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Education and Agricultural Productivity in Asia: A Review*

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Rural development strategies that 'overrated land and underrated human beings' have not succeeded considerably (Schultz, 1981). It is realised that "the fundamental problem of agricultural growth is an education problem" (Wharton, 1965). Hence, the need for education arises for rural development in general and agricultural development in particular. It is necessary to note in this context that education has two components: *(a)* education for peasants which improves their skills, replaces their traditional attitudes, with modern ones, which improves their innovative and allocative abilities, etc. and *(b)* research in agriculture which provides the peasant with new techniques of production and new inputs as well. This paper presents a review of research on the role of education in rural development in general and in farm efficiency in particular, in the Asian countries, with respect to these two components. After briefly describing the various effects of education on agricultural productivity in Section I, a short review is attempted in Section II of the methodologies adopted in analysing the impact of education on agricultural productivity; Section III summarises the empirical aspects of the vast research evidence; and the last section presents a short summary and concluding observations.

I

EFFECTS OF EDUCATION ON FARM PRODUCTIVITY

The mechanisms through which education enhances the productivity of farmers are of various kinds. It enables the farmer to produce larger quantities of output from the same quantities of inputs, as it helps him to allocate resources in a cost efficient manner, choosing which and how much of each output to produce, and in what proportions to use inputs in production (Jamison and Moock, 1984, p. 68). The physical effects of education on agricultural productivity of workers include a few distinct ones (see Welch, 1970; Schultz, 1975): *(a)* innovative effects such as ability to decode new information, know what, why, where and how; ability to establish quicker access to newly available economically useful information, *(b)* allocative effects such as ability to choose optimum combinations of crops and agricultural practices in least number of trials and ability to choose optimum time for marketing, transportation, etc., *(c)* worker effects such as ability to perform agricultural operations more efficiently in economic sense, and *(d)* externalities. The worker effect is related to the enhanced capacity of production with a given set of inputs, and the allocative effect has to do with the farmer's ability to acquire and decode information about costs and productive characteristics of other inputs. A central effect of the allocative effect is the capacity to evaluate and adopt profitable new technologies. Education enhances the productivity of labour directly; it lowers the cost of deciphering information about the production technology, which thereby increases productive efficiency by enhancing the selected mix of output and inputs; and it facilitates more rapid entrepreneurial response to

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disequilibria created by changes in output and input prices and by the introduction of new inputs and production technologies. Thus there is significant direct and indirect impact of education on farm efficiency.

Differences in educational levels were found to explain one-quarter to one-half of the differences in labour productivity in agriculture between the United States, on the one hand, and India and the Philippines in Asia, on the other (Hayami and Ruttan, 1970, p. 906). A survey of evidence on 37 countries concluded that on an average, education of four years of primary schooling of farmers would enhance the farm output by 8.7 per cent (Lockheed *et al.*, 1980).

II

A REVIEW OF RESEARCH: ALTERNATIVE METHODOLOGIES

Literature on education and rural development in Asia is overwhelming, and confirms strong positive effect of education on agricultural productivity.[1] While in all, one finds a variety of approaches being adopted to study the effect of education on agricultural productivity, including simple coefficients of correlation, simple and multiple linear and non-linear regression equations, internal rates of return, and simple bi-variate distribution of the sample in terms of two-way tables, etc., use of Cobb-Douglas production function of the form

$$Y = f(X_i, E_i) \qquad \text{....(Equation 1)}$$

where Y is a measure of agricultural productivity,
X_i is a set of traditional and/or modern inputs, and
E_i is a set of educational variables

dominates the research. The traditional inputs generally include area under cultivation, labour input, irrigation facilities and manure. Modern inputs, other than education and technical know-how, include chemical fertilisers, level of mechanisation, high-yielding variety (HYV) of seeds, etc. Sometimes linear production functions relating output to various independent variables have also been adopted. Mostly either elasticities of agricultural output with respect to education have been estimated using double logarithmic equations; or simply the marginal productivity of education is estimated with the help of linear equations. As Lockheed *et al.* (1980) summarised, at least five variants of the production function have been used in the literature, as follows:

$$\ln Y = a_0 + a_1 \ln L + a_2 \ln T + \beta \ln E + \gamma EXT \qquad \text{....(Equation 1.1)}$$
$$\ln Y = a_0 + a_1 \ln L + a_2 \ln T + \beta E + \gamma EXT \qquad \text{....(Equation 1.2)}$$
$$\ln Y = a_0 + a_1 \ln L + a_2 \ln T + \beta D + \gamma EXT \qquad \text{....(Equation 1.3)}$$
$$Y = a_0 + a_1 L + a_2 T + \beta E \qquad \text{....(Equation 1.4)}$$
$$Y = a_0 + a_1 L + a_2 T + \beta D \qquad \text{....(Equation 1.5)}$$

where Y refers to output, T area under cultivation, L labour input, E the educational level, EXT indicator of exposure of the farmer to extension, and D is defined as an indicator variable that takes the value of 1 if E takes a value in a specified range, and 0 otherwise (see also Lockheed, 1987).

It is clear that β in equation 1.1 gives the elasticity of output with respect to education; in equation 1.2 it gives the percentage increase in output in response to a unit change in education; in equation 1.3 it gives the percentage increase in output of a farm with the farmer's educational level specified as D, compared with illiteracy (or no education); in equation 1.4 it gives the marginal increase in output in response to a unit change in education; and in equation 1.5 β gives the increase in output with the farmer's specified number of years of education, compared with illiterates. Equations 1.4 and 1.5 are less used than the former three equations.

Alternatively, the contribution of education to agricultural productivity is also estimated in terms of rate of return, which is estimated either with the help of regression equations, or the internal rate of return (IRR) is estimated. In the case of estimation of IRR, the earnings (or the net income) of the farmers are related to costs of their education. Estimation of IRR involves estimation of a discount rate that equates the costs of education to the life-time benefits of the farmers, which itself is called the rate of return to education. The rate of return is a discount rate that equates the present value of life-time benefits of education to the present value of costs of education. The rate of return (r*) is estimated by solving the following equation:

$$\sum_{t=s}^{n} [(E_t - C_t) / (1 + r^*)] = 0 \qquad \text{....(Equation 2)}$$

where E_t represents earnings differentials associated with a given level of education over the life-time for t years, and C_t the costs of education, s minus n being the working life of the individual. In simple terms, the higher the rate of return, the higher is the effect of education on productivity.

While the rate of return method has been extensively used in general, its application to measure the productivity of education to agriculture is very limited. Even in those very few cases, it is not the agricultural output that was studied, but the rate of return to education in rural areas (*e.g.*, Tilak, 1992), or the rate of return to agricultural graduates (*e.g.*, Shortlidge, 1974), or returns to investment in agricultural research (*e.g.*, Nagy, 1985; Evenson and Kislev, 1975; Kahlon *et al.*, 1977).

The rate of return method is used mostly with respect to the effect of education on wage earnings,[2] which led many to question the very marginal productivity hypothesis, besides several other aspects. In fact, analysis of the effect of education on farm productivity is also used to answer some of the criticisms levelled in the context of the rate of return method, against the relationship between education and productivity. The most important part of the criticism of the returns approach is that it is based on the assumption that earnings reflect productivity, and that the relationship between education and productivity is spurious. Education might increase earnings, but not necessarily productivity. The criticism is effectively answered, by measuring productivity not in monetary terms, but in real output in agriculture.

A few studies also used simple coefficients of correlation to analyse the relationship between education and the farm output. The correlations explain the nature of association between the two, but not the direction of the relationship or the cause and effect relationship between the two, even though correlations derived from methods like path analysis (*e.g.*, Harker, 1973) serve better. Tetrachoric correlations, cross tabulation of the farmers' educational levels and their output, or tabulation of farmers' education and several farm activities (*e.g.*, Raza and Ramachandran, 1990), also belong to the same category.

