t values) Note t_{∞} , .10 = 1.28; t_{∞} , .05 = 1.645

potential yield on farms may contribute to the fact the farmers do not follow the recommended practices of levels of input use. The majority of farmers in these samples have completed four-year compulsory education which may not allow them to assimilate and execute successfully the application of HYV's.

The results regarding the effects of land tenure on agricultural production is not new, but interesting in this case. While similar studies such as those by Thani, Kongkaphet, and Land Development concluded that owners were more productive than tenants, this study, nevertheless, cautions that it might not always be the case. Currently, the results indicate that with the same amount of all inputs, part owners will produce more output than owners (thus, more technically efficient). However, owners are more technically efficient than tenants.

The present methodology olso allows one to perform a statistical test regarding ability of farmers to efficiently use each individual input at a margin (called allocative efficient) by adding interaction terms and reestimate Model 1. Consequently, Model 2 was estimated.

$$
\begin{aligned}
\text{Model } 2^{1}: Y \;=\; & 2.76 + 0.182\ 1nL + 0.078\ 1nN + 0.374\ 1nK \\
& (5.45)\ (1.87)\ (1.94)\ (4.6) \\
& + \ 0.044\ 1nT + 0.192M1 + 0.271M2 \\
& (1.95)\ (0.31)\ (0.36) \\
& + 0.457\ 1nLM1 - 0.379\ 1nLM2 - 0.016\ 1nNM1 \\
& (3.2)\ (2.19)\ (+0.26) \\
& - \ 0.033\ 1nNM2 - 0.22\ 1nKM1 - 0.182\ 1nKM2 \\
& (-0.57)\ (-1.98)\ (-1.24) \\
& + \ 0.012\ 1nTM1 - 0.017\ 1nTM2 \\
& (0.4)\ (-0.57)
\end{aligned}
$$

$R^2 = 0.695$ $F = 35.66$

Among tenurial groups the allocative efficiency varies, thus contribution to different levels of total output. Owners are best regarding land only, and come second among the three tenurial groups regarding labor. While part owners are the most efficient in allocating labor and capital, tenants are ranked second for land and capital. Considering the intersity of capital investment (employed) and new inputs used (Table 2), nevertheless, one might speculate that such heavy investments undertaken by owners, as compared to

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[1] $t_{\infty, .10} = 1.28$ $t_{\infty, .05} = 1.645$

(Figures in parentheses are t values)

tenants, would lead to higher productivity among the group in the long run. Hence, an improvement in tenure may lead eventually to higher output because of higher incentives regarding investment in new inputs and capital. Although current tests do not show stistical differences among farmers in the case of new inputs.

Table 2 Intensity of inputs used

Characteristic	Total	Owners	Partiowners	Tenants
Sample size	214	72	72	70
Labor-land ratio	7.938	8.767	6.155	9.92
Capital-land ratio	86.88	104.18	73.73	92.15
New inputs-land ratio	32.77	52.67	20.74	34.18
Capital-labor ratio	10.95	11.88	11.98	9.29
New inputs-labor ratio	4.13	6.01	3.37	3.45
Family labor (%)	71.24	68.74	72.46	71.97
Hired labor (%)	28.76	31.26	27.54	28.03
Yield (kg./rai)	34.95	38.71	33.18	34.47

Now that Model 2 asserts that land ownership affects only size of farm and capital investment, one may question why it does not affect levels of new imputs and labor employed. Looking back at Table 2 one sees that total labor intensity of owners and tenants is not very different--although owners use slightly more hired labor. Regrettable, this same explanation is inapplicable to new inputs

By a similar modification in Model 2, one can test if land ownership has any effect on HYV's adoption and level of education.

Model 3[1] : $Y = 3.0 + 0.13\ 1nL + 0.088\ 1nN + 0.418\ 1nK + 0.042\ 1nT$
$(4.34)\ (1.29)\ (2.08)\ (4.93)\ (1.82)$
$- 0.112M1 - 0.12M2 + 0.54\ 1nLM1 + 0.385\ 1nLM2$
$(-0.13)\ (-0.13)\ (3.59)\ (2.09)$
$- 0.045\ 1nNM1, - 0.035\ 1nNM2 - 0.288\ 1nKM1$
$(-0.68)\ (-0.57)\ (-2.45)$
$- 0.215\ 1nKM2 + 0.012\ 1nTM1 + 0.017\ 1nTM2 - 0.199\ H$
$(-1.4)\ (0.39)\ (-0.56)\ (-1.76)$
$+ 0.259HM1 + 0.243HM2 - 0.132E1 - 0.631E2$

[1] $t_{\infty, .10} = 1.28$, $t_{\infty, .05} = 1,645$

(Figures in parentheses are t values)

(1.6) (1.47) (−0.71) (−1.3)

− 0.167E3 + 0.151E3M1 + 0.232E3M2

(−0.31) (0.26) (0.35)

+ 0.526E1M1 + 0.44E1M2 + 0.77E2M1 + 1.225E2M2

(0.96) (0.8) (1.3) (1.9)

$F = 19.49\ \bar{R}^2 = 0.692$

One can see from Model 3 that at the level of significance at 10 percent land tenure enhances an adoption of HYV's. Similar effects on education, however, are likely to happen only on secondary education among Thai farmers at alpha ranges between .05 to .10.

POLICY IMPLICATIONS

A few unexpected empirical results are found in this study. First, HYV'S a form of R & D, and education are not significant factors that explain output variance. This may not be surprising since the chain of complementarity between successful applications of HYV'S and schooling is broken once either factor is ineffective. However, it is found that ownership does encourage adoption of such new technology as HYV'S and education. This finding thus suggests an agrarian reform program which would restructure agriculture and the rural society. Second, an emergence of part owners who are most technically efficient, is a phenomenon. This event has pointed to an upward spiral of land pressure and/or a striving for increasing the size of operation due to economic opportunities made possible by farm mechanization. More attention should be paid to examining the economic characteristics of this tenurial group. Since the group has the highest allocative efficiency in utilizing capital and labor input, a policy should be designed to assist the expansion of these farmers. For any reason, an increase in the number of part owners in Thailand had called for agricultural policy that aims at easing out tension that may result form land pressure in areas where the expansion occurs, as well as enhancing efficient operations of this group.

CONCLUSIONS

Sources of productivity differences among rice farmers in Thailand were explored in this study so that policy implications can be drawn. Applying regression technique to estimate a production function using 214 samples collected form two major rice-producing areas in the Central Plain of Thailand, this study concluded that institutional arrangements, namely land tenure, appears to be the main foundation of productivity differences among Thai rice farmers. Both total output and yield were affected by resource utilization which

was under the influence of different degrees of land ownership. Thus, increasing the degree of land ownership may lead to a better allocation of resources. Past owners are slightly more technically efficient than owners but neither owners nor part owners are always better users of inputs at the margin. Subsequent allocative efficiency tests indicate that incentives to use land, labor and capital more efficiently are much greater as land rights increase in degree.

Varieties of seed used and levels of education of farmers do not explain output differences among the tenurial groups. Measurement of these two factors in this study are rather crude. Therefore, a more careful investigation of their potential cntributions is suggested.

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