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WORKER EFFECT OF EDUCATION IN PADDY PRODUCTION : A CASE STUDY IN ORISSA

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Introduction

Orissa, one of the states of India, lies on the Bay of Bengal and is bordered by Andhra Pradesh, Jharkhand, and West Bengal states. Situated in a tropical savanna that is subject to cyclones, it has large rural population, which is mainly engaged in agriculture. Therefore, agricultural economy of the state is much dependent on the productivity of land. Orissa with its total geographical area of 15,540 thousand hectares the net sown area covered under different crops for agricultural purposes accounts for 59.90 thousand hectares, of which the gross irrigated land works out at 18.54 thousand hectares with a gross cropped area of 82.75 thousand hectares. Some distinctive features of agriculture in Orissa, which have relevance to planning, are - the pressure of population on land and the inadequacy of irrigation. About 40% of the geographical area of the state has been exploited for agricultural use. The exploitation has been the maximum in the coastal districts of Balasore, Cuttack, Puri and Ganjam, which have extensive areas of fertile alluvial soil. Temperature in Orissa is adequate for cropping of all crops although some crops such as wheat are limited by lower winter temperature. The main crops include rice, oilseed, jute and sugarcane. Agriculture continues to be the mainstay of the state's economy with contribution about 28.13 percent to the Net State Domestic Product during 2001-02. Agriculture alone provides direct and indirect employment to around 65 per cent of the total workforce of the state as per the 2001 census. Although, the contribution of agriculture to the state income has significantly declined, the percentage of the workforce engaged in agriculture has remained somewhat unchanged. This implies that there has been overowding in agriculture without any perceptible increase in production. The net availability of food grain, although increased from 393 grams in 1951-52 to 521 grams in 2001-02, is much below the national average figure. Therefore, agricultural growth holds the key to the overall development of the state by way of creating employment, generating income, providing raw material to the industrial sector and last but not the least ensuring self reliance in food production and food security to the deprived section. One way

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to achieve sustainable agricultural development is to raise the productivity of their farm by improving efficiency within limits of the existing resources and available technology.

The present paper is an empirical analysis of the measurement of the technical efficiency of the effective farm households through frontier Cobb-Douglas Production function. The parameters of the production function are estimated with the help of the maximum likelihood method, using the computer programme FRONTIER 4.1 developed by Coelli (1994). The estimated efficiency of the farmers are regressed with other exogenous variables such as the average education of the family of the farm household, education of the effective farm house hold, and experience of the farm household to prove the significance of these exogenous variables of the farm households efficiency. The present paper consists of the following five sections. Section II throws light on the survey of the literature. Section III is about the empirical model specification. Methodology of the study is explained in Section IV. The section V is about the results and conclusion of the study and bibliography is in the last section.

Survey of Literature

This section is about the review of the worldwide available literature on the issue of the effects of education on efficiency in the farm production. The first part is about the role of education in the farm production and the last part is about the review of the empirical results of all the studies made so far.

The Role of Education in Farm Production

Many of the ways in which, education have a significant and a beneficial impact on the farm productivity grows out of Human Capital theory (Schultz, 1971). Simply put, the theory maintains that formal schooling will enhance the ability of the farmers to work with a production inputs at their disposal and to produce more output with fewer inputs. Education contributes to this result by increasing the cognitive abilities of the farmers. In microeconomic theory of perfect competition, allocative ability as a source of return to a factor is ruled out. With Perfect and complete information, there is no room for the superior concept of superior alternative technology since in equilibrium all alternatives are equally good at the margin. In other words, perfect information implies that the return to a factor is proportional to its marginal contribution to physical product. For education and some other intangibles, it was not clear that the direct contribution to physical production accounts for the total revenue.

There have been attempts to modify the competitive model to allow for 'entrepreneurial capacity', but the return to these factors is always considered as 'residual', which does not help for marginal analysis. As an alternative to computing marginal factor revenue as being proportional marginal physical product in which all other things remain constant is the implications of variations of an input (education) whose function, in part, is to vary the use of other inputs (Welch, 1970).

The productive value of education has its root in two distinct phenomena. Increased education simply may permit a worker to accomplish more with resources at hand. This 'Worker effect' is the marginal product of education as it is normally defined, that is the increased output per unit change in education, holding other factor quantities constant.

