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*EFFECT OF FARM SIZE AND TENURIAL STATUS OF LAND ON PRODUCTION EFFICIENCY IN AN AREA OF BANGLADESH**

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ABSTRACT

Field data collected from two samples of 101 pure owner-operators and 100 part-tenant farmers were analysed and interpreted for assessing effect of farm size and tenurial status of land on production efficiency. Medium farms (0.75--2.00 hectares) appeared to achieve the highest efficiency followed by small farms (below 0.75 hectare) and large farms (above 2.00 hectares) revealing that the relationship between farm size and efficiency is neither positive nor negative throughout. If one moves from small farms to medium farms, the relationship is positive ; and if o ie moves from medium farms to large farms, it is negative. Production efficiency tended to be the highest on owned land followed by cash rented land crop share rented land with input coat-shaving and crop-share rented land without input cost-sharing suggesting that, irrespective of rental arrangements, the mechanism of land tenancy acts acts as a hindrance to higher production efficiency. Inter-rental system comparison reveals that cash renting system is a better mechanism than crop-share renting even with input-cost sharing. However, input cost-sharing practice accelerated production performance on crop-share rented land.

I. INTRODUCTION

The crux of the problem of growth in agriculture in Bangladesh is how to increase output per unit of input: One way of approaching this problem of improving agricultural production efficiency is to examine whether the present pattern of ownership a,-.d use of resources is efficient or inefficient. If it is found that the pattern of ownership and use of resources is inefficient, production efficiency may be increased by making adjustments in

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the ownership and use of resources among different categories of farms in optimal direction (Jabbar 1977a, p. 1; Singh 1975, p. 32; Myrdal 1968, p. 1253).

A set of interacting factors have multidirectional influences to the achievement of certain level of production efficiency. The present investigation attempts to test the hypothesis that size of farm and tenurial status of land are important factors that influence input productivity at the farm level[1]. The relative production efficiency with respect to farm size has long been debated. In the context of Bangladesh agriculture, recently two researchers have presented two different conclusions about size-efficiency relationships. Hossain (1977) reported a unique inverse relationship between farm size and production efficiency. Mandal (1980) observed that productivity per acre increased upto certain farm size limit (about 4.00 acres) and then decreased as the farm size increased. These differences in conclusions among researchers may confuse a planner in making policies in relation to ceiling on land holdings and land redistribution. Therefore, further verification of size-efficiency relationships is attempted.

Like farm size and efficiency, the tenancy-efficiency issue has also long been debated in this country. In recent years an empirical dimension has been added to the debate in an attempt to resolve the controversy. Results have varied, but in most cases it has been found that tenancy is necessarily less efficient than owner cultivation (Talukder 1980; Mandal 1980; Hossain 1977; Jabbar 1977a). Even then, since land tenancy is closely related to size of farm the relative production efficiency with respect to tenurial status of land has also been tested in this study. Moreover, the economics of different alternative rental systems was rarely examined. Most of the authors have pooled all forms of rented land in a single class for comparing with owned land directly. However, inter-rental system comparison is needed for formulating viable tenancy reform policies. In view of this, the study also attempts to make an overall assessment for the relative production efficiency position of owned land, crop share rented land with input cost sharing, crop share rented land without input cost sharing and cash rented land.

II. METHODOLOGY

STUDY AREA, SAMPLING FRAMEWORK AND DATA

The study pertains to a cluster of few villages purposively selected from Bailor union under Trishal upazila of Mymensingh district in Bangladesh. Two separate population lists were prepared through a preliminary survey of the study area: (1) comprising those cultivating all their own land (i.e., pure owner-operators[2]) including their individual size of cultivated holdings; and (2) comprising those owning some land and renting-in additional land (i.e., part-tenants). The pure owner-operators were further classified into three farm size (measured by size of cultivated holding) groups (e.g. small: below 0.75 hectare, Medium: 0.75–2.00 hectares and large: above 2.00 hec-

tares) applying square root method[3] . From each farm size group, about 25 per cent of the farmers were selected by simple random sampling[4], taking classwise proportionate fractions (i.e., by proportional allocation method[5]). In this way, 101 out of 410 pure owner-operators constituted the sample category (1). The whole sampling technique followed in this case can be statistically named as stratified random sampling with probability proportional to size. The distribution of sample pure owner-operators according to farm size is shown in Table 1. Applying the technique of simple random sampling, 100 out of 332 part-tenants were selected which constituted the sample category (2).

Sample category (1) was used to assess the effect of farm size on production efficiency. The rationale of selecting only pure owner-operators for examining size-efficiency relationships is to be confirmed that tenancy would not distort the results[6]. Sample category (2) was used to determine the impact of tenurial status of land on production efficiency. The logic of selecting only part-tenants for assessing tenancy-efficiency relationships is that it will control the effects of extrinsic factors, such as, management skill and resource availability of farms (also see, Talukder 1980 ; Mandal 1980 ; Bell 1977; Hossain 1977 ; Jabbar 1975 and Heady 1952). Except by Bell (1977) this method has been rarely used in estimating the effect of land tenancy on production efficiency. The limitation of this method is that the effect of farm size cannot be removed altogether. Also no appropriate technique was known to isolate the size effects from the tenancy effects.

Detailed input-output data for Aman paddy, Boro paddy and wheat crops collected from the sample farmers through a routine procedure of the farm survey method during the crop year 1984-85 were utilized for assessing effects of farm size and tenurial status of land on production efficiency.

ANALYTICAL TECHNIQUES

Both partial and functional analyses were carried out for examining the impact of farm size and tenurial status of land on production efficiency. In partial analysis, some partial measures of productivity were employed and in functional analysis Lau-Yotopoulos profit function model was applied.

Partial Measures of Productivity

In partial measures of productivity, output and/or net income is expressed per unit of a single input category. 'Land' may be such an important single input ; because, it is the most scarce factor in a developing agriculture. Therefore, physical output and/or value of output per hectare and similar other measures may be considered as measures of average performance in productivity scale (Britton and Hill 1975, p. 54). The limitation of such

partial measures is that they cannot catch anything about the overall relative economic efficiency at the margin (Bhuiyan 1986, pp. 26-27).

In the present study, seven different partial measures of productivity were employed :

(a) **Crop Yields :** Yield per hectare in quintals (100 kg) for individual crops was estimated for different size-tenurial categories of farms and lands.

