academicJournals

Vol. 10(7), pp. 637-644, 12 February, 2015
DOI: 10.5897/AJAR2013. 8229
Article Number: 44C682050353
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Technical efficiency of wheat and paddy farms in irrigated saline environment in Haryana State, India: An assessment

B. S. Kalra[1]*, B. Mondal[2] and A. Sarangi[1]

[1]Water Technology Centre, IARI, New Delhi-100 012, India.
[2]Central Rice Research Institute, Cuttack (Odisha) 753 006, India.

Received 13 November, 2013; Accepted 22 January, 2015

The farmers in certain areas of Western Yamuna Canal Command in Haryana State, India, face problems of water logging and salinity in the absence of adequate drainage; and sustainability of their farm operations is highly vulnerable due to fluctuations in rainfall. A study was undertaken to analyse the farm specific production processes and productivity in paddy and wheat farms and find out effect of socio-economic factors under the control of farmers to achieve the maximum output in adverse circumstances. A stochastic frontier production function incorporating a model for technical inefficiency was estimated. The results indicated that farmers combat the adverse situation by incurring higher expenses, in case of paddy, on transplanting operations, seed material and capital input and, in case of wheat cultivation, on fertilizer, irrigation and capital input. However, production function coefficients associated with number of ploughing and plant protection cost, in case of wheat, and seed and fertilizer cost, in case of paddy, were found to be negative indicating their overuse in cultivation. The inefficiency model further indicated that technical inefficiency tend to decline with increase in family size and access to both canal and tube-well water for irrigation in both wheat and paddy cultivation. The mean technical efficiency was found to be 0.84 in case of wheat and 0.93 in paddy. It indicated that there was a scope to increase productivity in wheat with the existing level of technology by improving the technical efficiency of the inputs used while productivity in paddy do not have much scope to increase through improvement of technical efficiency of inputs alone.

Key words: Paddy, saline environment, stochastic frontier, technical efficiency, wheat.

INTRODUCTION

Crop production is a very complex process involving both socio-economic conditions of the farmers and bio-physical environment where they operate. Many of the factors, like land topography, rainfall events, canal running operations and pest and diseases incidence, etc. are not under the control of the farmers and they are always found to combat these situations based on their experiences and collective wisdom at village level. In

*Corresponding author. E-mail: bskalra@iari.res.in. Tel: +91 9868841584.

these circumstances, estimation of productivity only in terms of ratio of input quantities, like land, labour, fertilizers, irrigation, seeds etc. to the output and finding sources of inefficiency are very difficult. It is more difficult at village level where farmers follow almost similar practices in terms of farm operations and input quantities. However, the same quantities of input factors used by different farmers have different costs due to quality differences which led to changes in the levels of output. Thus, the quality of inputs in terms of costs is also important along with the conventional indicators of input quantities in explaining observed cross sectional differences in productivity and shortfall from potential yield. Available literature suggests that farmers in the developing countries fail to exploit the full potential of a technology or practice and make allocative errors (Kalirajan and Shand, 1989; Bravo-Ureta and Evenson, 1994; Shanmugam and Palanisami, 1994; Thomas and Sundaresan, 2000). Thus, increasing the efficiency in production assumes greater significance in attaining potential output at the farm level. Embarking on new technologies is meaningless unless the existing technology is used to its full potential (Kalirajan et al., 1996). Further, the analysis of variations between the potential and actual yields on the farm, given the technology and resource endowment of farmers, provide better understanding of the yield gap. Thus, technical efficiency is an indicator of the productivity of the firm and the variation in technical efficiency can reflect the productivity difference across firms.

