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Effects of Education and Extension Contacts on Agricultural Production

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I

INTRODUCTION

The pioneering works of Schultz (1961) and Dension (1962) show that much of the modern economic growth of nations can be attributed to improvements in human capital. Mellor (1976) argues that rural development can only be achieved in conjunction with large expansion of formal education, due to the complementarity of education with new production inputs such as high-yielding varieties (HYVs), fertiliser, pesticides, etc., Although it is well recognised that human capital is an important factor in increasing the skill levels, productivity, dissemination of new technology, etc., very few attempts have been made to study the impact of various forms of human capital such as formal schooling, health, nutrition and information on agricultural production in the Indian context.

The literature on the role of human capital on farm production is surveyed by several researchers (Welch, 1978, pp. 271-277; Chaudhri, 1979, pp. 85-105; Norton and Davis, 1981; Jamison and Lau, 1982, pp. 232-249; Evenson, 1989; Birkhaeuser *et al.*, 1991). Evidence from thirty-seven data sets from 13 low income countries, summarised in Jamison and Lau (1982), show that farm productivity increases on an average by 8.7 per cent as a result of a farmer completing 4 years of elementary education and the effect of education is much more stronger in modernising environment than in traditional ones. Birkhaeuser *et al.* (1991) reviewed forty-seven studies from 17 countries and find that thirty-three studies show a significant and positive extension effect. These reviews indicate that very few attempts have been made to study the impact of education and extension services on farm productivity in India.

Past studies in India are mainly focused on testing whether resources (fixed and variable inputs) are allocated optimally, in line with the allocative hypothesis proposed by Schultz (1964), using production function method (Hopper, 1965; Reddy, 1967; Saini, 1968; Sahota, 1968 and others) and more recently applying the profit function methods (Sidhu and Baanante, 1981; Kalirajan, 1981; Kalirajan and Flinn, 1981; Subramaniyan, 1986.[1] Only a few studies have explicitly considered education as a factor of production and estimated its economic contribution using farm level (Chaudhri, 1979; Sidhu, 1978) and district level data (Ram, 1980). However, these studies are based on data from early or pre-green revolution period (around 1960 and 1970) and both the studies on farm level data are for the wheat belt of Punjab and Uttar Pradesh. The recent studies by Singh and Bhullar (1979) and Feder and Slade (1984) and Feder *et al.* (1987) on extension effect are also confined to North

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Indian states of Punjab, Haryana and Uttar Pradesh. To our knowledge, there is no published work on the role of education and extension contacts on farm production for the paddy dominant South India. This study constitutes such an attempt.

In this paper an attempt has been made to estimate the economic contribution of education and extension contacts on farm production using farm level data from one of the paddy dominant regions of South India - Tamil Nadu. We prefer to use the production function rather than the profit function method since the latter approach is less advantageous to estimate the economic returns to schooling and extension contacts on farm output. The neutral and non-neutral technical effects of education and the returns to scale are also tested.

The paper is organised as follows. In Section II, the role of education on agricultural production and the conceptual framework is discussed. The data, empirical specification and estimation are provided in Section III. The empirical results are presented and discussed in Section IV, followed by concluding remarks in the last section.

II

CONCEPTUAL FRAMEWORK

Education's contribution to agricultural production and productivity consists of worker and allocative effects.[2] The 'worker effect' of education refers to the technical efficiency - a more educated farmer's ability to produce more output from a given bundle of inputs. The worker effect arises because education may improve the quality of labour component.

The 'allocative effect' of education refers to allocative efficiency - the ability of the educated farmers to obtain, analyse and understand economically useful information about inputs, production and commodity-mix, which enhances their ability to make optimal decisions with regard to input use and product mix.[3]

Under perfect competition, given prices of inputs and outputs and technology (information about the production process), there is no scope for allocative efficiency. However, in a dynamic modernising agriculture with changing technology, farmers face imperfect information and make allocative errors, in the sense of not being able to equate the marginal value product (MVP) of inputs to their respective opportunity costs. The presence of disequilibria arising out of such changes in technology may create incentives for farmers to learn and adjust their resources towards attaining an optimum level. The allocative hypothesis proposes that education enhances the productive skills of persons by making them to adjust quickly to disequilibria (Schultz, 1975). It is expected that farmer's education and extension contacts enable him to acquire, receive and decode new information, to evaluate benefits of alternative sources of economically useful information and to have earlier access to such information. This kind of increase in information-acquisition is likely to constitute a major source of higher allocative and productive efficiency among more educated farmers.

