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Technical and Allocative Efficiency of Irrigated Sugarcane Farms in Northwest and Southwest Regions of Bangladesh.

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ABSTRACT

The present study was conducted during 1997-98 to estimate the technical and allocative efficiency of irrigated sugarcane farms in Northwest and Southwest regions of Bangladesh. The study examines the possibility of raising sugarcane productivity by improving technical and allocative efficiency of farms in sugarcane production. A Cobb-Douglas production function was employed to estimate technical and allocative efficiency of sugarcane farms. Timmer's measure of technical efficiency and Kopp's measure of allocative efficiency were examined. The technical efficiency index computed showed a mean average technical efficiency of 0.61 implying substantial inefficiency exists among the sample sugarcane farmers under study. The allocative efficiency worked out to be 0.60. Results determine enough scope of increasing sugarcane output using the available inputs and technology.

Key words: Frontier production function, allocative efficiency, technical efficiency.

INTRODUCTION

Sugarcane is an important cash crop to the farmers of Northwest and Southwest regions of Bangladesh. Rajshahi and Khulna divisions covered almost 70 per cent of total sugarcane area and produced 75 per cent of total production in 1998 (BBS, 1998). But the average sugarcane yield 42.13 tons per hectare in 1998 was the lowest as compared to other principal cane producing countries like Egypt (109.5), Australia (102.4), Indonesia (80.1), Mexico (76.6), U.S.A. (73.8), Columbia (71.2), Philippines (70.8), Brazil (67.2) and India (65.9) in 1996 (FAO, 1992-96; BBS 1998).

There is a shortage of sugar in the country, which is fulfilled through import by spending hard earn foreign currencies. It is evident that available new sugarcane production technological package with its efficient utilization may accelerate yield growth rate of sugarcane. It is needed to estimate farm specific efficient use of resources of farms in achieving maximum possible output through minimum input use. It can be evaluated through technical efficiency to obtain maximum possible output through a given set of resources while allocative efficiency explores needed adjustments in equating marginal revenue with marginal cost for maximum profitability (Panda, 1996).

Many studies have been attempted to estimate technical efficiency of farmers in developing countries in determining status of farmer, which is very important to raise productivity and policy purposes. Farrell (1957) pioneered the concept of measuring technical efficiency on deterministic approach. Forsund *et al.* (1980), Schimidt (1986), Battese (1991) and Das (1991) have reviewed frontier production function methodology. The stochastic frontier production function developed elsewhere Aigner *et al.* 1977; Schimidt, 1986; Bauer, 1990; Battese, 1992 give excellent review on efficiency measures.

MATERIALS AND METHODS

Carew & Co. and Thakurgaon Sugar mills were selected from Khulna division of the region and Rajshahi HQ division of the region respectively for the study Northwest-Southwest . One sub-zone from each sugarcane mills zone, was selected for sampling. The samples included 12 villages of Chuadanga and 8 villages of Thakurgaon districts. Stratified random sampling was followed in selecting the sample farms. In total 117 samples were selected for collecting data under irrigated conditions. Data were collected by field investigators during 1997-98 cropping season.

In the present study, frontier production function was derived from Cobb-Douglas production function estimated by Corrected Ordinary Least Squares (COLS) method. The specific Cobb-Douglas production function is :

$$Rev = A_0 B^{\beta_1} L_{\ 2} Cl_{\ 3} C_{\ 4} e_{\ i} \quad \ldots\ldots (1)$$

Where, Y= the output of sugarcane in Taka per hectare;

B = bullock power use in Taka per hectare;

L = labour use (family + hired) in Taka per hectare;

Cl = other cash input (fertilizer, pesticides, manure and irrigation cost);

C = capital (gross value of assets) in Taka per hectare;

A_0 = intercept, μ_i = error term.

β_1 β_2 β_3 and β_4 elasticities are to be estimated.

$$Rev^* = A^*_0 B^{\beta_1} LAB^{\beta_2} Cl^{\beta_3} C^{\beta_4} e^{\mu_i} \quad \ldots \ldots \ldots \quad (2)$$

Where Rev* revenue estimates of production gives the frontier level of sugarcane revenue and A* is corrected constant term of OLS.

