Bangladesh J. Agric. Econs. XVI, 1 (June 1993): 49-57

Research Note

RESOURCE USE EFFICIENCY IN HYV BORO PADDY PRODUCTION IN SOME SELECTED AREAS OF BRAHMAN BARIA DISTRICT

Khandaker Md. Mostafizur Rahman, Md. Iqbal Hossain and Md. Ferdous Alam

ABSTRACT

Input use efficiency and productivity of different sizes of farms producing FIYV Boro in some selected areas of Brahman Baria district were investigated by employing primarily a Cobb-Douglas production function. Returns to scale and farmer's capability of producing at the least cost level were statistically tested. Farm size and productivity relationships were found to be positive. Boro production was characterized by increasing return to scale for only the medium farms. Few inputs were used in Boro production at the least cost combination level. Adequate extension services including application of right quantity of inputs at right times may help achieve efficiency in input use and improve profitability.

1. INTRODUCTION

Resource use and production under different size/tenure groups of farms in less developed countries has been one of the most widely discussed and controversial issue in development literature. Schultz (1964), Hopper (1965), Chennareddy (1967), and Yotopoulos and Nugent (1976) observed no significant inefficiency in agriculture resource use in less developed countries. They attributed alleged low productivity of different farm resources mainly to relative factor endowments, e.g., unskilled labour relative to limited land and capital.

In contrast, Myrdal (1968, 1979) showed that considerable difference exists in resource use and production efficiency between different size/tenure groups. A few studies such as, Mandal (1980), Bhuiyan (1987) observed that input productivity increases upto certain farin size limit and then decreases as farm size increases. Sen (1962, 1964), Mazumdar (1963, 1965), Khusro (1964) and Hossain (1977) observed the existence of an inverse relationship between fann size and productivity, and farm size and resource use efficiency. Raj (1964) and Rao (1967), on the other hand, found no significant relationship between farm size and productivity, and *farm* size and resource use efficiency.
Therefore, the issues regarding the existence of actual relationship between fann size, productivity and resource use efficiency have remained inconclusive. The relationship is perhaps influenced by the state-of-art. A divisible and scale neutral technology may exhibit a

The authors are Lecturer and Professors respectively of the Department of Agricultural Statistics (the first and the second) and Agricultural Finance, Bangladesh Agricultural University, Mymensingh. The authors are grateful to the anonymous referees of the Journal for their useful comments on an earlier draft of this note. However, the authors are entirely responsible for the remaining errors, if any.

quite different picture in terms of productivity-efficiency and farm size than a non-divisible technology. Thus, the relationship observed at a point of time in the past may not hold to situations of to-day. Whatever relationship exists, the phenomenon is of crucial importance particularly in an economy like Bangladesh where land ownership is highly unequal, per hectare productivity of crops is low, per capita land is highly inadequate and where a large number of small, medium and marginal farms steer the agriculture. Besides, the implicit objective behind the provision of subsidized inputs and output price support is to make use of the full potential of the available technology, boost up production and achieve efficiency in resource use. Investigation relating to resource use efficiency is, therefore, very important in order to know whether technological improvement has brought any change in the inputs use.

The present paper aims at examining the relationship of inputs productivity and resource use efficiency with farm size in the production of Boro paddy. In particular, returns to scale, efficiency in input allocation and farmer's capability of producing at the least cost level are investigated. In section II, methodology is discussed. Findings of the study are presented in section III. Conclusions are drawn in section IV.

II. METHODOLOGY

Data

Data for the present study were collected in 1991 from selected farmers of five villages namely, Srirampur, Gopalpur, Aliabad, Nabibagar and Alamnagar of Brahman Baria district. Selection of district was purposive while random sampling procedure was applied in selecting the villages. Sampling frames for the Boro paddy producers of the chosen villages were prepared. Boro producers were further categorized into three groups: small farmers less than 1.o hectare; medium farmer - 1.00 to 2.00 hectares and large farmer-more than 2.00 hectares of Boro paddy. Selection of farmers was made from these sub-samples. Finally, stratified random sampling procedure was then followed to select the desired number of farmers based on a fixed proportion of the sub-populations of the strata. A total of 100 farms comprising 50 small 30 medium and 20 large farm were finally selected for the study.

