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RESEARCH ARTICLE

TECHNICAL, ALLOCATIVE AND ECONOMIC EFFICIENCY IN SUGARCANE PRODUCTION: A NON- PARAMETRIC APPROACH

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Abstract

This paper empirically investigated the Technical, Allocative and Economic Efficiency of the 200 sugarcane farm households of Odisha, India. The mean TE, AE and EE were respectively 0.792, 0.233 and 0.192. Of all the 200 farms, 23 farms were fully technically efficient and 148 farms were operating under increasing returns to scale. The Two-Limit Tobit regression result suggested that College education and high school education had significant impact in improving TE and AE. However, experience played significant role in improving cost efficiency. The marginal effect of College dummy and high school dummy gradually diminished in case of TE, AE and EE. However, the small farm size was more beneficial than large farms in improving cost efficiency. The study suggested government's focus on extension services, training of the farm people and investing on introducing farm education at all levels of education.

Introduction

Growth of agricultural sector is not only important for ensuring food security and reduction of poverty in rural areas but also sustaining growth of the rest of the economy. Though agriculture's contribution including ancillary sector is less than 20% towards, Gross Domestic Production (GDP), still it sustains and directly or indirectly provides employment to 70% of the total working force of the state. Despite frequent occurrence of natural calamities, agricultural sector contributed 17.59% of Odisha's Gross State Domestic Product (GSDP) during 2010-11. Out of the total cultivated land of 61.80 lakh hectares (lha), 35% is irrigated and majority of farmers are small and marginal. The average size of holding for all social groups has decreased to 1.15 hectares (ha). Hence, the objectives of the department of Agriculture is to increase production and productivity amidst those adverse conditions so as to uplift the rural farmers, who are the majority of the rural population and to sustain the growth process of of the other sectors of the economy. Though paddy continues to be the dominant crop and 90% of the total food grain production in terms of acreage, there has been gradual shift from paddy to cash crops. In 2008, the state Government has brought out a New Agricultural policy, with a blend of futuristic, flexible enough to anticipate and address emerging trends, identify potential areas and chalk out a clear agenda for agricultural improvement for at least next ten years It aims at enhancing productivity of major crops, shift the emphasis from subsistence agriculture to facilitate long term investment in agriculture by public and private sectors and by public private partnership ventures particularly for post harvest management, marketing agro processing and value addition (Economic Survey of Odisha, 2011).

In market economies, markets exercise power on the behavior of firms and individuals leading to failure of Decision Making Units (DMUs) to produce at the "best practicing frontier". This is called production inefficiency and has been elaborated by researchers (Debreu, 1951; Farrell, 1951;) on the basis of different approaches. The pioneering work of Koopmans (1951) provided the formal definition of technical efficiency as "A producer is technically efficient if and only if, it is impossible to produce more of any output without producing less of some other output or using more of some input". Later on Debreu (1951) and Farrell (1957) developed a slightly different definition of technical efficiency by ruling out the slack units. However, Debreu-Farrell technical efficiency is necessary but not sufficient for Koopman's technical efficiency (Kang, 1998). In Farrell's efficiency analysis the two fundamental efficiencies comprises of Technical Efficiency (TE) and Allocative Efficiency (AE). TE arises when outputs fall short from ideal production given input level and the later is the result of inappropriate input choices concerning certain input prices and output level. Economic Efficiency (EE) or cost efficiency is the product of TE and AE.

So as to measure the efficiency level of DMUs researchers have developed two separate methods: econometric approach and mathematical programming approach. The mathematical approach, known as the Data Envelopment Analysis (DEA) was originated by Charnes Cooper and Rhodes (1978). DEA does not presume any functional form for production. It usually involves the use of linear programming method to construct a non- parametric piece-wise surface over the data. Therefore efficiency of each DMU is calculated regarding the best practicing DMU. The comprehensive literature on the methodology of DEA can be reached in Charnes, Cooper and Rhodes (CCR) (1978), banker, Charnes and Cooper (1984) Seiford and Thrall (1990).