Chaudhri (1979) is the first (in 1968) to have made a clear distinction between the worker and allocative effects of education. Welch (1970) provides the theoretical framework to estimate the worker and allocative effects of education from parameter estimates of production functions. According to Welch, the worker effect can be estimated by estimating an engineering production function for a single commodity with education as one of the inputs. Consider an engineering production function:

$$(1)\ Q = q\,(X, E)$$

where Q is the physical output of a single crop, X is a vector of quantities of variable and fixed inputs and E is a vector of education, extension and other environmental variables. In this case the marginal product of education refers only to the worker effect, the ability to get more (physical output), given the resources at hand. Welch argues that in this production there is no room for allocative ability, since the question of allocation does not arise.

The allocative effect of education can be measured by estimating a production function for gross value of all crops produced by a farm. Consider the gross value production function

$$(2)\ G = g\,(Z, E)$$

where G is the gross value of output from all crops, Z is a vector of fixed and variable factors of production. Maximisation of G requires technical efficiency and also allocative efficiency. If we suppose that the allocation of Z among its competing uses is a function of education, then the marginal product of education captures the gains due to worker and allocative effects (Welch, 1970).

III

DATA, EMPIRICAL SPECIFICATION AND ESTIMATION

The data used in this study come from a primary survey conducted by the author in 1980-81 in Tamil Nadu. The 24 development districts of Tamil Nadu are classified into two groups based on agro-climatic aggregate characteristics. One district from each group is selected at random and the selected districts are East Coimbatore (Periyar) and North Salem. Using simple random method three taluks from each district and two villages from each taluk were subsequently selected. From the selected villages a list of farm households was prepared and 10 per cent of these households were selected at random. The survey thus covered 461 households from 12 villages in two development districts of Tamil Nadu. Detailed information pertaining to inputs, outputs and prices of all crops cultivated in 1980-81 and other environmental data such as socio-economic and education characteristics of the household members were collected. The main crop cultivated in this area during the rainy season is paddy and about 70 per cent of the farmers (323) in our sample cultivated it. The single crop production function is estimated for paddy cultivators and gross sales function is estimated using data from all farm households.

There are two major approaches used in estimating and testing the worker and allocative effects of education, namely, the production function and profit function methods. Although the profit function method offers several advantages over the production function method in testing the hypotheses related to various economic efficiencies (Duraisamy, 1990), it is more appropriate to use production function to measure the economic returns to education and extension services on output, not on profit.[4] Hence, we prefer to use the production function method rather than other methods such as frontier production function, profit function and linear programming in this study.

The choice of functional form for the engineering and gross sales production function (1) and (2) is a matter of empirical question. The choice depends on flexibility, computational ease, relevance for the study and comparability with previous studies. In this study we experimented with two functional forms - Cobb-Douglas and Translog.[5] However, the parameter estimates of the translog production functions (1) and (2) are contaminated due to collinearity between the square and cross product terms. Hence we resort to the familiar Cobb-Douglas form. The log-linear specification of the production functions (1) and (2) can be written as:

$$(3) \quad Y_{ij} = \beta_{oj} + \beta_{ij} \ln L_{ij} + \beta_{2j} \ln F_{ij} + \beta_{3j} \ln B_{ij} + \beta_{4j} \ln K_{ij} + \beta_{5j} \ln T_{ij} + \gamma_j \ln R_{ij} + \delta_{1j} \ln ED_{ij} + \delta_{2j} EXT_{ij} + u_{ij}$$

i = 1,...., N farms

j = engineering, gross value function

where

Y = the quantity of paddy output (in kilograms) in the engineering function (Q) and the gross sales value of all crops produced (in rupees) during the crop year 1980-81 (G),

L = the labour days (owned, hired and exchanged),

F = the quantities of fertiliser and organic manure (in kilograms) owned and purchased,

B = the animal (bullock) labour days,

K = the value of capital services (in rupees), sum of interest (12 per cent) and depreciation on fixed capital,

T = the area of land cultivated (in acres),

R = region dummy variable takes the value of one if the farm is located in East Coimbatore district and zero otherwise,

ED = measured as years the education of the head of the household (farm operator) or dummy varible (ED 1) takes the value of one if the head of the household completed at least 4 years of schooling and zero otherwise[6] or education level dummy variables defined as ED 2 for less than or equal to 3 years, ED 3 for 4-8 years, ED 4 for 9-11 years and ED 5 for above 11 years of education of the head of the household,

EXT = extension contact measured as number of times contacted (continues) or dummy takes the value of one if the head of the household contacted the extension agents and zero otherwise,

u = the independant and identically distributed random error term assumed to be normally distributed with zero mean and constant variance

and β, γ, δ = parameters of the production functions, to be estimated.