The Model

A Cobb-Douglous production function of the following logarithmic form was specified :

$$\text{Log } Y = \text{Log}a_0 + \sum_{i=1}^{6} a_i \text{ Log}X_i + u \qquad [1]$$

Where :

Y = Value of main product and by-product (in Taka)

X_1 = Area under HYV Boro paddy (in hectare)

X_2 = Value of seedling (in Taka)

X_3 = Value of fertilizer and manure (in Taka)

X_4 = Human labour (in man days)

X_5 = Bullock power (in pair days)

X_6 = Cost of irrigation (in Taka)

u = Random error term.

Hypothesis relating to return to scale was tested by applying a t-test. Marginal productivities of inputs were derived from the estimated parameters of the production function.

Allocative Efficiency

Allocative efficiency of the factor inputs was defined as the ratio of marginal value products[1] to the marginal factor input costs. The allocative efficiency coefficient R_i was defined as:

$$R_i = a_i \,.\, \overline{Y}/\overline{X}_i .\, P_y/Px_i$$

where $\overline{X}_i$ and $\overline{Y}$ represent arithmetic means of ith input factor and output respectively. P_Y and Px_i are respectively per unit output and price of i'th input-factor while a_i is the elasticity coefficient of the i'th input factor.

If R_i is equal to 1, then input factor is efficiently utilized (the farms are price efficient). R_i value less than 1 implies overutilization while that of more than 1 suggests underutilization of factor inputs. A t-test was applied to examine whether input utilization is significantly different from 1.

Least Cost Combination

Least Cost Combination of input (LCCI) for different types of farms were computed. If two or more factors are employed in production of a single product, cost is at a minimum when the ratio of factor prices is inversely equal to the marginal rate of technical substitution (MRTS) of the factors. Since land is a scarce input, immovable and farmers have limited flexibility of changing areas under HYV Boro paddy cultivation, the level of the use of land is taken as constant and the LCCIs of inputs excluding land were computed.

$$MRTS_{x2xi} = P_{xi}/P_{x2}, \text{ or}$$

$$a_i x_2 / a_2 x_i = P_{xi}/P_2 \qquad [3]$$

Equation [3], after some manipulations, can be shown as:

$$\overline{X}_2 = a_2 / a_i \,.\, P_{xi}/P_{xi} .\, x_i$$

$$\overline{X}_i = a_i \, Px_2 \, x_2 / a_2 \, Px_i \qquad [4]$$

By substituting all the variables except land in the form of seedling (x_2) in the production function [1], the following equation is obtained:

$$\text{Log}\,\overline{X}_2 = \frac{\text{Log}Y - \log a_0 - a_1 \log x_1 - \sum_{i=3}^{NV}[a_i .\, \log(a_i/a_2 \,.\, Px_2/Px_i)]}{\sum_{i=2}^{NV} a_i} \qquad [5]$$

Thus, $\overline{X}_2$ = antilong (log $\overline{X}_2$)
where :

NV = number of independent variables.

Px_i = price of i'th variable.

By plugging the value of $\overline{X}_2$ in equation [4] and taking i = 2 to NV, the Least Cost Combinations of Input (LCCI) were estimated for the HYV Boro Paddy.

III. FINDINGS OF THE STUDY

Results of the estimated production functions of different types of farmers are presented in Table 1. In terms of R^2 and F values, the goodness of fit of all the equations are good. The six inputs explained a maximum of 95 per cent of the variations of Boro production. As far as aggregate production function is concerned, areas under Boro and human labour appeared to be the most important variables significant at 0.01 probability level contributing postitively to the Boro paddy production. Seedlings appeared negative and significant at 0.05 level of probability. Fertilizer-manure, bullock power and irrigation did not show significant effect on the production of Boro paddy.

The negative algebraic signs and statistical significance of seedlings" variable for the all farms and "fertilizer-manure" for large farm estimates are rather unexpected and requires adequate explanations as these should usually positively contribute to the production. High complementarities exist among HYV seeds, fertilizer and irrigation. These three inputs (technology) work as a package. Therefore, it is difficult to dissociate actual effect of individual input in isolation. The appearance of the unexpected signs may thus sometimes unavoidable. Moreover, the exact combination of inputs favourable for production may not be known with certainty. Therefore, the overutilization as well as underutilization of each of these inputs might have resulted in such unexpected relationship.