As mentioned earlier, of the three approaches, the production function analysis has been most extensively used in the literature for obvious reasons: it is a more standard methodology, allows controlling for a variety of factors, so that the effect of education can be isolated, and it clearly establishes the nature and quantum of effect of education on agricultural productivity. Most of the research reviewed in the following section used one form or other of the production function.

Education entered the production function mostly defined as years of schooling, though use of dummy variable defined to represent various levels of education is also not uncommon, as used, for example, by Jamison and Lau (1982) in their study on Malaysia. In a few other studies (*e.g.*, on Nepal), a single dummy variable is used (E = 1, if the years of schooling exceed 5; or if the farmer is literate; and zero otherwise). The education variable is also defined in relation to the actual farm operator, or the head of the household (Jamison and Lau, 1982, on Thailand), or to the average of years of schooling of all the adult members of the household (*e.g.*, Chaudhri, 1968, 1979, on India; Jamison and Lau, 1982, on Korea), or to all agricultural adult workers in the household. Since education is believed to produce externalities, it would be generally more justified to consider the educational levels of all the members of the household, rather than confining to the educational level of the worker alone. It would have been, however, more desirable, to estimate total (not the average) educational level of a household, even though a method to measure the same is yet to be developed.

In almost all cases, the dependent variable is the value of farm production. Harker (1973) used, however, gross farm sales in Japan, and so did some of the researchers on Nepal and Taiwan. Net farm earning is also used but more rarely (*e.g.*, Halim's study in the case of Philippines).[3]

III

SUMMARY OF EMPIRICAL RESEARCH EVIDENCE

In India a strong effect of literacy and education on agricultural productivity per hectare was reported by several researchers from Chaudhri (1968) to Ram (1980). Using the multiple linear regression model of the log-linear form, Chaudhri (1968) fitted a production function of an unrestricted Cobb-Douglas type, and found strong influence of education on agricultural productivity in India. In Bangladesh, Nepal, South Korea, Philippines, and Malaysia, etc., education was found to enhance productivity substantially. The productivity of farmers is influenced by the technical knowledge of the farmers in Malaysia (Bhati, 1973).

The contribution of education to agricultural productivity is quite high in South Korea, Malaysia and Thailand (Jamison and Lau, 1982). One year of additional education was estimated to increase productivity by 2.22 per cent in South Korea, by 3 per cent in Thailand, and by as high as 5.11 per cent in Malaysia. Quite interestingly, the effect of education is higher in the case of non-mechanised farms, 2.33 per cent, compared to mechanised farms, 2.22 per cent in South Korea. On farms using chemical fertilisers in Thailand, one year of additional education increases productivity by 3.15 per cent, while on farms using non-chemical fertilisers, by 2.43 per cent only. Social rates of return are also calculated to rural schooling under various assumptions, which ranged from 25 to 40 per cent in Malaysia, 14 to 25 per cent in Thailand, and 7 to 11 per cent in South Korea. Interestingly, the effect of education on agricultural productivity declines with the increase in size of the farms, suggesting that the effect of education is greater for the small and poor marginal farmers than for the rich and big landlords.[4]

The use of modern inputs such as fertilisers, machines, etc., is also found to be positively influenced by education. In Thailand farmers with 4 years of schooling were three times more likely to use new chemical fertilisers than farmers with 1-3 years of schooling (World Bank, 1991, p. 57). Significant positive effects of education of farmers on demand for fertilisers, and on demand for various inputs, including negative effect on demand for bullock labour were found in Bangladesh (Khandker, 1988). Khandker (1988) incorporated 'input management ability' of the farmers as a behavioural component into the normal production function framework, and found significant impact of education on the farmers' supervisory skills and on farm production. Farmers' ability refers to ability to supervise and use of appropriate quality and quantity of traditional inputs (human and bullock labour) and ability to manage modern inputs. Utilisation of credit facilities, better irrigation facilities and use of improved seeds, fertilisers and pesticides were found to be positively associated with educational levels in rural households in India (Raza and Ramachandran, 1990). Education is also found to reduce the indebtedness of the rural households in India (Seetharamu, 1985).