Investigating the potential sources of TE in rural economies is important from a practical as well as a policy point of view. Bravo-Ureta and Pinheiro (1993) and Coelli and Battese (1996) identified a number of variables which influence TE in agriculture. Gorton and Davidova (2004) opined that there are two types of variables, viz., human capital and structural factors. Human capital includes variables such as formal and informal education, literacy, agricultural experience, training and farmer's age. The structural factors cover family income, family size, access to credit, land tenure status, gender composition of the labour force, off-farm employment and environmental variables. The impact of agricultural extension and training, education and agricultural experience on efficiency has been evaluated in several efficiency studies. For example, Stefanou and Saxena (1988) found that education and experience have significant positive effects on the level of efficiency, and in some cases these two variables can be treated as substitutes in explaining farm performance. Furthermore, O'Neill and Matthews (2000) studied the role of agricultural extension on farm efficiency in Ireland and found a positive relationship between these two variables. Kalirajan and Shand (1985) indicated that education and training have a strong and positive relationship with TE, especially among low-income farmers. Hence, the identification of those factors, which influence the technical efficiency of farming, is undoubtedly very significant for policy makers.

The Western Yamuna Canal (WYC) Command has a geographical area of about 13,543 km^2 and is located between 28° 20' to 30° 29' N latitude and 75° 48' to 77° 35' E longitude. The Command is spread mostly over the Haryana State and certain areas of Command have developed the twin problems of secondary soil salinization and waterlogging due to multiplicity of factors like, unlined canal system, excessive irrigation, shallow ground water depths and lack of adequate drainage in the Command area. The phenomena of water logging and salinization have led to substitution of paddy crop in k*harif* season (main rainy season, July to September) but the yield level always remain low with lower productivity of resources and high cost of production. Similarly, wheat is grown during the *rabi* season (mostly dry winter season, November to April) which is sown immediately after paddy.

In this background, the present study aimed to i) estimate technical efficiency (inefficiency) of individual farms related to paddy and wheat cultivation, which are the two important crops cultivated in two major crop seasons in a year in this region and ii) investigate influence of farmer-specific attributes on inefficiency in irrigated saline area of Haryana State.

MATERIALS AND METHODS

Study domain and data

The study area comprises the Western Yamuna Canal Command area in Haryana State of India. The Western Yamuna Canal takes off from River Yamuna and the main canal traverses eastern, central and southern parts of the State. A district, namely; Sonepat, located in this area was selected purposely as it has shallow groundwater depth and faces the problems of water-logging and secondary soil salinization. Thereafter, two villages, viz., Lath and Katwal were chosen randomly and 45 farmers cultivating paddy and the same number cultivating wheat were selected for detailed study. Information were collected through personal interviews of the respondents using structured and pre-tested interview schedule pertaining to the farm-specific socio-economic variables as well as crop cultivation practices during *kharif* (2010) as well as *rabi* (2010-11) season.

Theoretical framework

Since 1957, when Farrell (1957) published his seminal article on efficiency measurements, frontier techniques have been widely used in determining the farm-level efficiency in agriculture in developing countries. Production frontiers can be mapped (statistically or non-statistically, parametrically or non-parametrically) to find the locus of maximum output levels associated with given input levels, and estimate of farm specific TE as a deviation from the fitted frontier can be obtained. The stochastic frontier production function approach involving econometric estimation of parametric function (Aigner et al., 1977; Meeusen and Broeck, 1977) and non-parametric programming, known as data envelopment analysis (DEA) (Charnes et al., 1978), are the most popular among different major approaches followed to measure and estimate efficiency. The stochastic frontier approach is considered more appropriate for assessing TE in a developing country agriculture, where data are often heavily influenced by measurement errors and other stochastic factors such as weather conditions, diseases, etc (Fare and Lovell, 1985; Kirkley et al., 1998; Dey et al., 2005). To analyze determinants of technical efficiency or inefficiency traditionally, a stochastic production frontier is estimated first for measuring farm-level TE and then a second stage analysis (Lingard et al., 1983; Bravo-Ureta and Pinheiro, 1993) is performed where separate two-limit Tobit equations for TE are estimated as a function of various attributes of the farms/farmers in the sample. However, there is also argument that the socio-economic variables should be incorporated directly into the estimation of production frontier model because such variables may have a direct influence on the production efficiency. Keeping in view these advantages, stochastic production frontier approach have been employed in this study to obtain the farm-specific technical efficiency estimates.