On the other hand, increased education may enhance the worker's ability to acquire and decode information on cost and productive characteristics of other inputs. As such a change in education results in a change in other inputs including perhaps the use of some new factors that otherwise would not have used. In other words, higher levels of schooling entails the farm household to select the inputs and allocate the inputs in more efficient manner, which helps reducing the cost of production and increasing the revenue. This is other wise known as the 'allocative effect' of education. The return to education is therefore, considered as consists of two effects – 'worker effect and allocative effect'. In a pioneering study exploring the economic effects of education, Z. Grilliches (1964) used production function analyis to highlight the contribution of education in agricultural productivity. However, following Welch (1970), the subsequent literature has not deemed it necessary to maintain the distinction between the innovative and allocative effect.

Prof. Choudhuri (1968) has made the first clear-cut distinction between worker and allocative effect. Indeed, there have been many empirical tests of the effects of education on farm productivity. These studies generally have employed Cobb-Douglas production function. However, it has been shown that the engineering production function misses much of the education on production[1]. All the three measures – worker effect allocative effect and input selection effect can be measured by estimating engineering, gross sales and value added production function. A function with gross sales as the dependent variable will measure the allocative effect. A function with value added as the dependent variable and fixed inputs and education as the independent variables will estimate all the three effects (Pudasaini, 1983). But lack of information on the prices of inputs does not give a clear picture of the allocative

1 Welch (1970) hs shown that the engineering production function measures only the worker effect and neglects the allocative effect and input selection effect.

effect. Another problem with the traditional production function approach is that it may obscure the effects on education by mixing all farms into estimation.

Survey of the Empirical Results

A plenty of empirical studies have been made both in developed and developing countries such as USA, Korea, Chaina, Japan and developing countries including India. Evidence, from thirteen low-income countries, shows that farm productivity increases, on an average, by 8.7 per cent as a result of a farm completing four years of elementary education (Lockheed *et.al.*, 1980). Birkhauser *et.al.* (1991) reviewed Forty-seven studies from 17 countries and found that 33 studies show significant and positive extension effect. Past studies in India are mainly focused on testing whether resources (fixed and variable) are allocated efficiently in line with the allocative hypothesis of Schultz (1964) using production function method (Hopper, 1965; Reddy, 1967; Sahota, 1968; Saini, 1968 and others) and later on applying stochastic and deterministic frontier production function (Aigner, 1977) and profit function method (Kalirajan, 1981). However, only a few studies considered education as a factor of production and estimated its economic contribution using farm level and district level data (Chaudhuri, 1979; Sidhu, 1986). Research towards identifying and understanding the role of education can be categorized into two parts. In the first part, the technical efficiency part is investigated between two groups of farmers either educated or uneducated or traditional and modern farmers (Welch, 1970; Moock, 1981; Lockhead *et.al.* 1980; Pudasaini, 1983; Dhakal *et.al*, 1987; Azhar, 1991). In another sudy, Phillip (1994) used Meta Analysis revised by Lockheed *et.al.* The studies conducted to study allocative efficiency of education in the production are (Huffman, 1977; Ram, 1980). The studies used to analyze both technical and allocative efficiency are (Welch, 1970; Ram, 1980; Pudasaini, 1982, 1983; Duraiswamy, 1992, 1994; Mohapatra, 1998).

Empirical Model Specification

Efficiency measurement and the procedure of Maximum Likelihood estimation are the basic theoretical constructs on which this study is conceptualized. In economic analysis, much is concerned with the technical and economic efficiencies or resource transformation and allocation (Coelli, 1994). Production efficiency is concerned with the relative performance of the process used in transforming inputs and output. The concept of efficiency goes back to the pioneering work of Farrell (1957).

Farrell's measure of efficiency depends on the existence of the efficient production function with which observed performance of a firm can be compared. A production function based on the 'best' practical results would have to be used as a reference for measuring individual performance. However, due to the problem of complication, Farrel considered it better to compare performance with the best obtained than to set up some unrelizable ideal.

The stochastic frontier models, independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Vandent Broek (1977) and extended by Jondrow *et.al.* (1982), were used in alalyzing the data. The stochastic frontier production function is defined by

$Y_i = F(X_i, \beta) \exp(V_i - U_i), _I = 1$ .... N .... (1)

Where:-
Y_1 = output of the ith firm
X_i = corresponding (**m** x **z**) input vector of inputs
β = vector of unknown parameters to be estimated

V_i, the random variables of exogenous shock, are assumed to be iid [N $(0, \sigma_v^2)$] and independent of the term U_i which are nonnegative random variables and are assumed to account for technical inefficiency in production and are often assumed to be iid [N $(0, \sigma_u^2)$]. The efficiency scores of the farms are regressed with the exogenous variables, such as, education of the farm household, average education of the family and experience of the farm households.