Further, the impact of education on agricultural productivity is substantially influenced by socio-cultural factors in the society. Another study on Punjab in India (Chaudhri, 1979) also reaffirmed these findings.

Some evidence to the contrary is also found in a few countries in a few selected contexts. For example, correlations between education and farm sales, and variables on agricultural adoption in Japan were statistically non-significant (Harker, 1973). Effects of cognitive aspects of education on adoption of fertilisers in Nepal were very weak (Jamison and Moock, 1984; see also Dey, 1978).

The relationship between education and agricultural development is also not one way. Agricultural development increases farm incomes, and this might increase the educational levels of rural population. For example, high levels of agricultural production in 1961 in India resulted in high levels of literacy during the sixties, but high levels of rural literacy in 1961 did not cause higher levels of agricultural production between 1961 and 1971 (Barnes *et al.*, 1982). As Berstecher (1985, p. 52) summed up, "the causality behind these relationships (between education and rural development - farmers' incomes, occupational status, and land holding) is known to cut both ways. Perhaps the most plausible interpretation would be one of a cumulative relationship: the initial economic and social status of a rural family is likely to enhance its demand for schooling. Children from such families study longer and with greater success. Few would dispute that their educational achievements subsequently contribute to greater productivity and higher income levels."

Research on a few comparable studies in Asia is summarised in Tables I to IV. Table I presents some estimates on coefficients of education on agricultural output in several Asian countries. Based on several research results, Jamison and Lau (1982) re-estimated the per cent gain in output for each year of additional education[5] as given in Table II. It has been accordingly estimated that the contribution of education varies between 0.7 per cent gain in rice production in Taiwan for each year of education to 5.11 per cent in Malaysia. On an average, one year of formal education increases the output by 2.5 per cent. It should be noted that all the coefficients in Tables I and II are positive, and in many cases they are statistically significant.

Further, some studies reflected on threshold level of education. In Nepal, a minimum threshold level of 6-7 years of schooling was found to be necessary before education influences productivity. In Taiwan too, the effect of education turns positive from negative at 6.6 years of schooling of the farm operators (Wu, 1977). At least 4 years of education was found to be critical in Thailand farming, as the coefficient of education was found to increase between 4 and more than 4 years of education (Jamison and Lau, 1982). Chaudhri (1968, 1979) showed that the threshold level of education to have a significant effect on productivity increased over time to secondary level from primary education. Secondary level, or at least the level above upper primary is found to be strongly associated with the use of modern inputs in India (Raza and Ramachandran, 1990).[6]

TABLE I. COEFFICIENT OF EDUCATION IN AGRICULTURAL PRODUCTION FUNCTIONS

Country/ Author (1)	Reference year (2)	Description (3)	Average years of education (4)	Coefficient of education (5)	t- value (6)	R^2 (7)	N (8)
Korea	1961	Log-linear	Farm	0.712	3.05	0.85	895
Hong		Cobb-Douglas	operator	0.927	1.46	0.85	
Jamison	1973	Mechanised farming	Continuous	0.022	4.97	0.66	1,363
and Lau		Non-mechanised farm-ing	Continuous	0.023	2.95	0.61	541
India	1961-64			0.116	5.04	0.59	1,038
Chaudhri			Head of the household	0.114	3.65	0.59	1,038
Siddhu	1968-71	Mexican wheat	Family aver-age (adult)	0.036	1.90	0.92	369
		Traditional and Mexican wheat		0.038	2.25	0.92	236
Philippines	1963		Weighted for	0.020	1.53	0.77	274
Halim	1968		the workers in	0.019	1.26	0.70	273
	1973		family	0.027	2.25	0.80	220
Taiwan	1964-66	Rice farms	Farm	0.007	0.53	0.60	333
Wu		Banana and pineapple farms	operator	0.038	2.83	0.65	316
		Quadratic forms		0.009	0.95	0.87	310
				-0.066	1.82		
				0.005	2.12		
Nepal	1968-69	Wheat farms	Literacy	0.142	1.80	0.84	87
Sharma		Rice farms	Literacy	0.082	1.78	0.95	138
Thailand	1972-73	Chemical farms	Head of the	0.031	2.10	0.76	91
Jamison and Lau		Non-chemical farms	household	0.024	2.27	0.81	184
Malaysia	1973		Literate	0.109	1.61	0.69	403
Jamison			1-3 years	0.071	1.14		
and Lau			4 or more years	0.186	2.60		
Nepal Calkins	1973-74		7 or more years	0.530	3.53	0.77	540
Pudasaini	1975			0.014	1.71	0.90	102