(b) **Gross Output :** It is the gross value of crop and by-product produced. Gross output was estimated for both individual crops and aggregate of those crops. It was expressed as value per hectare in taka.

(c) **Gross output over Material Cost :** Per hectare gross output over material cost is the balance between per hectare gross output and per hectare material cost. Material cost included the costs involved in the use of all material inputs like seed/seedling, organic manures, chemical fertilizers, irrigation and insecticides for crop production.

(d) **Gross Margin :** It is the gross output over variable costs. Gross margin represents a return for the services of land owned, fixed labour and fixed capital. Gross margin being a return mostly over cash or out-of-pocket expenses, farmers are sometimes assumed to maximize this rather than profit in the short-run (Bachman and Christensen 1967, p. 240). In this study, variable costs included all material costs and wage costs of casually hired human labour and draft power services. Thus, except the imputed value of own seeds/seedlings and organic manures, all the variable costs were out-of-pocket expenses.

(e) **Cash Cost Basis Net Return :** It is the balance between gross output and cash costs. That means, only the out-of-pocket expenses were considered in estimating this net return. Thus, it is a more accurate measure than the measure of gross margin for examining farmers' average productivity performance in the short run.

(f) **Full Cost Basis Net Return :** This measure estimated gross output over total of variable and fixed costs. Fixed costs included the costs involved for the services of land, fixed labour and fixed capital. Two alternatives for computing cost of land use were adopted : (1) based on rental value of land ; and (2) based on interest on land value. Results from these two alternatives did not differ much probably because of the assumption of perfect market. Methods applied for estimating costs involved in the services of fixed labour (family and annually hired labour) and fixed capital used in crop production are given later.

Differences in per hectare average productivity with respect to farm size and tenurial status of land under each of the above efficiency measures were examined through estimation of indices. Statistical significance of these indices was tested by the estimated 't' values for index=100 under one-tail probability test.

(g) **Benefit-Cost Ratio :** Benefit-cost ratio refers to return per taka of cost. The benefit-cost ratios, i.e. returns per taka of cash cost and full cost for different crops and aggregate of all crops according to farm size and tenurial status of land were estimated.

Lau-Yotopoulos Profit Function Model

An operational model of measuring and judging the relative economic/productive efficiency has been developed by Lau and Yotopoulos in terms of unit-output-price profit function. The concept of economic efficiency is often decomposed into 'technical efficiency' and 'price/allocative efficiency'. While the former refers to the highest amount of output with given amounts of factor inputs, the later is the concept of efficiency with which the resources are allocated in the profit maximizing sense so that the marginal value products (of resources) are equal to the resource prices. Although these components of efficiency are at least conceptually independent of each other, an overall economic efficiency could be defined as the combination of 'technical' and 'price' efficiencies. Thus, economic efficiency=technical efficiency × price efficiency (Lau and Yotopoulos 1971 ; Farrell 1957).

The basic character of such a profit function is that the actual normalized restricted profit would be a decreasing function of the normalized prices of variable inputs while it would be an increasing function of the quantities of fixed inputs (like land and capital) and price of output (for details, see, Yotopoulos and Lau 1973 ; Lau and Yotopoulos 1972, 1971. Also see, Jabbar 1977 a ; Yotopoulos and Nugent 1976 ; Khusro 1973 ; Yotopoulos *et al.* 1970 ; Yotopoulos 1967). Thus, as is implied by the model, actual normalized profit function for two groups of farms/lands would differ to the extent that one or the other group would have higher technical and/or price efficiency.

The statistical test of relative economic efficiency as devised by the authors, lies in the estimation of profit function and utilizing a dummy variable distinguishing two different groups of farms/lands in order to test the significance of the value of its coefficient.

In this study, relative production efficiencies of small versus large farms, medium versus large farms, small versus medium farms, cropshare rented versus owned lands, cash rented versus owned lands, and crop-share rented versus cash rented lands were examined using Lau-Yotopoulos profit function model[7]. The concerned analytical framework, variables included and tests applied are explained below.

Analytical Framework of the Model

Lau-Yotopoulos profit function model was used in the following four forms :

$$\ln \pi_i = \ln \lambda_i + \delta L_i D_{Li} + \alpha_i \ln W_i + \beta_i \ln K_i + e_i \quad \ldots (I)$$

$$\ln \pi_i = \ln \lambda_i + \delta M_i D_{Mi} + \alpha_i \ln W_i + \beta_i \ln K_i + e_i \quad \ldots (II)$$

$$\ln \pi_i = \ln \lambda_i + \delta OW_i D_{Ow}i + \alpha_i \ln W_i + \beta_i \ln K_i + e_i \quad \ldots (III)$$

$$\ln \pi_i = \ln \lambda_i + \delta CR_i D_{CRi} + \alpha_i \ln W_i + \beta_i \ln K_i + e_i \quad \ldots (IV)$$

where, π is profit per hectare, W is the money wage rate, K is the capital input (in terms of service flows in takas) and D_L, D_M, D_{OW} and D_{CR} are the dummy variables ; α, β, λ, δL, δM, δOW and δCR are the coefficients to be estimated and e is the error term.

Land input has not been included in the model as the other variables are expressed on per hectare basis.

Variables Included in the Model

Profit (π) : Profit per hectare was defined as the total value of output per hectare minus the total wage bill per hectare. Profit thus includes interest on fixed capital and land rent. The actual profit per hectare was expressed in taka for the aggregate of crops studied.

Wage Rate (W) : It refers to the wage rate per day of an adult farm labourer. This variable was obtained by dividing the total wage bill by the number of days worked on the crop production. The wage bill for each farm was estimated by adding together the wages paid to the hired (casually and annually) labour and the imputed value of family and exchange labour. Family and exchange labour have been imputed according to the value of wages paid to annually hired labour. The wage rate per day of the annually hired labour has been worked out by dividing the total value of cash and kind wages paid annually to him by the total number of working days in a year.