Stochastic production frontier model

A stochastic production frontier model was used to measure the farm level technical efficiency (Aigner et al., 1977; Meeusen and van den Brock, 1977). The frontier production is the maximum feasible output which could be produced (of each firm) with a given level of input use and technology and measures efficiency of farms relative to their own frontier.

A stochastic production frontier with Cobb-Douglas functional form for the individual farms and crops is stated as follows:

$$\ln Y_i = \alpha + \sum_{j=1}^{5} \beta_j \ln X_{ij} + v_i - u_i$$

where, Y_i represents the actual output for the i^{th} sample farm unit; X_i is a vector of inputs and β is a vector of parameters to be estimated by the model which describe the transformation process, and v_i is random error term with normal distribution having mean zero and constant variance; u_i is the one sided error term reflecting technical inefficiency.

The variance parameters σ_u^2 and σ_v^2 were expressed in terms of parameterization (Battese and Corra, 1977): $\sigma_u^2 + \sigma_v^2 = \sigma^2$; $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ and $\lambda = \sigma_u/\sigma_v$ (>0). The parameter γ can take values from 0 to 1. A zero value of γ would indicate that the deviations from the frontier are entirely due to the noise and, in this case, the ordinary least squares (OLS) estimates of the model are equivalent to the MLE results. A value of one would indicate that all deviations are purely due to differences in TE across farms. The λ term with value above one would indicate that output variations due to inefficiency are higher than that due to random factors.

The dependent variable was the output or the yield obtained. The independent variables (X_j's) included in the model were number of ploughing, land preparation cost (that is, cost of ploughing), seed quantity (kg), cost of seed, transplanting cost (sum of cost of water supplied in puddled land and transplanting labour cost), quantity of fertilizers (nitrogen equivalent quantity of various types of chemical fertilizers and manures), inter-culture (man-days), irrigation (numbers), irrigation cost and the capital cost. Farmers use many sources of water, that is, canal water, electric tube-well, diesel pump-sets and buying water from the neighbor farmers. Cost of irrigation and quantity of water applied in each case differ vastly due to different costs and availability associated with each source. The capital cost represented the interest on the fixed capital like tractor, other machinery and water conveyance measures employed on the farms by the farmers. Mixed use of own resources and custom hiring is widely practiced in all types of farm operations which results in large variations in the cost. The flexibility in the use of resources helped in timely and better management of problem soils to the satisfaction of the farmers. In fact, the cost variables are the proxy for better management practices.

Inefficiency and its determinants

A farm unit with its actual output below the level given by the production frontier is termed inefficient and, therefore, the ratio of actual output of the farm unit to the potential output is the measure of technical efficiency of the individual farm unit. An inefficiency model was fitted and estimated simultaneously with the estimation of parameters of stochastic production frontier. The model for estimating technical inefficiency (TI) was specified as:

$$TI = u_i = \delta_0 + \sum_{j=1}^{7} \delta_j Z_{ij}$$

where, Z_{ij} is the vector of farm and farmer-specific characteristics, which included age, education of the head of the household, family size, total operational holding size (including leased in land) and access to irrigation sources. δ's are unknown parameters to be estimated for each Z_{ij} .

The above model for the inefficiency effects can only be estimated if the inefficiency effects are stochastic and have a particular distributional specification. This is ascertained by testing the following hypotheses: H_0: γ = 0, that is, inefficiency is absent and is not stochastic. If the null hypothesis (H_0) is rejected, it means that there are inefficiencies and the function could be estimated using maximum likelihood estimation method. If H_0 is not rejected, ordinary least squares method gives the best estimation of the production function.