Secondary Source: Jamison and Lau (1982).

TABLE II. EFFECT OF EDUCATION ON FARM OUTPUT IN ASIAN COUNTRIES

Country (1)	Year (2)	Description (3)	Percentage gain in output for each year of education (4)
South Korea	1973	Mechanised farming	2.22
		Non-mechanised farming	2.33
Malaysia	1973		5.11
Thailand	1972-73	Chemical fertilisers used	3.15
		Non-chemical fertilisers used	2.43
Nepal	1975		1.30
	1968-69	Wheat	5.09
		Rice	2.85
India	1968-71	Wheat	1.49
		Mexican wheat	1.41
Taiwan	1964-66		0.90
	1971	Rice	0.70
		Bananas and pineapples	3.87
Philippines	1963		2.20
	1968		1.92
	1973		2.74

Source: Jamison and Lau (1982).

While temporal comparisons need to be made with caution, as the different researchers had adopted different methodologies, different samples, and chose different variables, some comparisons still seem to be not inappropriate. The results of three studies on the Philippines, all conducted by the same author on somewhat comparable samples in 1963, 1968 and 1973, clearly indicate that the effect of education on agricultural output seems to increase over time, as shown in Tables I and II. Barring this, the available results do not allow us to make comparisons over time.

In monetary terms, one year of additional education of the head of the household was estimated to increase Rs. 153.12 in Indian agriculture (Chaudhri, 1968). A similar increase in the average years of schooling of the family will result in a gain of Rs. 107.43 per year (Chaudhri, 1979), indicating that education of the head of the household is more important than the average level of education of the whole family. However, educational level of the family is found to be a more important factor than that of the farmer in modernisation of agriculture in India (Harker, 1973). Similarly in Nepalese traditional agriculture, one additional year of education is reported to produce a monetary gain of Rp. 465.5 per year. Dhakal *et al.* (1989, p. 33) decomposed the effect of one year of additional education in Nepal into worker effect, effect on input selection and input allocation. For a 40-year working life the discounted monetary value of the total effect would be Rp. 5,551, compared to Rp. 2,485, which is the total costs of education of the family for four years, *i.e.*, the net present value would be Rp. 3,066 (Table III).

TABLE III. EFFECT OF AN ADDITIONAL YEAR OF EDUCATION ON TRADITIONAL AGRICULTURE IN NEPAL

Particulars (1)	1977 rupees per year (2)	For 40 years working life (3)
Effect on output per year		
Worker effect	19.9	(Discounted at 8%)
Input selection	159.9	
Input allocation	286.0	
Total education effect	465.5	Rp. 5,551
Educational costs		
Direct costs (unit costs)	94.9	
Foregone earnings	526.5	
Total costs (4 family members)		Rp. 2,485

Secondary Source: McMahon and Boediono (1992, p. 139).