India is world's largest producer of sugar and sugarcane. Sugarcane is cultivated in about 283 million ton (mt) of cane with an average productivity of 72.6 mt per hactare (ha). It is the most remunerative crop and at the same time requires huge water and fertilizer. The productivity of sugarcane is declining due to excess use of water and imbalanced fertilizer use. The major constraints are non availability of high yielding variety of seeds, dearth of good quality of seeds, improper water management, use of imbalanced fertilizer doses, negligence in plant protection, low awareness among the farmers to use improved cultivation process and poor attention to ratoon crop. Farm specific productivity and efficiency measurements can be a suitable index of evaluating the cost efficiency and profit efficiency of the DMUs. In addition to this, evaluation of TE, AE and Cost Efficiency (CE) help micro level planning for agricultural development, which helps in the development of the economy. The main objective of this paper is to measure CE/ EE of the sugarcane farms in Odisha. Further the technical and scale efficiencies of the farms are calculated to estimate the returns to scale of the individual farms. Lastly, statistical significance of the factors such as the education of the farm households, experience, family education, size of the farms on the efficiency scores (TE, AE and EE) are also empirically tested.

Several research studies have been focused on determining the efficiency in agricultural units and various products ranging from cultivation and horticulture to aquaculture and animal husbandry (Shafiq and Rehman, 2000: Sharma et al, 1999; Banaeian et al., 2010) DEA and related methods are widely applied in agricultural sectors of several countries located in Europe, America, Asia, Africa and Australia (Davidova and latruffe, 2007; Andre et al., 2010; Frija et al., 2011; Wadud, 2003; Coelli et al., 2002; Jha et al., 2000; Ureta and Pinheiro, 1993; and Fare et al., 1997).

MATERIALS AND METHODS:

Let's assume that each DMU use m inputs for the production of n outputs in a given technology. $\mathbf{X_{ij}}$ denotes the ith input **(i = 1, 2,.........., m)** of the jth DMU **(j= 1, 2, ..., k)** where $\mathbf{Y_{sj}}$ is the s th output **(s= 1, 2,........, n)** of the jth DMU. Given the data the efficiency of each DMU once and hence n optimizations one for each DMU_j has to be evaluated. The variables $\mathbf{u_r}$ **(r = 1, 2, ..., n)** and $\mathbf{v_i}$ **(i= 1, 2, ..., m)** are weights of each output and input respectively. The TE of DMU_0 can be evaluated by solving the fractional programming problem to obtain the input weights vi and output weight ui as variables

$$(FP_0)\quad \max_{v,u}\ \Theta = \frac{u_1y_{10} + u_2y_{20} + \dots + u_sy_{s0}}{v_1x_{10} + v_2x_{20} + \dots + v_mx_{m0}}$$

Subject to

$$\frac{u_1y_{1j} + \dots + u_sy_{sj}}{v_1x_{1j} + \dots + v_mx_{mj}} \leq 1 \qquad (j = 1, 2, \dots, n)$$

$$v_1, v_2, \dots, v_m \geq 0$$

$$u_1, u_2, \dots, u_s \geq 0 \qquad \dots\dots(1)$$

The above **(FP_0)** can be replaced by the following **(LP_0)** in the matrix form

$$\max_{v,u} \quad uy_0$$

Subject to

$$vx_0 = 1$$
$$-vX - uY \leq 0$$
$$v \geq 0, u \geq 0 \quad \text{.......................................(2)}$$

The dual of the **(LP_0)** is expressed in a real variable θ and the transpose T of a nonnegative vector $\lambda = (\lambda_1, \ldots\ldots\lambda_n)^T$ of variables as :

(DLP_0) $$\min_{\theta,\lambda} \quad \theta$$

Subject to

$$\theta x_0 - X\lambda \geq y_0$$
$$Y\lambda \geq y_o$$
$$\lambda \geq 0 \quad \text{.......................................(3)}$$

(DLP_0) has a feasible solution θ= 1, λ_0 =1, λ=0 (j≠ 0). Hence, the optimal θ denoted by θ* is not greater than 1. The value of θ is $0 \leq \theta^* \leq 1$. To discover possible input excess and output shortfall, the optimal value of the **(DLP_0)** is incorporated in the following phase II extensions of the **(DLP_0)**

$$\max_{\lambda, s^-, s^+} \quad w = es^- + es^+$$

Subject to

$$s^- = \theta^* x_0 - X\lambda$$
$$s^+ = Y\lambda - y_0 \quad \text{.......................................(4)}$$

Here (λ, s^-, s^+) are used as variable where e (1, ..., 1) a vector of Ones so that $es^- = \Sigma_{i=1}^{m} s^-$ and $es^+ = \Sigma_{i=1}^{m} s^+$ · If the optimal solution of DLP_0 and Phase II satisfies ($\theta, \lambda^*, s^{-*}, s^{+*}$) satisfies θ* =1 and zero slack s-* =0 and s+* =0 then the DMU is called CCR efficient. The input oriented Banker, Charnes and Cooper (BCC, 1984) model evaluates the efficiency of the DMU_0 (0 = 1, ……, n) by solving the following LP.