The tests of these hypotheses for the parameters of the frontier are conducted using the generalized likelihood ratio statistics. The test statistic g is defined as:

$$g = -2[\ln(H_0) - \ln(H_1)]$$

where, ln (H_0) is the log-likelihood function of a restricted frontier model as specified by null hypothesis H_0; and ln(H_1) is the log-likelihood function of unrestricted model (alternate hypothesis). The test statistic (g) has a χ^2 or a mixed-χ^2 distribution with degrees of freedom equal to the difference between the parameters involved in H_0 and H_1.

The variables on farmers' characteristics included in technical inefficiency model were age (years), education (years of schooling/higher education), family size (number of family members), operational holding size (net area cultivated) and access to irrigation sources (dummy variable, which assumes a value 1, if the farmer has access to both canal water and tubewell and 0 if it has access to any one of these sources).

Estimation of the model

Given the assumptions of the above stochastic frontier models, the inference about parameters of the model can be based on maximum likelihood estimation (MLE) method (Aigner et al. (1977). The likelihood function for this model is:

$$\ln (L) = -N/2 \ln(\pi/2) - N/2 \ln(\sigma^2) + \Sigma [\ln \Phi (-\varepsilon i\ \lambda / \sigma) - 1 / 2 (\varepsilon_i / \sigma)2]$$

where, $\lambda = \sigma_u/\sigma_v$, $\sigma^2 = \sigma_v^2 + \sigma_u^2$, and Φ is the cumulative standard normal distribution function and $\varepsilon i = (v_i - u_i)$; σ_u and σ_v are standard deviations of the residuals u and v, respectively. The maximum likelihood estimation (MLE) method can provide the estimates of

Table 1. Summary statistics for variables in the stochastic frontier model for paddy and wheat farms.

Variables	Parameter	Paddy		Wheat	
		Mean	Std. deviation (s.d.)	Mean	Std. deviation (s.d.)
Output (q/ha)		37.4	4.8	39.0	8.4
Number of ploughing	β_1	6.0	1.5	6.5	1.5
Land preparation cost (INR/ha)	β_2	3829	1289	3600	478
Transplanting cost (INR /ha)	β_3	4753	428	-	-
Seed quantity (kg/ha)	β_4	12.45	0.50	106.5	11.6
Seed cost (INR /ha)	β_5	654	68.9	2150	207
Fertilizer (nitrogen equivalent) (kg/ha)	β_6	132	42.3	139.8	51.8
Inter-culture/plant protection (man days/ha)	β_7	20.3	9.6	7.8	4.3
Number of irrigation	β_8	17.5	5.9	3.8	0.6
Irrigation cost (INR /ha)	β_9	6005	2015	3252	1097
Capital cost (INR /ha)	β_{10}	11317	4585	9400	3517
Inefficiency variables					
Age of the farmer (years)	δ_1	47.4	15.0	47.3	15.4
Education (years of schooling)	δ_2	8.0	3.6	8.0	4.0
Family size (number of adult members in the family)	δ_3	7.4	3.9	8.2	4.2
Operational holding size (ha)	δ_4	3.7	2.8	4.5	3.5
Access to irrigation sources*	δ_5				

INR: Indian National Rupees, *Dummy variable, value = "1", if the farmer has access to both canal water and tube-well and "0" if it has access to any one of these sources.

the stochastic frontier production equation. The individual specific TE is given by the conditional mean of exp ($-u_i$), given the distribution of the composite error term, ε_i. Hence, the technical efficiency of the farmer, given the specification of the model, is defined by $TE_i = \exp(-u_i)$. The technical efficiency of farmer is between zero and one and is inversely related to the inefficiency model. The parameters of the stochastic frontier production function model are estimated by the method of maximum likelihood using the Computer Programme FRONTIER Version 4.1 (Coelli, 1996).

RESULTS AND DISCUSSION

Description of variables used

The descriptions of variables considered in the stochastic frontier model (Table 1) for paddy and wheat farms are subsequently provided in the paper.