Effect of Non-formal Education

The effect of non-formal education is also quite significant in agricultural development (Coombs and Ahmed, 1974). Non-formal education relevant for agricultural development consists of mostly agricultural/rural extension programmes. Such activities have been found to be significantly and positively contributing to agricultural output, influencing both technical and allocative efficiency of the farmers. Strong correlation between non-formal education and several activities relating to rural development was found in India (Seetharamu, 1985). In several Asian countries, on which such research is available (Table IV), the contribution of non-formal education is found to be important. The exceptions are Thailand and the Philippines in 1973, where the coefficient of non-formal education is negative, small and either not significant, or significant at lower level. But the research stressing the positive contribution is substantial and solid. One unit of investment in Korea increased rice production by 4.49 units a year. The overall rate of return to non-formal education in the Philippines was estimated as 70 per cent. Non-formal education was also found to be more important for older farmers with more schooling than for younger ones with less education in Korea.

TABLE IV. NON-FORMAL EDUCATION AND AGRICULTURAL PRODUCTIVITY IN SELECTED COUNTRIES IN ASIA

Country (1)	Year (2)	Description of the variables (3)	Regression coefficient of non-formal education (4)	t-value (5)	N (6)
Japan	1966	Agricultural magazines, extension agents, agricultural broadcasts	0.14*		
South Korea	1961	Log-linear investment in extension	0.832	3.55	895
		Log-linear investment in extension	3.240	6.00	
Malaysia	1973	Exposure to advertisements on agricultural extension classes	0.237	1.73	403
Thailand	1972-73	Chemicals: Number of extension visits to villages	-0.123	-1.53	91
	1972-73	Availability of extension in villages	0.085	2.22	184
Philippines	1963	Number of weighted extension contacts	0.0063	3.44	274
	1968	Number of weighted extension contacts	0.004	2.40	273
	1973	Number of weighted extension contacts	-0.000	-0.77	220

Secondary Source: Jamison and Lau (1982).
Note: * Partial coefficient of correlation (r) derived from path analysis.

Formal and non-formal education seem to be highly correlated (Seetharamu, 1985). They seem to be complementary to each other. The farmers who had higher levels of formal education participated more in non-formal education and extension activities in rural India. Jamison and Lau (1982) also found strong interaction between formal and non-formal education. The relationship can be complementary in dynamic conditions of agricultural development, and substitutory in less developed agricultural environments.

Role of Education under Different Technological Environments

The role of education in agricultural development varies by level of farming. As Schultz

(1964) felt, education would be more effective in a changing, modernising agricultural environment where fertilisers and new technologies are becoming available than in a traditional one. The effects of education are due to more efficient use of seeds, fertilisers, the ability to read how to repair machinery, to keep livestock healthy and other ways that keep the farmer responsive to management techniques, book-keeping and other farm practices. The multiplier effects of a modernising environment on agricultural productivity gains are more likely to be available only where education is widely spread (Lockheed *et al.*, 1980). The impact of education on agricultural productivity in high technology and better environmental conditions as in Japan will be different from the impact of education on agricultural productivity in low technology and poorer environmental conditions as in Nepal, India and Pakistan. It is quite possible that in the areas of farming under better technological environment, the *relative* impact of education could be much smaller than estimated in aggregate situations.

As per the empirical evidence available, the impact of education is higher in the low technology conditions than in high technology conditions. Compare for example the case of South Korea and Taiwan with Nepal (Tables I and II). Within South Korea, the effect of education is higher in the case of farms not using machines than in the case of mechanised farms. But in the case of Thailand, the evidence is to the opposite: the effect of education is higher on farms using chemical fertilisers than on farms using non-chemical fertilisers, and the difference is larger. All this suggests the need for more research on the effects of education and of various levels of education in modern versus traditional forms of agriculture.

Education itself influences the selection of technologies. A better educated farmer may be able to choose a superior technology than a less educated farmer, and the productivity levels obtained with the new technology may crucially depend on the level of farmers' education. With the help of a simple behaviour model applied to a data set of 500 households in Hunan province in China, Lin (1991) had shown that education has a positive impact on the adoption of new technology. Education may favour adoption of a new superior technology not only because of the role education can play in the faster discovery and assessment of the new technologies, but also because it acts as a complementary input for the appropriate use of technologies (Cotlear, 1990, p. 76).