(BCC_0) $$\min_{\theta_B, \lambda} \quad \theta_B$$

Subject to

$$\theta_B x_0 - X\lambda \geq 0$$
$$Y\lambda \geq 0$$
$$E\lambda = 1$$
$$\lambda \geq 0 \quad \text{.......................................(5)}$$

Where, θ_B is a scalar. Similar to the second phase in the CCR model, the BCC model is solved using to phase procedure. If an optimal solution $\theta^*, \lambda^*, s^{-*}$ and s^{+*} obtained in the two phase procedure from the BCC_0 satisfies θ_B^* = 1 and has no slacks (both input and output) then the DMU is called BCC efficient. Since CCR model assumes Constant Returns to Scale(CRS) production possibility set i.e., radical expansion and reduction of all the observed DMUs and their non-negative combination are possible, hence the CCR score is called global technical efficiency. On the other hand, the BCC model assumes the convex combinations of the observed DMUs from the production possibility set and the BCC score is called local pure technical efficiency. If the DMU is fully efficient under CCR and BCC model then it is operating under the Most Productive Scale Size (MPSS). If it is under fully efficient under BCC but low CCR score then the DMU is operating efficiently locally but not globally due to the scale size of DMU. Hence

$$\text{Scale Efficiency (SE)} = \frac{\theta^* \text{(CCR)}}{\theta^* \text{(BCC)}}$$

OR

$$\theta^* \text{(CCR)} = \theta^* \text{(BCC)} \times \text{SE} \quad \text{.......................................(6)}$$

Thus, the sources of inefficiency is caused due to inefficient operation and by disadvantageous conditions displayed by SE.

The concept AE can be traced back to Farrell (1957) and Debreu (1951), Fare, Grosskopf and Lovell (1985) who developed linear programming (LP) formulation of these concepts. AE brings the price-cost information of the DMU into picture. Given the information on prices of inputs, the minimum cost required to produce the given amount of output. The optimal cost is obtained through the following LP (Farrell, 1957)

$$\begin{aligned} Cx^* &= \min_{x,\lambda} Cx \\ \text{Subject to } & x \geq X\lambda \\ & y_o \leq Y\lambda \\ & \lambda \geq 0 \quad \ldots\ldots (7) \end{aligned}$$

Where the $C = (c_1, c_2, \ldots\ldots, c_m)$ is the common unit input price or unit cost vector. The Overall Efficiency or Cost Efficiency (CE/EE) is defined as the ratio of the minimum cost to the observed cost i.e.,

$$EE/CE = \frac{Cx^*}{Cx_o} \leq 1 \quad \ldots\ldots (8)$$

This is a measure of the extent to which the originally observed values represented by the denominator have fallen short of achieving the minimum cost represented by the numerator.

Source and nature of Data:

Information on various inputs and the their cost share in the total cost of producing sugarcane have been collected from 200 sugarcane farm households (will be called as DMU) of the Goleipur Panchayat of Korei block, Jajpur district of Odisha through direct personal interviews through ready- made questionnaires. The main inputs used in the production of sugarcane are: hired labour, bullock labour, fertilizer (Urea, Potash, calcium and Super Phosphate) manures, tractor hours, and irrigation. In addition to this, information on the levels of education of the farm household, average education of the family, experience of the effective farm household (the real cultivator and decision maker on the farming, who may or may not be the head of the household) have been obtained. The selection of the study area is made on the ground that it is connected to the local market as well as the main cities such as Cuttack and Jajpur as well as Jajpur Road and Paradeep port. Secondly, the study area is located on the bank of the river Kharashrota, making it suitable for multiple cropping (paddy, Groundnut and sugarcane). The Table-1 presents the detail summary statistics on the production and cost share of various inputs used .