Paddy

The mean output level of paddy was 37.4 q/ha in the study area with a standard deviation (s.d.) of 4.8 q/ha indicating not very large variations in output among the farms. On an average, farmers carried out 6 dry ploughing before puddling of the fields with s.d. of 1.5. However, the land preparation cost was INR3829 which varied highly across the farms as indicated by the high s.d. of INR1289. Transplanting cost, which included labour and water charges, was INR4753 with standard deviation of INR428. On an average of 12.45 kg per ha (s.d. of 0.5 kg per ha), seed valued at INR654 (s.d. of INR68.9) and 132 kg nitrogen equivalent (s.d. of 42.3 kg) was used. Labour engaged for inter-culture operations were 20.3 man days (s.d. of 9.6 man days). Total number of irrigations provided were 17.5 (s.d. of 6) and the cost of irrigation was INR6005 per ha. The capital cost worked out to be INR11317 with s.d. of INR4585.

Under inefficiency variables, the average age of the farmers was found to be 47.4 years s.d. of 15.0 years) with average of 8 years (s.d. of 3.6 years) of schooling. The average family size was 7.4 (s.d. of 3.9) and average operational holding was 3.7 ha (s.d. of 2.8 ha). Nearly 72% farmers were found having access to both canal and tube-well water for irrigating their paddy crop.

Wheat

The mean output level of wheat was 39 q/ha in the study area with a standard deviation of 8.4 q/ha indicating large variations in output among the wheat farms. On an average, farmers carried out 6.5 ploughing with s.d. of 1.5 implying there was not much variation among the farms. However, the land preparation cost was INR3600 with s.d. of INR478. On an average, seed cost was INR2150 (s.d. of INR207) and 140 kg nitrogen equivalent fertilizers (s.d. of 51.8 kg) were used. Labour engaged for

Table 2. Maximum likelihood estimates of parameters of the stochastic frontier production function and inefficiency model (paddy).

Variables	Parameters	Coefficient	Standard error	t-ratio
Constant	β_0	1.374*	0.381	3.602
Number of ploughing	β_1	-0.032	0.033	-0.975
Land preparation cost	β_2	-0.005	0.014	-0.392
Transplanting cost	β_3	0.622*	0.114	5.426
Seed quantity	β_4	-0.436**	0.203	-2.149
Seed cost	β_5	0.157**	0.063	2.472
Fertilizer (nitrogen equivalent)	β_6	0.010	0.024	0.425
Inter-culture/plant protection cost	β_7	0.008	0.013	0.642
Number of irrigation	β_8	0.017	0.029	0.584
Irrigation cost	β_9	-0.060**	0.025	-2.413
Capital cost	β_{10}	0.154*	0.014	10.447
Inefficiency model				
Age	δ_1	0.001***	0.001	1.369
Education	δ_2	0.006*	0.002	2.918
Family size	δ_3	-0.006**	0.003	-1.774
Operational holding size	δ_4	0.002	0.002	1.216
Access to irrigation sources	δ_5	-0.037***	0.026	-1.407
Variance parameters				
σ^2		0.002	0.001	4.225
γ		0.999	0.001	1411.90

*. **, ***: Significant at 1, 5 and 10% level, respectively; Log likelihood function = 95.764; Mean efficiency = 0.93.

inter-culture/plant protection was 7.8 man days (s.d. 4.3 man days). Total average number of irrigations provided were 3.8 (s.d. of 1.3) and the capital cost worked out to be INR11317 (s.d. of INR4585).

Under inefficiency variables, the average age of the farmers was found to be 47.3 years (s.d. of 15.4 years) with average of 8 years (s.d. of 4.0 years) of schooling. The average family size was 8.2 (s.d.of 4.2) and average operational holding was 4.5 ha (s.d. of 3.5 ha). Nearly 52% farmers were found having access to both canal and tube-well water for irrigating their wheat crop.

Parameter estimates of stochastic frontier production function and determinants of technical inefficiency

Paddy

Table 2 depicts the maximum likelihood estimates of stochastic production function frontier in case of paddy crop. The variables having significant positive coefficients were transplanting cost, seed cost and capital cost. Seed cost was considered separately from seed rate as some enterprising farmers tend to purchase good quality seed at higher costs from reliable quality stores. The use of these inputs indicates potential of increasing the level of production through raising their usage. However, the effect of seed (kg) and irrigation cost was found negative which indicates their over-use in production of paddy.