Capital (K) : Capital input was expressed in terms of service flows in takas per hectare of the crop production. Two broad categories of capital have been distinguished: Fixed Capital and Working Capital. Fixed Capital items were again divided into two sub-categories ; live capital items (e.g., work animals) and non-live capital items (e.g., tools and equipment). Service flows for these two categories of fixed capital items were estimated, respectively, by the following equations[8]:

$$R_{jt}=\{rV_{jt}-(V_{j(t+1)}-V_{jt})\} \quad \ldots (1)$$

$$R_i=[rV_{oi} / (1-e^{-rT_i})] \quad \ldots (2)$$

where, R_{jt}=Current service flow of asset j in year t ;

R_i=Constant annual service flow of asset i ;

r=Discount rate ;

V_{jt}=Value of asset j at the beginning of year t ;

v_{oi}=Original undepreciated market value of asset i ;

T_i=Life expectancy of asset i.

Relevant maintenance and repair costs for each asset were added to the service flow.

Working capital included the costs of seeds/seedlings, organic manures, chemical fertilizers, irrigation, insecticides etc., applied in the cultivation of crops.

The sum of fixed capital service flows estimated on the basis of actual number of days of the capital items used in crop production and working capital values gave the total service flows of capital for the production of concerned crops. This total service flow of capital was expressed at takas per hectare.

Except labour input, for all other inputs, perfect market was assumed because prices of other inputs did not vary significantly among the sample farmers. Hence, only labour price was included in the model.

Dummy Variables : Four types of dummy variables have been used in the profit functions in order to capture the impact of farm size and tenurial status of land.

In form I, D_L, the dummy variable for large farms, takes the value of unity for large farms and zero otherwise. For comparing relative efficiency between small and large farms, $D_L=1$ in the case of large farms, and $D_L=0$ for small farms. Similarly, in testing the relative efficiency between medium and large farms, $D_L=1$ for large farms, and $D_L=0$ for medium farms.

In form II, D_M, the dummy variable for medium farms, takes the value of unity for medium farms and zero for small farms. That means, the dummy variable D_M has been applied for distinguishing small and medium farms.

In form III, D_{OW} is the dummy variable for owned land. It takes the value unity for owned land and zero for crophshere rented land when relative efficiency between owned land and crop-share rented land was examined. Again, it takes the value of unity for owned land and zero for cash rented land when comparison was made for owned versus cash rented land.

In form IV, D_{CR}, the dummy variable for cash rented land, takes the value of unity for cash rented land and zero for crop share rented land. That means, the dummy variable D_{α} was used for testing relative efficiency between cropshare rented and cash rented lands.

All the variables except the dummy variables were taken in natural logarithms. The estimates of the coefficients were obtained by the method of ordinary least squares.

The overall fitt of the models were tested by F-statistic. Significance of the coefficients of dummy variables was examined by one-tailed 't' test.

III. EMPIRICAL RESULTS

FARM SIZE AND LAND DISTRIBUTION

Average farm sizes of small, medium and large farmers were found to be 0.38, 1.23 and 3.13 hectares, respectively (Table 2). Land distribution among these farm size groups was highly skewed. Small farmers accounting for 50.5 per cent of the sample farmers shared only 18.4 per cent of the total cultivated area. Another 36.6 per cent were medium farmers who accounted for 43.1 per cent of the cultivated land. The remaining 12.9 per cent were large farmers cultivating 38.5 percent of the total cultivated area. Instability in farm size appeard to be the least on medium farmers followed by smallfarmers and large farmers. In strict sense, farm size of none of the specified size groups was stable, because variability in each case exceeded 20 per cent. Also, pattern of land ownership seemed to be seriously maladjusted with both size of farm family and proportion of members in productive age-group (Table 3).

TENURIAL STATUS OF LAND

Fifty seven per cent of the total cultivated holdings of the sample part-tenants was under ownership right, 38 per cent under crop-share renting and 5 per cent under cash renting. Half crop-sharing with sharing of half input (seed, fertilizer, irrigation and insecticide) cost accounted for 91 per cent of the total crop-share rented land. The remaining 9 per cent was also under half crop-sharing but without input cost sharing. Mandal (1980, p. 37) and Zaman (1973, pp. 149-172) found ample evidence of input sharing. However, Jabbar (1977b, p. 19) observed scanty evidence of cash renting and input sharing (mostly seeds) in the relatively backward region and argued that cash renting and input sharing may be less prevalent where concentration of land ownership and competition among tenants for renting land are greater[9].

FARM SIZE, TENURIAL STATUS OF LAND AND EFFICIENCY

Results of Partial Analysis

Crop Yields

Table 4 revealed that for TVs of both T. Aman and Boro paddy crops per hectare yield appeared to be higher on small farms (22.5 and 24.0 quintals, respectively) than on medium (22.1 and 22.0 quintals, respectively), and large farms (18.8 and 18.0 quintals, respectively). However, for HYVs of both T. Aman and Boro paddy crops per hectare yield appeared to be higher on medium farms (28.7 and 44.4 quintals, respectively) than on small (28.4 and 39.2 quintals, respectively) and large farms (26.4 and 35.4 quintals, respectively). Per hectare yield of wheat crop was found to be higher on large farms than on small and medium farms. But wheat crop accounted for only 3 per cent of the total cropped area. Estimated coefficients of variation suggest that per hectare yield of the selected crops with an exception of Boro paddy crop was more stable on small and large farms than on medium farms.

Although both small and medium farms compared to large farms had higher per hectare yield of either of the paddy crops (Table 4), yet the per hectare yield gap for TVs between small and large farms was observed to be greater than that between medium and large farms ; while the per hectare yield gap for HYVs between medium and large farms was greater than that between small and large farms (Table 5). On the other hand, although both small and medium farms compared to large farms had lower per hectare yield of wheat crop (Table 4), yet the per hectare yield gap between small and large farms was almost equal to that between medium and large farms (Table 5). Thus, since the per hectare yields of HYVs were remarkably higher as compared to TVs (Table 4), medium farms appeared to have the best yield performance.

In terms of per hectare crop yield rates and estimated yield indices thereof, the average productive performance tended to be higher on owned land than on any type of rented land for all the selected crops (Table 6 and 7). Compared to crop-share rented land with or without input cost sharing, cash rented land appeared to have higher yield of T. Aman (TV) paddy crop. However, the reverse was oserved in the case of T. Aman (HYV) paddy crop. For both TV and HYV of T. Aman paddy crop, crop-share rented land with input cost sharing achieved higher yield rate as compared to crop-share rented land without input cost sharing.