The efficiency scores of the farm households are obtained by the maximum likelihood Estimation (MLE). The MLE method provides estimators that are asymptotically consistent and efficient. The parameters of the stochastic frontier function model are estimated by the MLE using the computer program FRONTIER 4.1 (Coelli, 1994).

In order to test the contrinbution of education on technical efficiency of the farm household, primary data from 200 households have been collected from the Goleipur Panchayat of Jajpur district of Orissa. This study area was chosen because of the following four reasons: first, the farmers are dynamic in the sense that they use allthe HYV paddy seeds; second, the study area in linked to almost all the major commercial area of the district; third, the national Highway-5 passes amidst the study area, which creates an excellent communication facilities to the farmers in the area; four, the farmers consider education as a common and basic necessity of the people. The farm households are directly contacted and interviewed personally on the basis of the objectives of the study mentioned in the questionnaire. The questionnaire was framed both in English and Oriya to make the farmers confortable in answering them.

Methods of Analysis

The stochastic frontier production function is expressed as

$LnY_i = \beta_0 + \Sigma\beta_i lnX_i + (V_i - U_i)$ ....(2)

The explicit form of the model written in Cobb-Douglas production function form is

$Ln\mathbf{VO} = \beta_0 + \beta_i\, ln\mathbf{VC} + \beta_2\, ln\mathbf{NSA} + \beta_3\, ln\mathbf{LBH} + \beta_4\, ln\, \mathbf{BLKH} + \beta_5\, ln\mathbf{MAN} + \beta_6\, ln\mathbf{FER} + \beta_7\, ln\mathbf{PEST} + (V_i - U_i)$ .... (3)

Where, VO = value of output in rupees;

NSA = Net Sown Area in Acres (1 acre = 100 dcml);

LBH = Labour hour (1 LBH is equal to 6 hours);

VC = Value of the capital (calculated at 12% depreciation per annum);

BLKH = Bullock Hour;

FER = fertilizer in Kg. (N+P+K);

PEST = Value of Pesticides;

MAN = Manures in quintals.

β_i s are unknown parameters to be estimated, $\mathbf{V}_i$s are iid [N (0, σ_v^2)], U_i s are nonnegative random variables called technical inefficiency effects, which are associated with technical inefficiency of production of the farm households and are assumed to be independent of the V_i and are the nonnegative truncation (at zero) of the normal distribution with mean, μ and variance σ^2. The technical efficiency score of the ith farm is expressed as exp (U_i), Since the objective is to test the impact of the education (years of schooling completed) on the technical efficiency score of the effective farm household, all the technical efficiency scores are regressed with the average education of the family, education of the effective farm household, experience of the farm household and the education dummy[2]. Education dummy will be σ_1 when the farm households schooling is between 11 years to 13 years. It will be σ_2 when the years of schooling is in between 8 to 10 and it will be σ_3 when the years of schooling is between 3 to 7 years. The linear regression equation used to estimate the effects of education and other exogenous variable on the estimated efficiency score of the farm household is

$TE = \beta_0 + \beta_1 AEF + \beta_2 EXP + \beta_3 EEH + \delta_i + U$ .... (4)

Where the error term U is iid [N (0, σ)] and all the β_i s follow the BLUE. The estimates of the equation (4) are presented in the Table-1

Tabe-1

Estimates of the parameters of the Frontier production function

Variables	β coefficient	Coefficient	t-ratio
Constant	β_0	5.50226	4.4530***
VC	β_1	-0.17826	1.9276*
NSA	β_2	1.66936	1.7655
LBH	β_3	0.31229	2.20513**
BLKH	β_4	0.26684	0.37793
MAN	β_5	0.12613	1.0276
FER	β_6	0.29996	2.5587**
PEST	β_7	3.49998	7.0832***
Sigma-squared	σ^2	1.30469	6.9066***
Gama	γ	0.78268	12.683***
Log Likelihood Function	-	-	-238.68

*** Shows 1% level, ** shows 5% level and * shows 10% level of significance.

The coefficients of the parameters estimated shows that, the use of the primary factors, such as, land, labour, capital, fertilizers and pesticides are important and statistically significant. The coefficient of VC is negative and statistically significant. It implies that the farm households keep unnecessary fixed capital in the form of bullocks, farm machinery that are not used frequently, even though they could be used for other pruposes. Hoever, the positive and statistically significant coefficient for fertilizer and pesticide shows that the agricultural practices are heading towards more mechanization and use of HYV seeds is more prominent and more familiar among the farmers. The sigma-square is statistically significant. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. The frequency distribution of the farm-specific efficiency scores is presented in the table-2. 42.5 per cent of the total farmers have achieved 60 to 80 percent efficiency scores and 36% are in between 40 to 60 per cent efficient.