In cases of small and medium farms, the directions of inputs contribution are more or less similar although magnitudes differ. Areas, fertilizer-manure and human labour appeared significant in Boro paddy production for small farms. On the contrary, only human labour and bullock power are significant for the medium farms. Estimates of large farms seem to be quite different in terms of signs. magnitudes and R^2 from those of the small and medium farms.

In order to examine the size productivity relationship, value of Boro output was regressed against only Boro areas (equation shown in Table 2). The value of adjusted R^2 ranged from 0.64 to a maximum of 0.93 along with positive algebraic signs and high statistical significance at 0.01 level. This demonstrates that size-productivity relationship is positive irrespective of types of farm (Table 2).

Returns to scale for small, medium and large farms were estimated to be 0.99, 2.46 and 0.47 (Table 3). These indicate that production function is characterized by decreasing return to scale for the small farms, increasing return to scale for the medium farms and decreasing return to scale for the large farms.

The aggregate production function was, however, found to have been characterized by increasing return to scale. These results are consistent with those of Ghosh (1973), Mandal (1980) and Bhuiyan (1987). Of the three categories, medium farms were observed to be relatively better-off as their production is characterized by increasing return to scale[2]

Allocative efficiency coefficients of land, seedlings, fertilizer-manure, human labour, bullock power and irrigation are presented in Table 4. The allocative efficiency coefficients of seedling are statistically significant at 0.01 probability level and less than unity irrespective of farm size implying that farmers made overuse of seedlings. Allocative efficiency coefficients of fertilizer-manure are not statistically different from unity for small, medium and aggreagated all farms but it is significantly different for the large farm. Statistical significance along with negative sign for the large farms suggest that overuse of fertilizer-manure took place. All farm (aggregate) estimates, however, show that fertilizer allocation is efficient.

In so far as the allocation of human labour of specific farm size is concerned, it is efficient as the actual coefficient is not significantly different from unity. However, taken all farms together, the allocative efficiency coefficient of the same suggests that underuse of human labour characterizes the underlying Boro paddy production. Only the medium farm's allocative efficiency coefficient of bullock power is found to be significantly greater than unity while allocation of the same for other farm was consistent with unity as the coefficients were not statistically significant. Coefficient significantly higher than unity for the medium farm implies that bullock power was underused in Boro paddy production. One plausible explanation is that during the land preparation stage price of animal power was very high and since most of the medium farmers own animal power they sold it to others to earn monetary income. The allocative efficiency coefficients of irrigation of all the different sizes of farms are statistically insignificant indicating that expenses incurred for irrigation in cultivating Boro paddy were in line with efficiency.

Least Cost Combination of variable inputs are shown in Table 5. The existing combination of inputs of small farms are higher than the least cost combination for seedlings, bullock power and irrigation whereas it is lower for fertilizer-manure and human labour. In case of medium farms, existing cost of irrigation, fertilizer-manure and seedlings are higher than LOCI while that of the bullock power and human labour are lower than LCCI level. The existing input combinations of the large farms are all higher than the least cost level. All these suggest that farmers both undershoot as well as overshoot the point of Least Cost Combination of inputs. Most of the material input utilization are higher than least cost combination. These imply that farmers do not have the required technical knowledge on input mix which affects the production of HYV.

IV. CONCLUSIONS

The six variables namely, HYV areas, seedling, fertilizer-manure, human labour, bullock power and irrigation cost could explain 74 to 95 per cent of the variation of HYV Boro production. HYV area, fertilizer and human labour appeared to be the most important factors in Boro production. The positive algebraic signs for area under HYV Boro paddy and its statistical significance ensure that size-productivity relationship is positive for all types of farms. Diseconomies of scale exists for the small and large farms while economies of scale operate for the medium farms.

Seedling has been overutilized by each of the small, medium and large farmers. As far as fertilizer-manure application is concerned, small and medium farms' utilization is economically efficient but it is overtilized by the large farm. Allocation of human labour and irrigation was efficient irrespective of farm size. Allocation of bullock power appears to be economically efficient for small and large farms but it is heavily underutilized by the medium farms. Existing combination of most of the material inputs are higher than the least cost combination. There appears to be no unique farm size group whose allocation is efficient over all the inputs.

If agriculture is to properly contribute, then farmers must be provided with adequate technical knowledge of crop production. Mere substitution of abundant inputs for scarce/material input will not bring desirable result. Rather, right kind and quantity of inputs should be allocated in crop production for increasing efficiency. Extension services of the Government should demonstrate the timing and quantity of input mix for different crop in order to enable farmer to choose the most efficient mix.