Gross Output, Gross Output over Material Cost, Gross Margin and Net Return

The results on productivity relation with farm size in terms of the indicated partial measures are presented in Table 8. Irrespective of the productive efficiency criterior., for all the selected crops with an exception of wheat crop, either small or medium farms achieved

higher productive performance relative to large farms. Dutta (1982, p. 80), based on value of output per hectare and value of output over wage bill per hectare in relation to paddy and wheat data from Ranchi district of Bihar (India), reported similar findings. However, quite a reverse situation was noted by Nandal *et al.* (1982, pp. 56, 69) based on net income per hectare in relation to paddy and wheat data from Haryana state (India).

In Most cases, medium farms had the highest productivity for HYVs of both T. Aman and Boro paddy crops (Table 8). The overall average productivity estimates resulted from all the indicated productive efficiency measures taking all the selected crops together also suggest that medium farms achieved the highest productive efficiency followed by small farms and large farms. Statistical significance for the differences in productive efficiency among different farm size groups were found to be established at desirable probability levels except some cases with gross output (Table 9).

Aggregate analysis of all the selected crops revealed that irrespective of productivity criterion part-tenants achieved the highest average productive performance on their owned land followed by cash rented land, crop-share rented land with input cost-sharing and cropshare rented land without input cost-sharing (Table 10). Statistical significance for the differences in productivity with respect to different tenurial status of land also appeared to be established at desirable probability levels except some differences in per hectare gross output and gross output over material cost between crop-share rented land with input cost-sharing and cash rented land, and some other differences in per hectare gross margin and cash cost basis net return between owned land and cash rented land (Table 11). However, higher productivity on owned land compared to rented land in general was observed to be significant under each and every productivity criterion at desirable probability levels.

Benefit-Cost Ratio

Irrespective of the indicated measures of benefit-cost ratio, either small or medium farms had higher benefit-cost ratio relative to large farms for all the paddy crops (either TV or HYV) ; exactly the reverse was observed in the case of wheat crop (Table 12). Aggregation of all the selected crops depicted that under all the alternative measures, benefit-cost ratio was the highest on medium farms followed by small farms and large farms. Nandal *et al.* (1985) found higher benefit-cost ratio on large farms than on small and medium farms in the case of Basmati paddy, dwarf paddy and desi wheat crops while in the case of dwarf wheat crop they observed an opposite situation. However, Singh (1975) found no significant differences in benefit-cost ratio between different farm size groups.

Benefit-cost ratios under different alternative measures for both individual crops and their aggregation with respect to tenurial status of land are shown in Table 13. Irres-

pective of the measures applied, part-tenants achieved the highest benefit-cost ratio either on owned or cash rented land for all the individual crops ; only exception was with T. Aman (HYV) paddy crop in which highest benefit-cost ratio (cash-cost basis) was observed on crop-share rented land with input cost sharing. Aggregation of crops showed that on cash-cost basis benefit-cost ratio was the highest on cash rented land followed by owned land, crop-share rented land with input cost sharing and crop-share rented land without input cost sharing. However, on full cost basis, benefit-cost ratio appeared to be the highest on owned land followed by cash rented land, crop-share rented land with input cost sharing and crop-share rented land without input cost sharing.

Results of Lau-Yotopoulos Profit Function Model

Regression results of Lau-Yotopoulos profit function model are interpreted here to test the following null hypotheses :

(1) Equal relative efficiency of different farm size groups ; and

(2) Equal relative efficiency of different tenure groups of lands.

Equal Relative Efficiency of Different Farm Size Groups

The two profit functions of the two farm size groups either small and large or medium and large or small and medium would be identical if both are equally technically and/or allocatively efficient. This would be reflected in the coefficient of dummy variable. The coefficient of the dummy variable differentiates the two groups of farms and the test becomes that the coefficient of the dummy variable is not significantly different from zero. Thus, the null hypothesis for testing the equal relative efficiency of either small and large farms or medium and large farms has been set up as follows :

$$Ho : \delta L=0$$

Similarly, the null hypothesis for testing the equal relative efficiency between small and medium farms was formulated as follows :

$$Ho : \delta M=0$$

Form I and form II of the profit function model provided results for testing the above two null hypotheses, respectively. The estimates of the coefficients and other related test statistics in relation to form I and form II of the model are given in Table 14.

The coefficient of the dummy variable for large farms (δL) in relation to form I of the profit function model for the comparison between either small and large farms or

medium and large farms turns out negative (Table 14) and is statistically significant at 98.75 per cent confidence level as indicated by the one-tailed 't' test. This implies that the profit function for large farms has a lower intercept term, suggesting lower level of economic efficiency compared to small and medium farms. However, with regard to comparison between small and medium farms, the coefficient of the dummy variable for medium farms (δM) in form II of the profit function model is significantly positive at 99.97 per cent confidence level, suggesting higher level of economic efficiency for medium farms compared to small farms. Thus, the above analysis of the relative efficiency shows that the medium farms achieved the highest efficiency followed by small farms and large farms. Hence, the null hypothesis of equal relative efficiency of different farm-size groups can be rejected[10].

The higher level of economic efficiency on medium and small farms relative to large farms was attributed to higher adoption rate of high-yielding crop varieties, self-decision making by farm operator and greater care and attention paid by the peasant family labour resulting from lesser dependence on hired labour. Timeliness of transplantation/sowing, better cultivation practices through use of more human and animal labour and application of balanced fertilizer-mix of N, P and K tended to uplift the medium farms in achieving the highest level of economic efficiency[11].

Equal Relative Efficiency of Different Tenure Groups of Lands

The two profit functions of the two tenure groups of lands either crop-share rented and owned or cash rented and owned or crop-share rented and cash rented would be identical if both are equally efficient. This would be reflected in the coefficient of dummy variable. The coefficient of the dummy variable differentiates the two tenure groups of lands and the test becomes that the coefficient of the dummy variable is not significantly different from zero. Thus the null hypothesis for testing the equal relative efficiency of either crop-share rented and owned lands or cash rented and owned lands has been set up as follows :

$$Ho : \delta OW = 0$$

In the similar vein, we have set up our null hypothesis for testing the equal relative efficiency between crop-share rented and cash rented lands as follows :

$$Ho : \delta CR = 0$$

Form III and Form IV of the profit function model provided results for testing the above two null hypotheses, respectively. The estimates of the coefficients and other related test statistics in relation to forms III and IV of the model are presented in Table 15.