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[2] *A number of empirical studies (Pitt and Lee, 1981) have estimated stochastic frontiers and predicted farm level efficiency using these estimated functions and then regressed the predicted efficiencies upon farm-specific variables to identify some reasons for differences in predicted efficiencies between farms in an industry.*

Table-2

Fequency Distribution of Technical Efficiency Scores

Class of Efficiency scores	Frequency	% of total farm Households
00 – 0.2	18	9
0.2 – 0.4	21	10.5
0.4 – 0.6	72	36
0.6 – 0.8	85	42.5
0.8 – 1.0	4	2

The technical efficiency indicates derived from the MLE results of the stochastic production function are regressed with the exogenous variables, such as, Average education of the Family (AEF), Experience of the Effective Household (EXP) and the education of the Effective household (EEH). The results of the regression coefficients are shown in Table-3.

Table-3

Results of the regression equation (4)

Variables	Coefficients (t-value)	Coefficients (t-value)	Coefficients (t-value)	Coefficients (t-value)	Mean (SD)
Constant	0.277 (4.408)***	0.324*** (4.722)	0.311*** (4.867)	0.493*** (6.617)	53% (3.2)@
AFE	0.002 (0.355)	0.015*** (2.868)	0.013** (2.764)	0.006 (1.080)	8.24 (2.5113)
EXP	0.003 (0.683)	0.007 (1.482)	0.007 (1.520)	0.003 (0.655)	12.245 (2.64)
EEH	0.025*** (4.482)	-	-	-	8.19 (2.6)
Dummy 1	-	0.001 (0.013)	-	-	
Dummy 2	-	-	.0.072*** (3.001)	-	
Dummy 3	-	-	-	-0.105*** (3.833)	
R^2	0.152	0.066	0.107	0.128	
F	11.752	4.586	7.798	9.503	
N	200	200	200	200	

*** Shows 1%, ** shows 5% level of significance

@, Indicates the mean of the dependent variable.

The results in the second column of table 2 shows that one year increase of education of the effective household raises the efficiency level on the average, by 2.5 percent. Of course, the effects of the other variables are positive but not significant. However, the average education of the family becomes positively significant when education variable is replaced by the education dummy (δ_1). It indicates that the educated farmer with college level education considers and implements the decision of the family members. The education dummy δ_2 is positive and stastically significant. But the most important fact is that when the levels of education are very low, the dummy variable shows negatively significant effect on the efficiency index of the farmers. It is quite natural that the farmers having less years of education face difficulty in gathering information about the modern technology, decoding the information, analysis and diffusion of the available information into the farm practice. When, other farms adopt a new and better technology with good return, the other farmers follow it blindly without understanding it. For example, some farmers use fertilizer in the faith that it will increase the productivity without the knowledge of the consequences of indiscriminate use of fertilizer. Most often, the farmers use both fertilizer and pesticides in the wrong time leading to the reduction in the production. Ever since, Chaudhuri has rearticulated this idea as "lapses back into Illiteracy". According to Nelson-Phelps-Sehultz hypothesis, the effect of education is supposed to differ over time, as the time passes and new technological diffusions are made in the field of agriculture, the knowledge either from primary schooling or from higher primary schooling is totally outdated to grasp and implement that into practice.

Conclusion

In conclusion, it can be said that, human capital in form of education (formal schooling) plays an important and significant role in the sphere of agricultural production, which is very much dynamic in nature. From this aspect, it can be strongly argued that introduction of education linked to the farm practice must be introduced in the schools and colleges. The government should make initiatives in realizing the recent much-popularized program 'Sarva Siksha Aviyan.' Orissa, being an agricultural economy, the education curriculum in the schools must be linked to the farming method, so that it an help the drop-outs to engage them in agriculture in an efficient manner. Introducing farm-linked education system in the educational institute, especially in the primary and high school education, not only improves the efficiency of the farm households but also makes the people self-dependent, thereby, reduces the pressure of unemployment burden on the economy and leads to higher economic growth.

References

1. Azhar, R. A., (1991), "Educational Efficiency during the Green Revolution in Pakistan", *Economic Development and Cultural Change,* Vol.39, No.3.

2 Aigner, D. J. Lovell; C. A. K. and P. J. Schmidt, (1977), "Formulation and Estimation of Stochatic Frontier Production Model", *Journal of Econometrics,* Vol.6, pp. 21-37.