The education and extension variables are tried with alternative forms (continuous and dummy) in order to study the sensitivity of the production elasticities. In addition to the above, the age of the head of the household (to capture the farming experience - on the job training) and average education of the adult members of the household are also included.

The arithmetic mean and standard deviation of the variables in the single crop (paddy) and gross value production functions are given in the last column of Tables I and II respectively.[7]

The production functions (3) are estimated by Ordinary Least Squares (OLS) method.[8]

IV

EMPIRICAL RESULTS

Estimates of Paddy Production Function

The OLS parameter estimates of Cobb-Douglas engineering production function for paddy with alternative specification of the education and extension service variables are reported in columns 1 to 5 of Table I. The production elasticities of all the inputs - labour, fertiliser, animal input, capital and land - are positive and statistically significant at 10 per cent or above except animal input and capital. The production elasticities are more stable across the specifications, indicating that these inputs are crucial to the production of paddy, The parameter estimate of the regional dummy variable which takes account of the soil, weather and climatic variations across the two regions (districts) is also positive and statistically significant.[9]

TABLE I. REGRESSION ESTIMATES OF ENGINEERING PRODUCTION FUNCTION: SINGLE CROP (PADDY), TAMIL NADU, INDIA, 1980-81

Dependent variable: Ln output of paddy

Independent variable	1	2	3	4	5	Mean (Std)
Constant	4.830	4.876	4.925	4.928	4.949	7243.11[a]
						(8521.73)
L Labour	0.387	0.370	0.364	0.361	0.364	376.34
	(8.651)	(8.324)	(8.210)	(8.089)	(8.174)	(416.21)
F Fertiliser	0.059	0.053	0.049	0.049	0.051	771.05
	(2.209)	(2.025)	(1.886)	(1.860)	(1.939)	(974.14)
B Animal input	0.032	0.039	0.037	0.035	0.037	26.87
	(1.229)	(1.495)	(1.421)	(1.325)	(1.419)	(28.30)
K Capital	0.033	0.033	0.030	0.030	0.026	356.38
	(1.258)	(1.265)	(1.170)	(1.248)	(0.981)	(372.62)
T Land area	0.531	0.526	0.535	0.542	0.531	4.14
	(9.408)	(9.420)	(9.640)	(9.702)	(9.526)	(4.21)
R Region dummy	0.261	0.270	0.271	0.270	0.269	0.573
	(7.721)	(7.870)	(8.131)	(8.074)	(8.085)	(0.495)
E Education of head		0.009				5.760
		(2.860)				(4.680)
AE Average education of household members					0.012	4.810
					(2.414)	(3.84)
ED1 Education dummy ($E \geq 4$)			0.008			0.650
			(2.463)			(0.477)
ED3 Education dummy ($4 \leq E \leq 8$)				0.027		0.393
				(0.698)		(0.489)
ED4 Education dummy ($9 \leq E \leq 11$)				0.081		0.152
				(2.377)		(0.357)
ED5 Education dummy ($E > 11$)				0.087		0.105
				(1.697)		(0.307)
EXT Extension contact		0.0007				6.740
		(0.372)				(9.250)
EXD Extension dummy ($EX > 0$)			0.059	0.064	0.054	0.653
			(1.819)	(1.977)	(1.647)	(0.477)
AGE Age of the head					-0.0009	41.590
					(-0.055)	(8.94)
$\bar{R}^2$	0.946	0.947	0.947	0.948	0.948	
F	937.09	723.31	731.01	582.39	533.88	
N	323	323	323	323	323	323

Figures in parentheses in cols. (1) to (5) are t-values.
a. Mean and standard deviation of the dependent variable.

The years of education of the head of the household has a positive and statistically significant effect (column 2). The calculated MVP for one year of education, the worker effect, is approximately Rs. 108.86. This seems to be little lower than the worker effect on wheat production of Rs. 150.12 obtained by Chaudhri for 1960-61 and of Rs. 172.90 estimated by Sidhu for 1967-71. The annual returns at sample mean education of the head (5.76 years) is Rs. 627.03. In the next specification, education of the head is treated as a dummy variable and introduced as a shift parameter in production. The coefficient is positive and statistically significant. The result suggests that the educated farmers get about one per cent higher paddy output than the uneducated farmers. The coefficient estimates of education level dummy variables are positive but the effect of ED 3 (3-8 years) is not significantly different from ED 2 (less than 3 years schooling). The estimated effects on output is 2.7, 8.1 and 8.7 per cent for 3-8 years, 9-11 years and above 11 years of education respectively. This suggests that the farmers having higher than middle school level education has higher returns to their schooling in paddy production. The average education of the household members also has a positive and significant effect. The impact is a little bigger than the years of education of the head of the household.