The coefficient of the dummy variable for owned land (δOW) in relation to form III of the profit function model for the comparison of relative productive efficiency between either crop-share rented and owned lands or cash rented and owned lands appears to be positive (Table 15) and is statistically significant at 99.97 per cent confidence level as suggested by the one-tailed 't' test . This indicates that the profit function for owned land has a higher interecpt term,suggesting higher level of productive efficiency compared to crop-share rented and cash rented lands. Similarly, with respect to comparison of relative efficiency between crop-share rented and cash rented lands,the coefficient of the dummy variable for cash rented land (δCR) in form IV of the profit function is also significantly positive, implying higher productive efficiency on cash rented land than on crop-share rented land. Thus, the above analysis of the relative efficiency with respect to tenurial status of land reveals that the highest efficiency appeared to be achieved on owned land, followed by cash rented land and crop-share rented land. Therefore, the null hypothesis of equal relative efficiency for different tenure groups of lands can be rejected[12].

IV. SUMMARY AND POLICY IMPLICATIONS

Both partial and functional analyses revealed that medium farms achieved the highest production efficiency followed by small farms and large farms. Thus, according to the present study, unlike many other studies, the relationship between farm size and efficiency is neither positive nor negative throughout. If one moves from small farms to medium farms, the relationship is positive ; and if one moves from medium farms to large farms, it is negative.

Production efficiency tended to be adversely affected by the mechanism of land tenancy. Inter-rental system comparison revealed that part-tenant farmers achieved higher production efficiency on cash rented land than on crop-share rented land. Incidence of input cost sharing enhanced production performance on crop-share rented land. However, cash renting system appeared to be the better mechanism than crop-share renting system even with input cost sharing.

The direct policy implications of the pointers in relation to size-efficiency relationships would be that land transfer from large farmers to small farmers might improve agricultural productivity for the economy. At the very least, the results indicate that policies with respect to ceilings on land holdings and land redistribution can be guided not only by equity considerati on, as there will be efficiency improvements also.

The policy implications emerging from the tenancy-efficiency relationships lead to recommend that the mechanism of land tenancy should be abolished through a series of land reform measures. If such major land reform measures are not feasible under the existing political ideology of the government, cash renting rather than cropshare renting should be encouraged through legal policy actions. If crop-share renting is not

abolished, legal provisions are to be made for sharing variable inputs in proportion to the crop share.

NOTES :

1. Although the average size of holding per farm in Bangladesh is small (slightly greater than 3 acres), yet its distribution is highly skewed. Slightly less than 10 per cent of all rural households own almost 51 per cent of all cultivated lands, slightly more than 22 per cent of all rural households own nearly 75 per cent of all cultivated lands. Most of the cultivable lands are not cultivated by owners. Only 10.47 per cent of all cultivable lands are under owner cultivation with mostly family labour. Major portion of land is cultivated by pure tenants (4.39 per cent), part-tenants (30.48 per cent) and owners with mostly hired labour (43.48 per cent). Around 23 per cent of which is transacted under crop-sharing arrangements, the principal form being half crop share without sharing of inputs (Bangladesh 1977). These size-tenurial features of Bangladesh agriculture are generally considered as hindrances to higher level of production efficiency (Alam 1974, pp. 15-36 ; Bangladesh 1973, pp. 5, 187 ; Khan 1972, pp. 52-53).
2. This category of farmers neither rent out nor rent in any land. Therefore, degree of tenancy for such farmers is zero.
3. Square root method was found to be better and more efficient than simple cumulative method and cube root method.
4. Some studies in Bangladesh (e.g., Jabbar 1977a, Mandal 1980) used non-random samples. However, random samples are preferred to non-random samples. Because, "a good sample is one from which generalizations to the population can be made ; a bad sample is one from which they cannot be made. To generalize from a sample to a population, we need to be able to deduce from any assumptions about the population whether the observed sample is within the range of sampling variation that might occur for that population under the given method of sampling. Such deductions can be made if and only if the laws of mathematical probability apply. The purpose of randomness is to ensure that these laws do apply." (Ostle and Mensing 1975, p. 51).
5. The formula for proportional allocation is as follows :

$$n_h = \frac{nN_h}{N}$$

Where, n_h = Sample size in h_{th} stratum
n = Sample size
N_h = Total population in h_{th} stratum
N = Total population.

6. If the sample includes both owner and tenant farms, it may be difficult to disentangle the impact of farm size from tenancy effects. Unfortunately, a number of field level studies conducted in India (Nandal *et al.* 1985, 1982 ; Dutta 1982 ; Pandey and Sarup 1981 ; Pal and Pal 1981; Sampath 1979 ; Singh 1975 ; Saini 1969 ; Sen 1967), Pakistan (Khan and Maki 1979 ; Khan 1977) and Iran (Soltani 1978) examined size-efficiency relationships from the sample of both owner and tenant farms rather than the sample of owner farms alone. Hossain (1977) and

Mandal (1980), in their studies conducted in Bangladesh, tried to take off this deficiency through selecting the sample of owner farms alone. However, the definition of owner farm in Hossain's study was pointed out to be questionable because he included part-tenant farms with less than 25 per cent rented land of cultivated holding in the sample of owner farms (Mandal 1980, p. 22).

7. Saini (1969) ; Singh (1975) ; Dhawan and Bansal (1977) and many other investigators applied Cobb-Douglas Production Function technique in studying size-efficiency relationships. However, the whole approach of examining the allocative efficiency of farmers by using Cobb-Douglas production function and judging it on the criterion of the equality of marginal value product (at the geometric mean of input) to the market price of inputs, which is relevent for the 'average farms' has been questioned (Rudra 1973, pp. 107-112). It has been contended that "the equality of market price to the marginal value product at average point directly implies that one section of the farmers is over-allocating the resource concerned and the remaining under-allocating it. In other words, every individual farm is - by the assumption of the model itself-inefficient." (*ibid*, pp. 109-110). Moreover, Cobb-Douglas production function ignores the problem of technical efficiency by assuming that all the techniques of production (and, thereby, the isoquants) are identical across farms and as such everybody has achieved perfect technical efficiency. In other words, by implication, it assumes that there are no differences in entrepreneurial ability, managerial capacity and technical know-how among different farms as far as the use of technology is considered (Sampath 1979, p. 18). But, in practice, it is not so. Hence, the estimates of production function approach to measuring efficiency may contain simultaneous equation bias (also see, Jabbar 1977a, p. 21). Some researchers (Lau and Yotopoulos 1971 ; Yotopoulos and Lau 1973 ; Sidhu 1974 ; Khan and Maki 1979 ; Dutta 1982) tried to remove the above mentioned methodological flaws in mesuring efficiency by using a unit-output price (UOP) profit function.