Notes :

1. The calculation of land cost involves two alternative methods: i) based on rental value of land and ii) based on interest on land value. The determination of the value of land is essential to determine the interest for the use of land. The cost of land was calculated on the basis of its rental value.
2. Economies of scale exists if production is characterized by increasing returns while diseconomies of scale operates when production is characterized by decreasing returns (see Doll and orazem, 1984 pp. 202-3 for a good discussion on return to scales).

Table 1. Estimates of Production Functions According to Various Farn Size Groups

Farm size groups	Number of observation	Constant	Co-efficients and t-value						
			HYV land	Seedlings	Fertilizer and manure	Human labour	Bullock power	Irrigation	$\bar{R}^2$
Small	50	6.04770	0.273203*	-0.125	0.209866*	0.343448**	0.168556	0.116048	0.94283
			(2.214)	(-1.028)	(2.667)	(2.703)	(1.583)	(1.745)	
Medium	30	6.11095	0.224847	0.057147	0.013832	0.317278*	0.386360*	0.0825438	0.95411
			(1.079)	(0.582)	(0.152)	(2.486)	(2.350)	(0.641)	
Large	20	17.03050	1.70217*	-1.133**	-0.684090*	1.033470	-0.0261454	-0.0179447	0.74092
			(2.256)	(-2.925)	(-2.144)	(1.576)	(-0.046)	(-0.045)	
All	100	8.13182	0.540595**	-0.230*	-0.0135601	0.490677**	0.221369	0.0277462	0.90160
			(3.120)	(-2.042)	(-0.159)	(3.469)	(1.575)	(0.304)	

Notes: "*" indicates significant at 0.05 probability level.
"**" indicates significant at 0.01 probability level.
Figure in parentheses are the t-values.

Table 2. Regression Results Showing the Relation Between Size of HYV Land Holding and Yield per Hectare

Farm size groups	Number of observation	Intercept term	Regression co-efficient	t-value	$\bar{R}^2$
Small	50	9.407	0.955**	21.011	0.90193
Medium	30	9.248	1.126**	19.235	0.92964
Large	20	9.413	1,073**	5.707	0.64404
All	100	9.392	1.033**	28.148	0.88992

Notes: "**" indicates significant at 0.01 probability level.

Table 3. Test of Returns to Scale for Various Farm Size Groups

Farm size groups	Sum of regression co-efficients	Deviation from unity	t-value	Returns to Scale
Small	0.986	0.015	9.06	Decreasing**
Medium	2,464	1.464	542.22	Increasing**
Large	0.478	0.522	10.47	Decreasing**
All	1.164	0.164	126.46	Increasing**

Table 5: Levels of Inputs at LCCI and ECI for HYV Boro Paddy

Farm size group	Small		Medium		Large		All	
Inputs	ICCI	ECI	LCCI	ECI	LCCI	ECI	LCCI	ECI
Land (hectare)	0.46	0.46	1.01	1.01	1.67	1.67	0.87	0.87
Seedlings (Tk.)	353.79	573.96	1220.65	1248.95	1784.40	1977.00	1035.85	1057.07
Fertilizers and manures (Tk.)	1590.91	1329.76	1295,33	2781.20	3695.35	4482.94	1459.63	2395.83
Human labour (man-days)	91.37	89.48	188.83	184.03	220.75	337.60	188.99	167.47
Bullock power (Pair days)	4.75	9.06	31.00	20.13	26.66	32.40	20.99	17.05
Irrigation (Tk.)	1326.30	1469.98	1762.90	3185.57	3843.09	4688.03	1269.62	2628.27

Table 4. Marginal Value Products, Factor Costs, Marginal Benefit and Allocative Efficiency Coefficients of Inputs in Various Farm Size Groups