RESULTS AND DISCUSSION:

The mean total cost of sugarcane cultivation was Rs. 11630 with minimum of Rs. 5554 and maximum of Rs. 32075.The huge range of total cost clearly indicated that the range of cultivation of sugarcane was also very high. Since more financial investment and more time were required, some farmers did not cultivate more area under the crop. The labor cost share in the total cost was 39.35 per cent. Since sugarcane cultivation took longer period (18 months to 20 months), plenty of manual labor works were to be used; the use of labor power was comparatively more. Second thing was that, sugarcane cultivation required use of different fertilizer in different times. Hence, the share of each fertilizer was estimated. The maximum share was by Nitrogen (Urea) is 4.74 per cent followed by calcium (3.01%) and Super (2.05%). The high share of irrigation cost (10.28%) also indicated the importance of continuous requirement of water in the sugarcane production. It should be mentioned that most the farm households in the study area used diesel water pump 5 Horse Power (hp) for irrigating their sugarcane fields. Last but not the least was the tractor cost share, which were 16. 4 per cent. The significant share of the tractor hour was proved from the fact that, the traditional bullock driven plough wood cultivation could not achieve deeper cultivation of the land, as it is essential for sugarcane crop. Secondly, the easy availability of tractors power tillers in the local area and the consequent hiring cost benefit for the farmers were another factor for the large share of the tractor cost in the total cost. The value of capital included the depreciation of the water pump, cow shed, and the bullocks.

The equations 1-5 were estimated by using the DEAP programme of Coelli (1996) and the results on TE by CCR (technical efficiency assuming constant returns to scale) and TE by the BCC model (technical efficiency assuming variable returns to scale) and the scale efficiency scores were obtained. Table-2 showed the frequency distribution of the scores of TE under CCR and BCC model. The mean efficiency scores of CCR TE was 0.793 and the mean TE scores under BCC model is 0.906. Hence, the Scale efficiency was 0.883 (CCR TE/ BCC TE). Of all the DMUs, 23 DMUs were fully CCR efficient and 93 DMUs were fully BCC efficient. However, 23 DMUs were operating under Most Productive Scale Size (MPSS) , i.e., these DMUs were efficient both locally and globally. Hence some of the

DMUs were working efficiently under local conditions but remain inefficient under the global condition i.e., 73 DMUs were working in full managerial efficiency condition but they did not perform at the same rate when the scale of the production changes. The close look at the projection summary results of DMUs at individual level revealed the fact that those DMUs

Table-1:
Summary Statistics of Variables in the Sugarcane Production and Cost (In Rupees)

Variable	Mean	Standard Deviation	Minimum	Maximum	% of the total cost
TC	11630	5554	5600	32075	
VO	2709.5	1377.6	7080	51200	
Labor cost	4576.8	2202	640	12400	39.35
Bullock labor cost	245.2	1335.7	840	10500	2.2
Urea cost	551.70	315.7	175	3750	4.74
Potash cost	230	149	80	1500	1.28
Super cost	239.55	126.87	60	750	2.05
Calcium cost	350.475	202.33	75	1125	3.01
Manure cost	34.31	18.47	12	120	0.3
Tractor cost	1906.5	983.85	600	5400	16.4
Irrigation cost	1195.6	598.04	160	4000	10.28
Average Education of the Family*	8.270	2.514	4	10	
Average Education of the effective head*	8.13	2.35	3	13	
Experience*	8.21	2.521	3	13	

*The figures are in number of years of farming experience for the crop

Table-2:
Frequency Distribution of TE under CRS and VRS

Class Interval (TE–CRR scores)	No. of DMUs	Class Interval (TE-BCC scores)	No. of DMUs
0.3-0.4	1	0.5-0.6	2
0.4-0.5	1	0.6-0.7	2
0.5-0.6	6	0.7-0.8	40
0.6-0.7	35	0.8-0.9	43
0.7-0.8	75	0.9 up to 1	113
0.8-0.9	36		
0.9 up to 1	46		
Mean	0.793	0.906	

Table-3:
DMUs UNDER CRS, IRS AND DRS

DMUs under (CRS) Constant Return to Scale	DMUs under (IRS) Increasing Returns to Scale	DMUs under(DRS) Decreasing Returns to Scale
1, 2, 5,8, 12, 13, 15, 17, 18, 20 23, 31, 34, 36, 79, 85, 88, 91, 93, 101, 124, 137, 143, 147, 149, 153, 158, 165, 173, 183 and 199 = Total 32	3,6, 7, 9, 10, 11, 14, 16, 21, 24, 26, 29, 30, 32, 33, 35, 38, 39, 40-50, 52, 53, 55, 57, 58, 59, 60,61-63,65-72, 75-77, 80-84, 87, 87, 89, 92, 94, 95, 97-100, 102-105, 107-123, 125-136, 138-142, 144-146, 148, 154-157, 159-161, 163, 164, 166-169, 171, 172, 174-182, 184-198, 200 = Total of 148	4, 22, 27, 28,37, 51, 54, 56, 64, 73, 74, 78, 90, 96, 106, 150, 151, 152, 162 and 170 =Total 20