8. For details, see, Jabbar (1977a) and Yotopoulos (1966). Some investigators used the capital stock concept for the estimation of service flows from the fixed capital items and found negative coefficients and high standard errors. For a critical discussion on the reasons behind such unsatisfactory results using the capital stock concept, see, Yotopoulos (1967, pp. 483-485) and Griliches (1960, pp. 1416-1427).

9. For a theoretical and empirical discussion on the relationship between technology, wage rate and incidence of share-cropping, see, Bardhan and Srinivasan (1971, pp. 48-64).

10. Equal relative efficiency of different farm size groups was also rejected by Sen (1962, 1964, 1966) ; Mazumdar (1963) ; Sen (1967) ; Lau and Yotopoulos (1971) ; Yotopoulos and Lau (1973) ; Dhawan and Bansal (1977) ; Sampath (1979) ; Pandey and Sarup (1981) and Roy (1982). They all reported higher efficiency of small farms relative to large farms. On the contrary, Soltani (1978) ; Khan and Maki (1979) and Nandal *et al.* (1985) observed better performance of large farms compared to small farms. However, Yotopoulos (1968) ; Sidhu (1974) ; Singh (1975) and Nandal *et al.* (1982) found evidences to accept equal relative efficiency of different farm size groups.

11. For empirical results and discussions see, Bhuiyan (1986; pp. 106-107, 114-116, 128, 131, 134-135 162-166).

12. This hypothesis has also been rejected by a number of other studies (Rai *et al.*, 1981 ; Hossain 1980 ; Talukder 1980 ; Mandal 1979 ; Bell 1977 ; Jabbar 1977a). All these studies have shown negative effects of land tenancy on productive efficiency in the context of Bangladesh and Indian agriculture. Pal and Pal (1981) in their West Bengal (India) study observed a positive impact of tenancy on paddy and other foodgrains but a negatve impact on wheat and jute. Ghose (1981) in Burdwan district of West Bengal found higher productive efficiency on cash rented land than on crop-share rented land.

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TABLE 1. PROPORTIONAL ALLOCATION OF SELECTED PURE OWNER-OPERATORS INTO DIFFERENT FARM SIZE GROUPS

Farm size groups	Cultivated holding (ha.)	Total number of pure owner operators	% total population	Number of sample pure owner-operators	% total sample
Small	Below 0.75	207	50.5	51	50.5
Medium	0.75-2.00	150	36.6	37	36.6.
Large	Above 2.00	53	12.9	13	12.9
All size groups		410	100.0	101	100.0

TABLE 2. DISTRIBUTION OF SAMPLE FARMERS AND CULTIVATED AREA, AVERAGE AND COEFFICIENT OF VARIATION OF FARM SIZE

Size groups	% farmers	% cultivated area	Average farm size (ha.)	Coefficient of variation
Small	50.5	18.4	0.38	43.8
Medium	36.6	43.1	1.23	29.4
Large	12.9	38.5	3.13	45.7
All size groups	100.0	100.0	1.04	38.3

TABLE 3. MALADJUSTMENT OF LAND OWNERSHIP WITH RESPECT TO FAMILY SIZE AND MEMBERS IN PRODUCTIVE AGE GROUP

Comparison criteria (2nd compared to 1st)	% difference in		
	Family size	Members in productive age-group[a]	Owned land
Small vs. Medium	+44.4**	+56.0*	+223.7**
Medium vs. Large	+29.5*	+48.7*	+154.5**
Small vs. Large	+87.0***	+132.0***	+723.7***

a. 15-59 years.

***, **, * indicate that 't' values estimated from separate variances significant at least at 1, 5 and 10 percent level, respectively.

TABLE 4. AVERAGE AND COEFFICIENT OF VARIATION OF YIELD PER HECTARE OF SELECTED CROPS BY FARM SIZE

Size groups	T. Aman		Boro		Wheat
	TV	HYV	TV	HYV	
	Yield per hectare (in quintals)				
Small	22.5	28.4	24.0	39.2	9.1
Medium	22.1	28.7	22.0	44.4	9.2
Large	18.8	26.4	18.0	35.4	14.3
All groups	20.1	27.9	22.1	38.4	9.8
	Coefficient of variation				
Small	25.4	20.9	34.3	48.4	46.7
Medium	33.4	32.0	34.5	32.6	52.4
Large	24.3	25.9	35.8	33.9	25.6
All groups	27.4	26.3	36.7	40.1	47.3

T. Aman means Transplanted Aman.
TV means Traditional Variety.
HYV means High Yielding Variety.

TABLE 5. INTERRELATIONSHIP BETWEEN FARM SIZE AND CROP YIELD IN TERMS OF INDICES

Comparison criterion	Yield indices for the selected crops				
	T. Aman		Boro		Wheat
	TV	HYV	TV	HYV	
Small with Medium=100	101.8	98.9	109.1	88.3	98.9
Small with Large=100	119.7	107.6	133.3	110.7	63.7
Medium with Large=100	117.5	108.7	122.2	125.4	64.3

TABLE 6. PER HECTARE AVERAGE YIELD OF SELECTED CROPS BY TENURIAL STATUS OF LAND

Tenurial status of land	Yield per hectare (in quintals)				
	T. Aman		Boro		Wheat
	TV	HYV	TV	HYV	
Owned (a)	21.3	26.5	21.7	39.0	11.9
Share rented with cost shared (b)	20.0	22.8	15.8	32.5	9.8
Share rented without cost shared (c)	9.9	22.1	NA	NA	NA
Cash rented (d)	20.4	20.2	NA	NA	NA
All rented (b, c & d)	19.4	22.5	15.8	32.5	9.8
Owned and all rented (a, b, c & d)	20.3	25.0	18.3	36.3	11.0

NA means Not Available.