	HYV land				Seedlings				Fertilizer and manure				Human labour				Bullock power				Irrigation			
Farm size groups	MVP (Tk)	MFC (Tk)	MB (Tk)	R	MVP (Tk)	MFC (Tk)	MB (Tk)	R	MVP (Tk)	MFC (Tk)	MB (Tk)	R	MVP (Tk)	MFC (Tk)	MB (Tk)	R	MVP (Tk)	MFC (Tk)	MB (Tk)	R	MVP (Tk)	MFC (Tk)	MB (Tk)	R
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Small	3483.74	4644	-1100.26	.75 (0.74)	-106.81	516	-622.81	-.21** (-6.01)	12.36	5.98	6.98	2.30 (1.51)	53.76	25.19	28.57	2.13 (1.43)	256.48	100.00	156.48	2.56 (0.96)	147.98	134.54	13.44	1.09 (0.14)
Medium	2284.94	4490	-2205.06	.64 (-.60)	48.91	540	-491.39	09** (-5.35)	0.84	5.40	-4.56	0.16 (-.82)	52.62	25.25	27.37	2.08 (1.29)	569.80	106.21	463.59	5.36** (7.34)	96.28	131.09	-34.81	0.73 (-0.21)
Large	21641.39	4530	17111.34	4.78 (1.78)	-960.32	495	-1455.32	-1.94** (-4.43)	-43.36	5.36-	-48.72	-8.09* (-2.41)	159.75	25.28	134.47	6.32 (1.33)	-40.29	104.00	-144.29	-.39 (-.16)	-19.01	110.63	-129.64	-0.17 (-1.78)
All	6902.18	4575	2327.18	1.51 (1.05)	-195.84	519	-714.84	-0.38** (-7.46)	-0.82	5.38	-6.14	-0.11 (-1.20)	77.93	25.23	52.70	3.09* (2.35*)	334.48	102.45	232.03	3.36 (1.09)	33.11	128.11	-95.00	0.26 (-.87)

Notes: R is the coefficients of allocative efficiency of inputs.
MVP is the marginal value products and MFC is the marginal factor cost and MB is the marginal benefits of inputs.
Figures in parentheses indicate t-values.
"*" indicates significant at 0.05 probability level and "**" indicates significant at 0.01 probability level.

REFERENCES

Bhuiyan, M.S.R. (1987). "Effect of Farm Size and Tenurial Status of Land on Production Efficiency in an Area of Bangladesh", *The Bangladesh Journal of Agricultural Economics,* X (1).

Chennareddy, V. (1967). "Production Efficiency in South Indian Agriculture", Journal of Farm Economics, 49 (4): 816-20.

Ghosh, A. (1973). "Size-Structure, Productivity and Growth: A Case Study of West Bengal Agriculture", *Bangladesh Economic Review,* 1 (1): 59-70.

Hopper, W.D. (1965). "Allocative Efficiency in a Traditional Indian Agriculture", *Journal of Farm Economics,* 47 (3): 611-24.

Hossain, M. (1977). "Farm Size, Tenancy and Land Productivity: An Analysis of Farm Level Data in Bangladesh", *The Bangladesh Development Studies,* 5 (3): 285-348.

Khusro, A.M. (1964). "Returns to Scale in Indian Agriculture", *Indian Journal of Agricultural Economics,* 19 (3 & 4): 51-80.

Mandal, M.A.S. (1980). "Farm Size, Tenure and Productivity in an Area of Bangladesh", *The Bangladesh Journal of Agricultural Economics,* 3 (2): 21-42.

Mazumdar, D. (1963). "On the Economics of Relative Efficiency of Small Farmers", *Economic Weekly,* (Special Number): 1259-63.

Mazumdar, D. (1965). "Size of Farm and prductivity: A Problem of Indian Peasant Agriculture", *Economica,* 32 (126): 161-73.

Myrdal, G. (1968): *Asian Drama: An Inquiry into the Poverty of Nations,* London: Allen Lane The Penguine Press.

Myrdal, G. (1979). "Underdevelopment and the Evolutionary Imperative", *Third World Quarterly,* 1 (2): 24-42.

Raj, Krishna (1964). "Some Production Functions for the Punjab", *Indian Journal of Agricultural Economics,* 19 (3 & 4): 87-113.

Rao, A.P. (1967). "Size of Holding and Productivity", *Economic and Political Weekly,* Special Number (November 11) :1989-91.

Schultz, T. W. (1964): *Transforming Traditional Agriculture,* New Haven: Yale University Press.

Sen, A. K. (1962). "An Aspect of Indian Agriculture", *Economic Weekly,* 14 (Annual Number): 243-46.

Sen, A. K. (1964). "Size of Holdings and Productivity", *Econmic Weekly,* 16 (Annual Number): 323-26.

Yotopoulos, P.A. and J.B. Nugent (1976): *Economics of Dvelopment: Empirical Investigations.* New York: Harper International Edition, Harper and Row, Publishers, Inc.