Whether it is traditional farming or farming based on intermediate technology or fully improved or advanced technology and/or fully irrigation based farming, the role of education is very important; but educational requirements of course vary by the type and state of farming. The level of education required depends on the sophistication of the technologies adopted. Simple numeracy may be adequate for traditional farming as in Nepal (Jamison and Moock, 1984), and numeracy and rudimentary literacy may be needed for farming with intermediate technology. Recourse to memory may be insufficient and personalised transmission of information may be inefficient in farming based on better technology. Higher level of numeracy may be required when chemical inputs are introduced, to calculate the correct proportions in their use. Formal education of secondary and above that gives basic knowledge of chemistry, biology, etc., besides mathematics, would be a basic requirement of farming based on improved technology or fully irrigation based technology (Heyneman, 1983). The relationship between education, including research and development and agricultural productivity may be strong in the case of modern technology based agriculture.

Looking at the same problem in another way, there exists a gap between the best practice of farming and current practice. Economic conditions, particularly the level of technology and agricultural prices significantly explain the best practice while the low levels of current practice could be attributed to, *inter alia,* low levels of literacy and education. The path from current to the best practice is not a smooth one, as both go on changing in a dynamic sense. In this context, literacy and general education, extension education and research and development (R & D) assume much importance. Their relative importance, however, is determined by the gap between the best and the current practices. One may intuitively argue that the smaller the gap, the larger would be the role of R & D and vice versa. But in all cases, literacy and basic education form minimum conditions. Modernisation of agriculture is closely associated with levels of education in India (Rao and Shetty, 1968). Modernisation of rural communities as a whole does require spread of literacy and education (Adelman and Dalton, 1971).

The gap between the best and the current practices in terms of technical efficiency is analysed by Kalirajan and Shand (1988). The gap in the technical efficiency is inversely related to human capital variables, including education (formal schooling), experience and non-formal education (extension visits). The higher the human capital investment, the less would be the gap between the best and the current practice.

The role of research in agricultural development in any economy in general is quite significant. Advancement in research is a decisive factor in achieving increases in crop production throughout the world. The returns to investment in research are found to be as high as 65 per cent in Pakistan (Nagy, 1985). The green revolution in India could be attributed largely to research and development activities, besides of course, to the widespread levels of literacy and education of the farmers. Basic education prepared the people for the change, and R & D made the change possible. The rate of return on agricultural research in India was estimated to vary from 40 to 63 per cent (Evenson and Kislev, 1975; Kahlon *et al.,* 1977).

Basically, the impact of education is not instantaneous; it is sequential. Production function approaches may not only assume that it has not only an instantaneous effect, but also that it can be explained with the help of static data analysis. Research based on production function approaches and also discrete approaches, both yield not altogether inconsistent results. The results on the whole reassert that effects of education on physical output are substantial, leading to improvement in productivity and economic growth. Of the more than twenty studies reviewed here, hardly half a dozen studies reported either insignificant or negative impact of education on agricultural development. To sum up, the evidence shows that: *(a)* formal, non-formal and informal education have positive effect on farm productivity; *(b)* the role of education is likely to be stronger in modern, dynamic set-ups than in traditional ones; *(c)* the required level of education varies by the level of technology adopted and *(d)* since extension activities are more concerned with transmission of information than with the formation of competencies, its relative role diminishes with time.

IV

SUMMARY AND CONCLUSIONS

Agricultural productivity is traditionally explained with the help of factors such as land - quantity and quality of land, inputs such as seeds, fertilisers, machinery, weather conditions/irrigation facilities, etc. But these factors are found to have explained only a fraction of the variance. Later research has shown that agricultural productivity is considerably influenced by not only physical capital, but also by human capital - the educational levels of the labour force employed in agriculture. Education is also found to be influencing significantly various agricultural practices, such as use of HYV seeds, modern fertilisers, machinery, etc., besides utilisation of credit facilities, etc. The rates of return to education in rural areas are also found to be favourably comparable with those to education in urban areas, if not higher (Tilak, 1992). Both micro level investigations and macro level analyses found significant effect of education on agricultural development. This short paper presented a quick summary view of research on the role of education in rural development in general and in farm efficiency in particular, in the Asian countries.