The Timmer's measure of technical efficiency of farm i is the ratio of actual output to potential output, given the level of input use on farm i. It indicates how much extra output could be obtained if farm i were on the frontiers.

As the revised residuals (ei <o) are defined as
ei = Revi - Revi* i = 1, ... 117

$$\text{Timmer } TE_i = \exp(e_i) = \frac{Rev_i}{Rev_i^*} \leq 1 \quad \ldots \ldots \quad (3)$$

Revi = Revenue from sugarcane per hectare;
Revi* = Revenue from frontier (potential) level of sugarcane per hectare.
Rev* denotes maximum value of revenue obtainable from given level of inputs. The largest positive estimated residual was added with intercept value to get the frontier function. Rev* is similar to equation (2).

Kopp's measure of allocative efficiency was derived for all resources. The Kopp's measure of allocative efficiency compares actual level of input use to the level which could be used if farm i was located on the frontiers, given the actual output of farm i and given the same ratio of input usage.

Where R1 = Bullock power use/labour use (LAB); R3 = other cash input/labour use (LAB); R4 = Capital/labour use (LAB). LNLABi* (LN Labouri*) are defined as natural log of labour use and LN Rev* as natural log of revenue as the optimum use of inputs on farm i for out-

$$LNLAB_i^{\cdot} = LN\ Rev_i^* - A^{\cdot}_0 - \beta_1\ LN\ R1 - \beta_2\ LNR3 - \beta_3 LNR4\ /\ ?_i \quad \ldots \ldots \quad (4)$$

put level Revi and LN Cash inputi*, LN Capitali*, and LN Bullocki* may be calculated in similar manner.

We may then compute

Kopp's measure of allocative efficiency (AE i) = LN bullock power usei*/LN bullock power usei= LN LABi*/LN LABi = LN Cash inputi*/LN Cash inputi = LN Capitali*/LN Capitali ... ... (5)

In the present study, an attempt was made to examine the Timmer's measure of technical efficiency and Kopp's measure of allocative efficiency in Northwest and Southwest regions of Bangladesh.

RESULTS AND DISCUSSION

The production function of sugarcane farms revealed diminishing returns to scale. The coefficient of multiple determination (R2) worked out to be 0.38. The elasticity of sugarcane output with respect to bullock power (0.10157), human labour (0.33237), cash input (0.38359) and capital (0.00629) was found to be positive. Human labour and cash input were significant at 1% level and bullock power was significant at 5% level and in case of capital, it was not significant (Table 1). The results of frontier production function revealed that overall technical efficiency (TE) and allocative efficiency (AE) worked out to be 61% and 60% respectively.

Table 1: Results of Resource Use Efficiency Functions Cobb-Douglas Type.

SL. No.	Variables	Coefficient	t- ratio	Significance level
1.	Bullock power	0.10157	1.8989	*
2.	Human labour	0.33237	5.2145	**
3.	Cash input	0.38359	5.3864	**
4.	Capital	0.00629	0.6286	NS

R2 = 0.38, Ao= 3.512575, NS = Not significant

Table 2 : Technical efficiency (TE) of sugarcane farms at Thakurgaon and Chuadanga districts.

SL. No.	Technical efficiency level (%)	Average TE	Number of farms	% of farms
1.	Up to 40	.38	3	3
2.	41 – 50	.47	23	20
3.	51 – 60	.56	37	32
4.	61 – 70	.66	32	27
5.	71 – 80	.75	12	10
6.	81 – 90	.85	7	6
7.	91 – 100	.97	3	3
	Total/average	.61	117	100

Table 2 presents seven categories of farms with different levels of technical efficiency of total 117 farmers, 3 were up to 40% TE, 23 were up to 41 and 50% TE; 37 were between 51 and 60% TE; 32 were between 61 and 70% TE; 12 were between 71 and 80% TE; 7 were between 81 and 90% TE and 3 were between 91 and 100% TE.

Table 3: Technical efficiency, yield and excess revenue of sugarcane farms at Thakurgaon and Chuadanga districts.