The estimated significant coefficients in the explanatory variables in the model for technical inefficiency indicate that inefficiency tend to decline as the family size and access to irrigation sources increases. The effect of age and education was found to be positive to the inefficiency, that is, inefficiency tended to increase with the higher age and education level. The younger farmers are more likely to tap the scientific knowledge in paddy cultivation. The results supports the findings of Singh (2008) who also reported positive relationship with the age and technical inefficiency of the wheat farmers in Haryana and argued that as the age increases the farmers tends to be more risk averter and hesitate to adopt new technologies making the production process inefficient. However, the results contradict the findings of Coelli and Battese (1996) who reported from a study of two villages in India that older farmers are relatively more efficient. However, the positive association of education and technical inefficiency is not in line with general perception. This phenomenon may be linked to the more employment opportunities available to educated people in the nearby metropolitan city of New Delhi and consequent neglect of agriculture. However, this needs to

Table 3. Maximum likelihood estimates of parameters of the stochastic frontier production function and inefficiency model (wheat).

Variables	Parameter	Coefficient	Standard error	t-ratio
Constant	β_0	9.99*	0.973	10.273
Number of ploughing	β_1	-0.083***	0.056	-1.481
Land preparation cost	β_2	0.215	0.395	0.544
Seed cost	β_3	-0.033	0.142	-0.234
Fertilizer (nitrogen equivalent)	β_4	0.013**	0.006	2.236
Plant protection cost	β_5	-2.075*	0.594	-3.489
Irrigation cost	β_6	2.259*	0.577	3.912
Capital cost	β_7	0.263*	0.037	6.960
Inefficiency model				
Age	δ_1	0.001	0.006	0.241
Education	δ_2	0.043**	0.025	1.713
Family size	δ_3	-0.061***	0.043	-1.407
Operational holding size	δ_4	0.005	0.014	0.366
Access to irrigation sources	δ_5	-0.324 ***	0.226	-1.430
Variance parameters				
σ^2		0.099	0.036	2.740
γ		0.999	0.000	3505.5

*. **, ***: Significant at 1, 5 and 10% level, respectively. Log likelihood function = 26.504. Mean efficiency = 0.840.

be looked into and tested separately for more evidences. The mean technical efficiency was 0.93 in paddy cultivation which indicates that the selected farms remained near the frontier and there is less scope to further increase the productivity at the existing technology.

Wheat

Table 3 depicts the maximum likelihood estimates of stochastic production function frontier in case of wheat crop. The variables having significant positive coefficients were fertilizer (nitrogen equivalent), irrigation cost and capital cost. The use of these inputs indicates potential of increasing the level of production through raising their usage. However, irrigation and capital costs included market based components like use of diesel pump sets and purchase or hiring of irrigation water from neighbour farmers and investments in water conveyance methods and other machinery. These activities help raise productivity by having more controls over farm operations and timely applications. The effect of number of ploughing and plant protection cost (including inter-culture) was found negative which indicates their over use in production of wheat. These point towards the need for more intensive knowledge dissemination on input use in the current technologically advanced cultural practices scenario.

The estimated coefficients in the explanatory variables in the model for technical inefficiency indicate the association between various farm specific socio-economic characteristics and inefficiency effects. It was observed that inefficiency tend to decline as the family size and access to irrigation sources increases. The effect of education was found to be positive to the inefficiency which indicated inefficiency tended to increase with the higher level of education. The findings need to be investigated further as it contradicts with the hypothesis of Schultz (1964) that education increases the ability to perceive, interpret and respond to new events and enhances farmers' managerial skills, including efficient use of agricultural inputs. However, it is very plausible that the farmers with education may be attracted/associated with other employment opportunities and consequently offers less attention to the agricultural operations.