The extension variable, a form of non-formal education, has a positive effect on output but it is statistically significant only at 10 per cent level when it is introduced as a dummy variable.[10] The coefficient estimates suggest that there is a 6 per cent increase in the output if the farmer had any extension contact.

The estimate of the returns to scale, 1.009, is not significantly different from unity [F(1, 316) = 1.51] implies that the production relation for paddy is constant returns to scale.

Estimates of Gross Value Production Function

The regression estimates of the multi-crop production function are given in columns 1 to 5 of Table II. The production elasticities of labour, fertiliser, capital and land are positive and statistically significant. The animal input elasticity is positive but not significantly different from zero as in the paddy production. The education of the head of the household exerts a positive and statistically significant effect in both continuous and dummy variable form. The parameter estimates suggest that one year increase in the education of the farm head yields a return (worker and allocative effects) of Rs. 365.51 per year. The returns to allocative effect of education is Rs. 256.65.[11] An earlier study by Sidhu (1978) shows that the allocative returns to education is Rs. 668.46 for Punjab. The coefficient of education dummy implies that the educated farmers get 4 per cent higher value of output than the uneducated farmers. The coefficients of education dummy variables are positive but ED 3 is not significantly different from the reference group, ED 2. This implies that less than middle school level education does not exert a significant impact on farm productivity. The average education of household members also has a significant positive effect.

The extension dummy has a positive effect and its effect is significant only when it is introduced as dummy variable. The results suggest that the value of output increases by 9-10 per cent if the farmer has contacted extension service for guidance. Previous studies by Singh and Bhullar (1979) and Feder *et al.* (1987) found that the extension effect is 18 and 15 per cent respectively.

TABLE II. REGRESSION ESTIMATES OF GROSS VALUE PRODUCTION FUNCTION: MULTI-CROP PRODUCTION, TAMIL NADU, INDIA, 1980-81

Dependent variable: Ln gross value of output from all crops

Independent variable	1	2	3	4	5	Mean (Std)
Constant	3.541	3.557	3.569	3.564	3.603	30459.33[a]
						(46850.89)
L Labour	0.351	0.357	0.354	0.356	0.357	1151.62
	(12.855)	(13.208)	(13.045)	(13.254)	(13.187)	(1371.64)
F Fertiliser	0.329	0.322	0.319	0.323	0.323	3261.64
	(10.493)	(10.381)	(10.185)	(10.385)	(10.371)	(4760.18)
B Animal input	0.029	0.019	0.025	0.021	0.019	118.71
	(1.307)	(0.868)	(1.167)	(0.963)	(0.865)	(297.34)
K Capital	0.050	0.049	0.047	0.048	0.048	1809.44
	(3.452)	(3.412)	(3.266)	(3.364)	(3.331)	(2932.23)
T Land area	0.371	0.356	0.355	0.346	0.356	13.69
	(10.189)	(9.788)	(9.720)	(9.546)	(9.688)	(16.04)
R Region dummy	0.176	0.168	0.175	0.171	0.169	0.495
	(4.645)	(4.327)	(4.624)	(4.581)	(4.274)	(0.501)
E Education of head		0.012				5.792
		(3.127)				(4.446)
AE Average education of household members					0.014	4.306
					(2.901)	(4.539)
ED1 Education dummy			0.043			0.636
(E ≥ 4)			(2.228)			(0.482)
ED3 Education dummy				0.010		0.388
(4 ≤ E ≤ 8)				(0.259)		(0.488)
ED4 Education dummy				0.068		0.150
(9 ≤ E ≤ 11)				(1.964)		(0.357)
ED5 Education dummy				0.193		0.098
(E > 11)				(3.283)		(0.297)
EXT Extension contact		0.0004			0.002	30.824
		(0.971)			(1.032)	(44.425)
EXD Extension dummy			0.099	0.085		0.677
(EX > 0)			(2.457)	(2.138)		(0.468)
AGE Age of the head					-0.001	41.063
					(-0.571)	(7.604)
$\bar{R}^2$	0.93	0.94	0.94	0.94	0.94	
F	937.09	723.31	731.01	582.39	531.42	
N	461	461	461	461	461	461

Figures in parentheses in cols. (1) to (5) are t-values.
a. Mean and standard deviation of the dependent variable.