Table-4: DMUs and their Peer counts

DMUs	No Peer counts	DMUs	No. of Peer counts	DMUs	No. of Peer counts
2	13	85	20	157	11
8	8	95	8	158	12
13	37	116	20	160	9
15	8	124	10	165	20
20	**102**	128	11	185	24
23	4	133	16	192	17
24	11	139	13	199	34
79	**85**	149	**88**	-	-
81	6	153	13	-	-

Table-5:
TE, AE and EE Scores Frequency
Distribution of the Sugarcane DMUs

Class Interval (TE Scores)	No of DMUs	Class Interval (AE scores)	No. of DMUs	Class Interval (EE scores)	No of DMUs
0.3-0.4	1	0.05-0.1	4	0.05-0.1	40
0.4-0.5	1	0.1-0.15	46	0.1-0.15	41
0.5-0.6	6	0.15-0.2	33	0.15-0.2	55
0.6-0.7	35	0.2-0.25	47	0.2-0.25	20
0.7-0.8	75	0.25-0.3	27	0.25-0.3	14
0.8- 0.9	36	0.3-0.35	16	0.3-0.35	16
Upto 1	46	0.35-0.4	15	0.35-0.4	6
-	-	0.4- 0.45	08	0.4- 0.45	4
-	-	0.45-0.5	02	0.45-0.5	2
-	-	0.5 up to 1	02	0.5 up to 1	2
Mean	0.793		0.233		0.190

Table-6: Tobit Two-limit Regression Results on TE, AE and EE

Coefficients	Values (t-value) for TE parameters	Values (t-value) for AE parameters	Values (t-value) for EE parameters
Constant	0.7183 (20.09)**	0.2153(7.73)**	0.1587(5.73)**
Fam Edu	0.00109(0.3)	-0.00546(1.90)	-0.004958(1.73)
Exp	.001460(0.56)	0.00179(0.88)	0.0021(10.48)**
Land Dum	0.1183(5.91)**	0.1527(9.79)**	0.1626(3.31)**
Colege Edu Dum	0.0805(2.75)*	0.06228(2.73)*	0.0751(1.21)
High School Dum	0.3640(1.99)*	0.0119(0.84)	0.0171(5.73)**

*,** shows level of significance at 5% and 1%

Table-7: Marginal Effects of Dummy Variable on Efficiency

Variable	AE dy/dx(Z-value)	EE dy/dx (Z-value)	TE dy/dx (Z-value)
Land Dum@	0.1523(9.78)**	0.1528(10.36)**	0.1187(5.94)**
College edu Dum@	.0359(1.90)*	0.01845(2.64)*	0.0830(3.41) **
High school Dum@	–0.00060(0.05)	0.01201(0.42)	0.0378(2.30) *

@- dy/dx is for discrete change of dummy variable from 0 to 1.
***,** show level of significance at 5% and 1%**

Operating with full TE under BCC model but not under the CCR model is due to large input slacks in the use of the fixed input, fertilizers and irrigation. As per the Table-3 the number of DMUs operating under CRS, IRS and DRS are 32, 148 and 20. The result suggested that most of the DMUs were in the early expansion stage and hence a lot of scope was there to improve the efficiency through proper reallocation of the resource use. Out of all the 32 firms operating under CRS, 23 are working under MPSS i.e., they are fully efficient both under CRS and VRS model known as CCR and BCC model. Out of all those DMUs operating under CRS, the DMU 20 was treated as the most frequently peer (120 times) followed by 149 (88 times) and 79 (85 times) (refer Table-4).

Further, TE AE and EE/CE or Overall Efficiency (OE) is estimated by using the equations 7-8 specified in the materials and methods section. As far as the TE, AE and EE scores are concerned, the mean TE is 0.793 as mentioned earlier and 23 DMUs are operating on the efficient frontier. It means these DMUs are technically fully efficient. But the performance of the DMUs changes drastically whenever the price information is used in estimating the cost efficiency and AE scores. As mentioned in the Table-5 the mean AE is 0.233 which, suggests that the inputs use of all the DMUs can be radially reduced by 50% on an average or the DMUs can reduce 50% of their cost in order to be allocatively efficient and around 60% of their cost can be reduced to achieve economic efficiency. The summary of the cost minimizing input quantities suggests that all the DMUs except 143rd DMU can reduce their input cost by reducing the excess inputs used specially the huge cost incurred in running the fixed assets such as the diesel pumps and the use of excess fertilizers and expenses on irrigating the crop.