TABLE 7. INTERRELATIONSHIP BETWEEN TENURIAL STATUS OF LAND AND CROP YIELD IN TERMS OF INDICES

Comparison criterion	Yield indices for the indicated crops				
	T. Aman		Boro		Wheat
	TV	HYV	TV	HYV	
Owned with Share rented with cost shared=100	106.5	116.2	137.3	120.0	121.4
Owned with Share rented without cost shared=100	215.1	119.9	NA	NA	NA
Owned with Cash rented=100	104.4	131.2	NA	NA	NA
Owned with All rented=100	109.8	117.8	137.3	120.0	121.4
Share rented with cost shared with Share rented without cost shared=100	202.0	103.2	NA	NA	NA
Share rented with cost shared with Cash rented=100	98.0	112.9	NA	NA	NA
Share rented without cost shared with Cash rented=100	48.5	109.4	NA	NA	NA

[illegible] AVERAGE PRODUCTIVITY PER HECTARE BY FARM SIZE FOR THE SELECTED CROPS

Size groups	T. Aman		Boro		Wheat	All Crops
	TV	HYV	TV	HYV		
	Gross ouput in taka					
Small	13760	17782	13760	18820	5450	14360
Medium	13539	17956	12874	21253	5493	15076
Large	11720	16627	11101	16944	7721	13798
All groups	12437	17494	12873	18451	5769	14298
	Gross output over material cost in taka					
Small	12239	16014	11678	13861	3784	12434
Medium	12218	16229	10516	17152	3504	13367
Large	9499	14196	8607	10433	5941	10822
All groups	10719	15508	10553	12812	3972	12092
	Gross margin in taka					
Small	10626	14264	9487	11001	2970	10740
Medium	10931	14174	8269	13854	3149	11700
Large	6895	11697	6218	6690	4741	8235
All groups	8948	13357	8242	9330	3278	10068
	Net return in taka[a]					
Small	10769	14471	9480	11076	3245	10904
Medium	11016	14310	8244	13909	3565	11813
Large	6876	11728	6251	6964	5045	8280
All groups	9000	13472	8235	9515	3611	10165
	Net return in taka[b]					
Small	4626	7979	4246	3946	—1442	4857
Medium	4363	7801	1962	7943	—2155	5316
Large	1484	5841	330	—102	—1109	2466
All groups	2830	7164	2459	2722	—1655	3967
	Net return in taka[c]					
Small	4281	7635	4901	5469	—1096	4836
Medium	4325	7771	2740	8463	—1253	5401
Large	1170	5527	878	979	48	2420
All groups	2694	7028	3144	3786	—1004	4035

a. Cash cost basis ; b. Full cost taking rental value of land ; c. Full cost taking interest on land value.

TABLE 9. INTERRELATIONSHIP BETWEEN FARM SIZE AND PRODUCTIVITY FOR THE AGGREGATE OF SELECTED CROPS

Comparison	Gross output	Gross output over material cost	Gross margin[a]	Net return[b]	Net ruern[c]	Net return[d]
Small with Medium=100	95.2 (0.227)	93.0 (0.050)	91.8 (0.017)	92.3 (0.015)	91.4 (0.018)	89.5 (0.001)
Small with Large=100	104.1 (0.251)	114.9 (0.043)	130.4 (0.028)	131.7 (0.039)	196.9 (0.006)	199.8 (0.004)
Medium with Large=100	109.3 (0.103)	123.5 (0.054)	142.1 (0.036)	142.7 (0.015)	215.7 (0.012)	223.2 (0.014)

a. Return over variable cost.
b. Cash cost bosis.
c. Full cost basis (taking rental value of land).
d. Full cost basis (taking interest on land value)

Note : Figures in parentheses represent level of significance of the estimated 't' values for index = 100 under one-tail probability test.

TABLE 10. AVERAGE PRODUCTIVITY PER HECTARE BY TENURIAL STATUS OF LAND FOR THE SELECTED CROPS

Tenurial status of land	Per hectare productivity in taka under different productivity measures					
	Gross output	Gross output over material cost	Gross margin[a]	Net return[b]	Net return[c]	Net return[d]
Owned	13998	11958	10505	10607	3735	4099
Share rented with cost shared	11875	10026	8797	8837	1621	2238
Share rented without cost shared	9490	7788	6379	6305	—15	190
Cash rented	12252	10513	9515	9612	2984	2640
All rented	11772	9940	8722	8758	1637	2155
Owned and all rented	12982	11035	9686	9759	2776	3209

a. Return over variable cost.
b. Cash cost basis.
c. Full cost basis (taking rental value of land)
d. Full cost basis (taking interest on land value)

TABLE 11. INTERRELATIONSHIP BETWEEN TENURIAL STATUS OF LAND AND PRODUCTIVITY

Comparison criterion	Indices in relation to indicated measures of productive efficiency					
	Gross output	Gross output over material cost	Gross margin[a]	Net return[b]	Net return[c]	Net return[d]
Owned with Share rented with cost shared=100	117.9 (0.091)	119.3 (0.100)	119.4 (0.082)	120.0 (0.101)	230.4 (0.005)	183.1 (0.003)
Owned with Share rented without cost shared=100	147.5 (0.010)	153.5 (0.032)	164.7 (0.017)	168.2 (0.002)	NA	2157.4 (0.001)
Owned with Cash rented=100	114.2 (0.104)	113.7 (0.102)	110.4 (0.154)	110.3 (0.267)	125.2 (0.052)	155.3 (0.012)
Owned with All rented=100	118.9 (0.051)	120.3 (0.053)	120.4 (0.044)	121.1 (0.050)	228.2 (0.001)	190.2 (0.005)
Share rented with cost shared with Share rented without cost shared=100	125.1 (0.010)	128.7 (0.022)	137.9 (0.017)	140.1 (0.003)	NA	1177.9 (0.007)
Share rented with cost shared with Cash rented=100	96.9 (0.492)	95.4 (0.567)	92.4 (0.101)	91.9 (0.100)	54.3 (0.011)	84.4 (0.008)
Share rented without cost shared With Cash rented=100	77.4 (0.007)	74.1 (0.002)	67.0 (0.005)	65.6 (0.001)	NA	7.2 (0.023)

NA means Not Applicable.

a. Retutn over variable cost.
b. Cash cost basis.
c. Full cost basis (taking rental value of land).
d. Full cost basis (taking interest on land value).