The estimated returns to scale is 1.129 which is not significantly different from unity at 5 per cent level [F (1, 454) = 3.47]. The explanatory power of the model is high, *i.e.*, 93 per cent and the R^2 remains constant across alternative specifications.

Neutral and Non-neutral Effects of Education

The estimates of the production functions, presented above, assume that the effect of education is neutral. That is, education changes the whole production function by a multiplicative scale factor. This assumption on the neutrality effect of education is tested using F-test. The procedure consists of estimating the production functions separately for educated and uneducated farmers and testing the equality of coefficients in the two groups. The computed F(6,N-K) statistics for single crop paddy and multi-crop production functions are 0.05 and 0.07 respectively, which are not statistically significant. Hence, the null hypothesis that education has a neutral effect is accepted.

An alternative method to test the neutral technical effect of education is to interact education dummy variables with all inputs and test whether the interaction terms are jointly significant. The results show that none of the interaction terms is significantly different from zero. This confirms the fact that the production elasticities of the inputs in educated and uneducated categories of farms are homogeneous, as observed in F-test. Hence, the results are not reported.

V

CONCLUSIONS

The economic contribution of farmer's education and extension contacts are examined by estimating the engineering and gross sales production functions. The empirical results based on the farm level data from one of the paddy dominant regions of India, Tamil Nadu, suggest that education has a positive and significant effect on single and multi-crop production. One year increase in the education of the head of the farm household increases the paddy output by one per cent and the gross sales value from all crops by 4 per cent. In monetary units, one year additional year of education yields the worker effect of Rs. 109 and the allocative effect of Rs. 257. The results also imply that above middle school level of education is needed to have a significant impact on farm productivity. Education seems to have a neutral technical effect on farm production. Average education of the adult members of the household has a little bigger effect than the education of the head of the household on farm production.

The extension effect on paddy output is about 6 per cent and on the gross value is about 10 per cent. These results call for more investment in formal schooling in rural areas and extension services to accelerate the agricultural growth.

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NOTES

1. See Rudra (1973) for a critical appraisal of the methodology used in testing the allocative efficiency hypothesis.
2. The literature also identified other benefits of education, namely, innovative effect, market efficiency (Jamison and Lau, 1982) and externality effect (Chaudhri, 1979). Using the same data set, Duraisamy (1989) examines the innovative effect of education on the adoption of high-yielding varieties. Due to lack of data, no attempt has been made in this study to ferret out the market efficiency and the externality effect of education.
3. Welch's (1970) concept of allocative effect has two components: input allocation and input selection. The latter is called the innovative effect.
4. Although it is possible to derive the production elasticities from the parameter estimates of profit function, the standard errors cannot be computed and hence the tests of hypotheses on production elasticities and education coefficients cannot be performed.
5. The CES function is another candidate which has less restrictive assumptions. In this case, the parameters of the production function should be estimated by non-linear Maximum Likelihood methods. The difficulty in using CES is not the computational complexity, given software packages for PCs, but the inherent problems in finding global optimum using non-linear optimisation techniques.
6. According to UNESCO standard, at least four years of schooling is necessary to retain the literacy and numeric skills.
7. The standard deviation of a dummy variable is the square root of $(1-\mu)\mu$, where μ is the mean of the dummy variable. The mean of the education reference group, ED2 (< 4 years), is one minus the mean of ED1 ($\geq$ 4 years).

8. It is often criticised that the OLS estimates are inconsistent since the output and inputs are simultaneously determined through the condition of profit maximisation. Griliches (1957), Zellner *et al.* (1966) and others argued that there will not be any simultaneous equation bias if there is a lag in the input and output decision and assuming that the farmers maximise expected rather than actual profit. Further, the extension variable cannot be conveniently treated as exogenous since more productive farmers have inclination to meet the extension agents (Birkhaeuser *et al.*, 1991). We ignore this source of simultaneous equation bias as there is no identifying instrument in the data set to handle this problem.

9. Unless otherwise qualified a 5 per cent level of significance is assumed for the rest of the discussions.

10. The poor performance of the number of extension contacts variable is due to collinearity between this and the years of education of the head of the household variable. This problem is considerably reduced by introducing extension as a dummy variable in columns 3 to 5.

11. It is possible to generate the income streams for different levels of education. This, together with published information on unit cost of education one can compute the private rate of return to education for the rural sector (see Chaudhri, 1979 for details).

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