The mean technical efficiency was 0.84 in wheat cultivation which implies that the farmers can increase their output by 16% without additional resources through more efficient uses of existing inputs and technology. Frequency of occurrences of farmers indicates that 33% farms have technical efficiency below 0.80 and 22% of sample farms were operating close to the frontier with technical efficiency estimate of more than 0.95.

Frequency distribution of technical efficiencies

Table 4 presents the distribution of estimated technical

Table 4. Frequency distribution of technical efficiencies.

TE ranges	Paddy		Wheat	
	No. of farms	%	No. of farms	%
<0.70	0	0	6	13.3
0.71-0.80	0	0	9	20.0
0.81-0.85	0	0	3	6.8
0.86-0.90	6	13.3	8	17.8
0.91-0.95	21	46.7	9	20.0
>0.95	18	40.0	10	22.3
Total	45	100	45	100

efficiencies among selected wheat and paddy farms. The technical efficiency values were grouped into six categories, that is, below 0.70, 0.70 to 0.80, 0.81 to 0.85 and 0.86 to 0.90, 0.91 to 0.95 and above 0.95. The result shows that, in case of wheat, the farms were fairly distributed among the selected categories. Six farms (13.3%) were having technical efficiency below 0.70. The number of farms in the ranges 0.71 to 0.80, 0.81 to 0.85, 0.91 to 0.95 were 9 (20.0%), 3 (6.8%) and 8 (17.8%), respectively. The number of farms in technical efficiency ranges from 0.91 to 0.95 and 0.96 to 1.0 were 9 (20%) and 10 (22.3%), respectively.

In paddy cultivation, no farm was having technical efficiency below 0.86. The number of farms in the ranges 0.86 to 0.90 and 0.91 to 0.95 were 6 (13.3%) and 21 (46.7%), respectively. The numbers of farms in technical efficiency range above 0.96 were 18 (40%). Therefore, paddy farms were more skewed to higher efficiency ranges due to water logging and consequent more uniform cultivation practices.

Conclusion

The estimated mean technical efficiency of 0.93 in paddy production imply that farmers were doing their best in current situation of water logging and salinity build up in the Command area and have limited maneuverability in the prevailing conditions. The unexploited potential in paddy cultivation was only 7%. However, in case of wheat, it was revealed that realized mean technical efficiency was 83%, signifying an unused potential for productivity enhancement.

The study indicated that transplanting cost, seed cost and capital cost in paddy cultivation positively influenced the output level indicating their under use and scope to further increase the output by enhancing their quality. Similarly, in wheat cultivation, fertilizer (nitrogen equivalent), irrigation cost and capital cost positively and significantly influenced the level of output with an indication of their further enhancement. So, the results revealed a significant association between the output levels, and the cost parameters which are the proxies for the quality of inputs. Hence, the farmers need to have state support in terms of availability of quality inputs and appropriate knowledge for enhancing their efficiency level to realize higher yields. The existing negative coefficients of seed rate and irrigation cost, in case of paddy and number of ploughings and plant protection cost (including inter-culture), in case of wheat, indicate their over-use in the cultivation process.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Aigner DJ, Lovell CAK, Schmidt P (1977). Formulation and estimation of stochastic frontier production function models. J. Economet. 6(1):21-37.

Battese GE, Corra GS (1977). Estimation of a production frontier model with application to the pastoral zone of eastern Australia. Aust. J. Agri. Econ. 21:169-179.

Bravo-Ureta BE, Evenson RE (1994). Efficiency in agricultural production: The case of peasant farmers in Eastern Paraguay. Agric. Econ. 10(1):27-37. http://dx.doi.org/10.1016/0169-5150(94)90037-X

Bravo-Ureta BE, Pinheiro AE (1993). Efficiency analysis of developing country agriculture: A Review of the frontier function literature. Agric. Res. Econ. Rev. 22:88-101.