Note : Bracketed figures are levels of significance of the estimatted 't' values for index = 100 under one-tail probability test.

TABLE 12. EFFECT OF FARM SIZE ON BENEFIT-COST RATIO FOR THE SELECTED CROPS

Size groups	Benefit-cost ratio		
	Cash cost basis	Full cost basis[1]	Full cast basis[2]
		T. Aman (TV)	
Small	4.60	1.51	1.45
Medium	5.37	1.47	1.47
Large	2.42	1.14	1.11
All groups	3.62	1.29	1.28
		T. Aman (HYV)	
Small	5.37	1.81	1.75
Medium	4.92	1.77	1.76
Large	3.39	1.54	1.50
All groups	4.35	1.69	1.67
		Boro (TNV)	
Small	3.21	1.45	1.55
Medium	2.78	1.18	1.27
Large	2.29	1.03	1.08
All groups	2.77	1.24	1.32
		Boro (HYV)	
Small	2.43	1.26	1.41
Medium	2.89	1.60	1.66
Large	1.70	0.99	1.06
All groups	2.06	1.17	1.26
		What	
Small	2.47	0.79	0.83
Medium	2.85	0.72	0 81
Large	2.88	0.87	1.01
All groups	2.67	0.78	0.85
		All crops	
Small	4.15	1.51	1.51
Medium	4.62	1.54	1.56
Large	2.50	1.22	1.21
All groups	3.46	1.38	1.39

1. Based on rental value of land.
2. Based on interest on land value.

TABLE 13. EFFECT OF TENURIAL STATUS OF LAND ON BENEFIT-COST RATIO FOR THE SELECTED CROPS

Tenurial status of land	Benefit-cost ratio		
	Cash cost basis	Full cost basis[1]	Full cost basis[2]
		T. Aman (TV)	
Owned (a)	4.22	1.30	1.32
Share rented with cost shared (b)	4.80	1.22	1.30
Share rented without cost shared (c)	2.08	0.70	0.72
Cash rented (d)	5.20	1.34	1.28
All rented (b, c & d)	4.63	1.20	1.26
Owned and all rented (a, b, c & Dd)	4.38	1.25	1.25
		T. Aman (HYV)	
Owned (a)	5.61	1.70	1.71
Share rented with cost shared (b)	5.63	1.46	1.46
Share rented without cost shared (c)	4.11	1.38	1.40
Cash rented (d)	3.74	1.28	1.26
All rented (b, c & d)	5.23	1.43	1.43
Owned and all rented (a, b, c & d)	5.48	1.60	1.60
		Boro (TV)	
Owned (a)	3.27	1.19	1.32
Share rented with cost shared (b)	2.64	0.90	0.99
Owned and rented (a & b)	2.93	1.03	1.14
		Boro (HYV)	
Owned (a)	2.34	1.11	1.24
Share rented with cost shared (b)	2.00	0.91	1.02
Owned and rented (a & b)	2.21	1.03	1.15
		Wheat	
Owned (a)	4.08	0.84	0.95
Share rented with cost shared (b)	2.55	0.71	0.75
Owned and rented (a & b)	3.34	0.78	0.86
		All crops	
Owned (a)	4.13	1.36	1.41
Share rented with cost shared (b)	3.91	1.16	1.23
Share rented without cost shared (c)	2.98	0.99	1.02
Cash rented (d)	4.64	1.32	1.27
All rented (b, c & d)	3.90	1.17	1.22
Owned and all rented (a, b, c & d)	4.03	1.27	1.33

1. Based on rental value of land.
2. Based on interest on land value.

TABLE 14. REGRESSION RESULTS OF PROFIT FUNCTION FOR COMPARISON OF RELATIVE EFFICIENCY IN DIFFERENT FARM SIZE GROUPS

Comparison base	Number of observations	λ	δL	δM	α	β	R^2	F	Fo. 01
			Form I (H_O : $\delta L=0$; $H_1=\delta L<0$)						
Small & Large	64	5.97264	-0.38425** (0.16148)		-0.04203 (0.00513)	0.16327 (0.03912)	0.785	111.36	7.08 (1,60)
Medium & Large	50	6.82395	-0.49232** (0.21478)		-0.05541 (0.00711)	0.29164 (0.05833)	0.798	92.85	7.15 (1.46)
			Form II (H_O : $\delta M=0$; $H_1=\delta M>0$)						
Small & Medium	88	7.17792		0.10062* (0.00337)	-0.02835 (0.00079)	0.14628 (0.00371)	0.774	145.55	6.94 (1.84)

Figures in patentheses under the estimates of coefficients indicate standard errors of estimates while those under F0.01 indicate the degree of freedom for numerator and denominator, respectively.

** and * Indicate values significant respcitively at 99.97 and 98.75 percent confidence level.

TAZLE 15. REGRESSION RESULTS OF PROFIT FUNCTION FOR COMPARISON OF RELATIVE EFFICENCY IN DIFFERENT TENURE GROUPS OF LAND

Comparison base	Number of observations	λ	δOW	δCR	α	β	R^2	F	F0.01
			Form I		(H_o : δOW=O ; H_1 : δOW<O)				
Share rented and owned	190	4.28345	0.18670** (0.00485)		-0.03621 (0.00085)	0.18207 (0.02078)	0.627	157.17	6.63 (1,86)
Cash rented and owned	120	5.88342	0.11247** (0.00391)		-0.04681 (0.00021)	0.20411 (0.01992)	0.729	117.01	6.86 (1,116)
			Form II		(H_o : δCR=0 ; H_1 : δCR>O)				
Share rented and Cash rented	110	6.64128		0.14773** (0.00245)	-0.02998 (0.00043)	0.19572 (0.02451)	0.706	128.47	6.90 (1,106)

Figures in brackets under the estimates of coefficients indicate standard errors of estimates while those under F0.01 indicate the degrees of freedom for the numerator and denominator, respectively.

** indicate 't' value significant at least at 99.97 percent confidence level.