3. Banker, R.D., Charnes, A. and Cooper, W.W.., (1984), "Some models for Estimating Technical nd Scale Inefficiency in Data Envelopment Analysis," *Management Science,* 30, pp.1078-1092.

4. Birkhaeuser, D: Evenson, R.E. and Feder, G., (1991): "The Economic Impact of Agricultural Extension: A Review", *Economic Development and Cultural Change,* Vol. 39 (3) April.

5. Choudhuri, D.P., (1968), *Education and Agricultural Productivity in India,* PhD Thesis, University of Delhi, Delhi.

6. Choudhuri, D.P., (1979), *Education and Innovation and Agricultural Development : A Study of North India (1960-72)*, London Croom Helm, Ltd.

7. Coelli, T.JU., (1994), "A Guide to frontier 4.2: A computer Programme for Stochastic Frontier Production and Cost Function Estimation, Development of Econometrics, University of England, Armidale, NSW 2351, Australia.

8. Duraiswamy, P. (1992) "Effects of Education and Extension Contact", *Indian journal of Agricultural Economics,* Vol.47, No.2, PP.205-14.

9. Duraiswamy, P. (1994), "Technical and Allocative Efficiency of Education in Agricultural Production: A Profit Function Approach", *The Economic Journal,* Vol. XXV, No.1.

10. Farrell, M.J. (1957), "The Measurement of Productive Efficiency", Journal of Royal Statistical Society, A CXX, Part 3, pp.253-290.

11. Grilliches, Z., (1963), "The Sources of Measured productivity Growth: United States Agriculture, 1940-60", *Journal of Political Economy,* pp. 331-346.

12. Hopper, D.W., (1965), "Allocative Efficiency in a traditional Agriculture", *Agricultural Journal of Farm Economics,* Vol. 47, No.3, PP.611-24.

13. Huffman, W., (1977), "Decision Making: Allocative Efficiency: The Role of Human Capital",, *Quarterly Journal of Economics, Vol. 91, No.1-4, pp.5.*

14. Jondrow, J.C.K. Lovell, M. and Schmidt, P. (1982): "On the Estimation of Technical Inefficiency in Frontier Stochastic Production Function," *Journal of Econometrics,* Vol. 19, PP. 233-38.

15. Kalirajan, K., (1981), "The economic Efficiency of farmers Growing High Yielding Irrigated Rice in India", *American Journal of agricultural Economics,* Vol. 63, No.3, pp.566-70.

16. Lockhead *et.al.* (1980), "farmer Education and farm efficiency: A Survey", *Economic Development and Cultural Change,* Vol. 29, No.1, October, pp.37-76.

17. Meeusen, W. and Broeck Vanden, (1977), "Efficiency Estimates from Cobb-Doughlas Production Function with Composed Error," International Economic *Review,* Vol. 18, PP. 435-44.

18. Mohapatra, R., (1998), "Effects of Education on Technical and Allocative Efficiency in Farm Production : Evidence from Orissa", *Indian Journal of Economics,* No.312.

19. Moock, P.r., (1981), "Education and Technical Efficiency in Small Farm Production, *Economic Development and Cultural Change,* pp.722-39.

20. Nelson, R and Phelps, E., (1966), "Investment in Humans Technological Diffusion and Economic Growth", *American Economic Review*, Vol. 56, pp 69-75.

21. Philip, J.M., (1994), "Farmer Education and Farm Efficiency: A Meta Analysis", *Economic Development and Cultural Change,* pp. 149-65.

22. Pudasaini, S, (1983), "The Effects of Agriculture : Evidence from Nepal", *American Journal of Agricultural Economics,* Vol. 65, pp. 509-515.

23. Pudasaini, S., (1982), "The Contribution of Education to Allocative Efficiency in Sugarcane Production in Nepal", *Indian Journal of Agricultural Economics,* pp. 8-55.

24. Ram, R., (1980), "Role of Education in Production: A slightly New Approach", *Quarterly journal of Economics,* Vol. 95, September, pp. 365-73.

25. Sahota, G.S., (1968), "Efficiency of Resource Allocation in Indian Agriculture", *American Journal of agricultural Economics,* Vol. 50, No.3, pp. 584-605.

26. Saini, G.R., (1968), "Resource Use Efficiency in Agriculture", *Indian Journal of agricultural Economics,* Vol. 24, April-June.

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

28. Schultz, T.W., (1971), "*Investment in Human Capital*", Free Press, New York.

29. Welch, F., (1970), "Education in Production", *Journal of Political Economy,* Vol. 78, No.1, Jan-Feb.