Group No.	Technical efficiency level (%)	Actual yield (Tons)	Potential yield (Tons)	Yield gap (Tons)	Actual revenue (Tk.)	Potential revenue (Tk.)	Excess revenue (Tk.)
1	Up to 40	46	122.7	76.7	45705	121672	75967
2	41 – 50	47	99.7	52.7	46866	98920	52054
3	51 – 60	57.5	102.7	45.3	57102	117809	60707
4	61 – 70	68.2	102.8	34.6	67641	101999	34358
5	71 – 80	75.6	101.4	25.8	74945	92145	17200
6	81 – 90	86.3	101.4	15.1	85584	100553	14969
7	91 – 100	100.9	104.2	3.3	100091	103287	3196
Mean		68.8	105.0				

Yield gaps between potential and actual yields was found to be the highest (76.7 tons/ha^{-1}) in case of group 1 (30 to 40% TE) and it was the lowest (3.3 tons) while the TE was between 91- 100 per cent. The same trend was also observed in case of excess revenue earning (Table 3). The average yield of sugarcane was 68.8 tons per hectare, due to incorrect use of inputs for lack of knowledge of correct practices and average potential yield was 105.0 tons per hectare. The allocative efficiency of the farmer's shows that sample farmers were allocatively inefficient in input usage's (Table 4).

Table 4: Levels of allocative efficiency of sugarcane farms at Chuadanga and Thakurgaon districts.

SL. No.	Technical efficiency	Excess use of			
		Labour (Tk.)	Bullock power (Tk.)	Cash input (Tk.)	Capital (Tk.)
1.	31 - 40	7459 (223.12)	2044 (239.06)	12720 (230.31)	1866 (42.55)
2.	41 - 50	6154 (145.79)	874 (67.39)	8396 (148.18)	826 (149.64)
3.	51 - 60	5413 (102.09)	640 (101.26)	7529 (98.34)	826 (100.96)
4.	61 - 70	4126 (64.36)	480 (64.00)	5940 (65.00)	667 (66.83)
5.	71 - 80	3221 (42.63)	393 (42.95)	4182 (43.29)	482 (44.42)
6.	81 - 90	1767 (21.02)	280 (21.02)	2672 (21.63)	339 (21.17)
7.	91 - 100	287 (3.64)	56 (3.95)	684 (4.05)	123 (4.32)

Note: Figures in parentheses are the percentages of excess use of inputs calculated from the appendices 1-7 (actual input use/ input gaps or excess input uses x 100).

The technical efficiency index computed shows that sample of irrigated sugarcane farmers under study are highly technically inefficient with a mean efficiency ratio of 0.61. Results clearly show that there exists potentiality in sugarcane production and it determines enough scope of increasing sugarcane yield in Northwest and Southwest regions of country.

In conclusion, research findings indicate that there is a scope to increase technical efficiency of sugarcane farms substantially. The farm-specific technical efficiency and input-specific allocative efficiency exhibited scope for minimizing inefficiency in sugarcane production.

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Appendix 1. Actual and Potential input gaps of TE (91-100)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	8285	1473	17586	2969
Potential	7998	1417	16902	2846
Excess	287	56	684	123

Appendix 2. Actual and Potential input gaps of TE (81-90)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	9926	1611	15026	1940
Potential	8159	1332	12354	1601
Excess	1767	280	2672	339

Appendix 3. Actual and Potential input gaps of TE (71-80)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	10777	1308	15026	1568
Potential	7556	915	9661	1085
Excess	3221	393	4182	482

Appendix 4. Actual and Potential input gaps of TE (61-70)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	10537	1231	15080	1665
Potential	6411	750	9139	998
Excess	4126	480	5940	667

Appendix 5. Actual and Potential input gaps of TE (51-60)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	10571	1272	14933	1660
Potential	5302	632	7404	834
Excess	5413	640	7529	826

Appendix 6. Actual and Potential input gaps of TE (41-50)

Particulars of inputs use	Labour (Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	10375	1463	14061	1378
Potential	4221	589	5666	552
Gaps	6154	874	8396	826

Appendix 7. Actual and Potential input gaps of TE (31-40)

Particulars of inputs use	Labour(Tk.)	Bullock (Tk.)	Seed (Tk.)	Capital (Tk.)
Actual	10801	2899	18243	2660
Potential	3342	855	5523	794
Gaps	7459	2044	12720	1866