In the first stage of the analysis, the technical efficiency of individual farms is evaluated by the DEA. Since the production frontier in the DEA approach is deterministic, the resulting efficiencies contain noise from data. Therefore, in the second stage of this analysis, the features of the operating environment (farm characteristics) are used to explain the computed technical efficiency scores by estimating an efficiency model. As it follows from the DEA efficiency score definition, the DEA score falls between the 0 and 1, making the dependent variable (efficiency score from the first stage of analysis) a limited dependent variable. Therefore, the Tobit model is suggested (e.g., Cooper 1999; Grigorian and Manole, 2002) as an appropriate model in the second stage of analysis when considering the effects of a farm's characteristics on the farm's efficiency score. In order to know the impact of the social variable on the different categories of Efficiencies (TE, AE and EE) Two-Limit Tobit regression had been used to estimate the coefficients and to know the marginal effects of categorical variable on TE, AE and EE scores. The models for TE, AE, and EE in equation 7-8 were estimated separately using the two-limit Tobit procedure, given that the efficiency indices are bounded between 0 and 100 per cent (Greene 1991; Hossain 1988).

EFFIC = f (fam Edu, Exp, edu dummy , Land Dummy)........................(9)

Education Dummy of the DMU is D1 (for college Education (11-15) =1 otherwise 0; for high school Education 8-10 is 1 otherwise 0 and the base is primary education 3-7). For land dummy (D3) if area is less than 2 acres D3=1 otherwise 0). Table-6 showed the results of the parameters of Tobit regression. In case of TE the coefficient of the constant term, land dummy, college education dummy were highly significant but high school dummy is significant at 5% level. The impact of the family education and experience of the effective head, even though positive, was found not to be statistically significant. The marginal effect (table-7) of the land dummy suggested that the decrease in the area under sugarcane cultivation from 3 acres to 2 acres increases the TE by 12%. The economic reasoning was that sugarcane cultivation takes longer time and hence more money was spent on irrigating the crop and using more and more of fertilizers to keep the crop safe from the insects and pests attack. The larger the area the more was the managerial difficulty in managing the crop. Therefore, TE reduces with large area. (Toluwase and Apta 2013; Ariyaratne et.al 2006; Mohapatra, 2013) support this result. As far as college dummy was concerned, the TE scores increases marginally by 8.3% if the schooling level was increased from high school to college. However, the marginal effect of high school dummy was found to be 3.7%. This means in case of sugarcane cultivation, higher educational qualification had more influence in improving TE.

In case of AE, both land and college education dummy were statistically significant, the marginal effect of reducing the land size from 3 to 2 acres was 15%. The marginal effect of college education dummy was 3.5% on AE. But interestingly, in case of cost efficiency, the DMU's experience was highly significant (not in other two cases) and college education dummy was positive but not statistically significant. It means the experience of the DMU in dealing with cost efficiency played a significant role.The DMUs with more experience were more efficient in allocating their resources to minimize the cost of input uses. The marginal effect of the land dummy was 1.5% and college dummy was 1.8%. Hence the effect of education seems declining in case of allocative and cost efficiency

CONCLUSION:

The paper focused on the estimation of TE, AE and EE by using the Data Envelopment Analysis Approach. The TE scores under CCR and BCC model were computed along with returns to scale. Out of 200 DMUs 32 were under CRS, 20 under DRS and 148 under IRS. It implied that most of the DMUs were in the beginning of the 1st stage of production and there was much scope for expansion of efficiency and productivity. The TE, AE, EE scores suggested that most of the DMUs were failed to achieve EE and AE even though few DMUs were fully technically efficient. The size of the farm was inversely related to the efficiency. Though college and high school education enhanced TE and AE, experience played an important role in improving cost efficiency. Hence, the government should give more priority on training farm people in case of cash crops, extension services and introduction of agricultural education in all spheres of formal education system. Further, priorities should be made in investing on development of the skills of the farm people. Farm people should be informed about the market information at all levels without any difficulty.

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