Charnes A, Cooper WW, Rhodes E (1978). Measuring the efficiency of decision making units. Europ. J. Oper. Res. 2:429-44.

Coelli TJ (1996). A Guide to FRONTIER Version 4.1: A computer program for stochastic frontier production and cost function estimation. CEPA Working Paper 96/07, Centre for Efficiency and Productivity Analysis, University of New England, Armidale, NSW P. 2351, Australia.

Coelli T, Battese G (1996). Identification of factors which influence the technical inefficiency of Indian farmers. Aust. J. Agric. Econ. 40(2):103-128

Dey MM, Paraguas FJ, Srichantuk N, Xinhua Y, Bhatta R, Dung Le TC (2005). Technical efficiency of freshwater pond poly-culture production in selected Asian Countries: Estimation and implication. Aqua. Econ. Manage. 9:39-63.

Fare SG, Lovell CAK (1985). The measurement of efficiency of production. Boston: Kluwer-Nijhoff Publishing.

Farrell MJ (1957). The measurement of productive efficiency. J. Royal Stat. Soc. 120(3):253-290.

Gorton M, Davidova S (2004). Farm productivity and efficiency in the CEE applicant countries: A synthesis of results. Agric. Econ. 30:1-16.

Kalirajan KP, Obwona MB, Zhao S (1996). A decomposition of total factor productivity growth: The case of Chinese agricultural growth before and after reforms. Am. J. Agric. Econ. 78:331-338. http://dx.doi.org/10.2307/1243706
Kalirajan KP, Shand RT (1989). A generalized measure of technical efficiency. Appl. Econ. 21:25-34.
Kalirajan K, Shand R (1985). 'Types of education and agricultural productivity: A quantitative analysis of Tamil Nadu rice farming'. J. Dev. Stud. 21:222–243.
Kirkley JE, Squires D, Strand IE (1998). Characterizing managerial skill and technical efficiency in fishery. J. Prod. Anal. 9:145-160.
Lingard J, Castillo L, Jayasuriay S (1983). Comparative efficiency of rice farms in Central Luzon in the Philippines. J. Agric. Econ. 34:163-173.
Meeusen W, Broeck J van den (1977). Efficiency estimation from Cobb-Douglas production functions with composite error. Int. Econ. Rev. 18(2):435-444.
O'Neill S, Matthews A (2000). Does contact with the extension service improve farm efficiency? Paper Presented at Permanent Seminar on Efficiency and Productivity, University of Oviedo, Asturias, Spain.
Schultz TW (1964). Transforming traditional agriculture. New Haven, CT: Yale University Press.
Shanmugam TR, Palanisami K (1994). Measurement of economic efficiency – frontier function approach. J. Ind. Soc. Agric. Stat. 45(2):235-242.
Singh S (2008). An analysis of factors affecting technical efficiency: A study of wheat cultivation in Haryana. Arth Anvesan 2(2):3(1):9-14.
Stefanou S, Saxena S (1988). Education, experience and allocative efficiency: A dual approach. Am. J. Agric. Econ. 2:338-345.
Thomas K, Sundaresan R (2000). Economic efficiency of rice production in Kerala. Bihar J. Agric. Mark. 8(3):310-315.

Filename: Kalra et al pdf
Directory: \\192.168.1.24\qa operation data\Agric. Sci\AJAR\2015\QA\2. Feb\NUMBERED\12 February\AJAR-13.11.13-8229(Tega)\Publication\proof
Template: C:\Users\Daniel\AppData\Roaming\Microsoft\Templates\Normal.dotm
Title:
Subject:
Author: Azeez
Keywords:
Comments:
Creation Date: 1/23/2015 9:42:00 AM
Change Number: 69
Last Saved On: 2/13/2015 8:58:00 AM
Last Saved By: Daniel
Total Editing Time: 1,316 Minutes
Last Printed On: 2/13/2015 8:58:00 AM
As of Last Complete Printing
Number of Pages: 8
Number of Words: 5,147 (approx.)
Number of Characters: 29,343 (approx.)