The survey leads us to conclude:

Education significantly influences methods of production, use of modern inputs like fertilisers, seeds and machines and selection of crops.

Wages among landless labourers are also positively influenced by differences in their levels of education.

There also exists a threshold level of education for its impact to be significant and while this level varies for different countries marginally and for different purposes, mostly it tends to increase to secondary level education of about ten years of schooling.

The threshold level of education is relevant not only for farm efficiency, but also for other activities like utilisation of credit facilities, improved seeds and better methods of farming.

As the economy develops and technological developments take place, this threshold level goes up. For example, in India elementary education was the threshold level during the sixties, while it was secondary level during the seventies.

Socio-cultural factors and the caste system (in India) substantially influence the impact of education on agricultural productivity and other variations.

Non-formal education also contributes to rural development. But the effect of non-formal education is contingent upon its integration with and reinforcement by non-educational factors.

All this provides strong support for expansion of education in rural areas. However, the kind, type and content of education has to be decided by the level of development in general and agricultural development in particular and the corresponding needs of the people. Particularly, economies characterised by traditional farming should spread literacy and expand basic education in rural areas. Non-formal education will also have a significant role in this. This helps in preparing an environment congenial for change, by making people more receptive to ideas of modernised farming. Societies characterised by moderate to high levels of literacy but with intermediate technology in agricultural production, need to concentrate relatively more on improvement in the levels of education of labour force, by providing probably technical skills through expansion of agricultural schools and training places. Agricultural systems based on high and modern technology have to focus on higher education and R & D. These are obviously relative priorities. Economies cannot develop R & D activities in agricultural sciences all of a sudden. Hence, countries characterised by intermediate technology have to concentrate more on secondary education, but should also initiate building up potential for R & D programmes. But the emphasis should continue to be less on the latter, until the country crosses the second stage. Thus appropriate prioritisation in educational development helps the societies to move from traditional non-modern environments to modern dynamic ones, from the current less efficient practices to the best practices in agricultural production.

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NOTES

1. Jamison and Lau (1982) surveyed the vast amount of literature, besides making fresh analysis on Malaysia, Korea and Thailand. Tilak (1984) surveyed the literature on India. See also Tilak (1989) for a general survey.

2. See Tilak (1987) for an application of the rate of return method on India, and also for a discussion on several methodological and empirical questions. See Chapter 5 in Tilak (1993) for a review of research on rates of return to education in Asian countries.

3. In a study on Kenya, however, physical output is used as the dependent variable.

4. This is difficult to explain. But some limited explanation can be offered as follows: Allocative effects of education are significant; and the allocative effects may be larger in the case of small farms than in the case of large farms, as allocative functions include allocation of time and other resources efficiently, ability to choose optimum combination of inputs and crops, optimum time for several agricultural practices, including marketing, etc. Such kind of 'managerial efficiency' can be expected to be higher in the case of small and marginal farms than in the case of large farms. Of the total effect of education, allocative effects are found to be generally very large, as reported later in the case of Nepal in Table III. Secondly, it may also be argued that as generally education and size of the land holding are positively related, big land owning households have higher levels of schooling, and the marginal effect of education may be small, compared to small and marginal farmers.

5. The method adopted was follows: If $\bar{E}$ is the average educational level of the sample, and β the estimated coefficient of education, then the percentage increase in output for one additional year of education is estimated by computing the ratio of the value of output when the level of education is half a year greater then $\bar{E}$, Y_1, to the value when it is half a year less, Y_0, subtracting one, and multiplying by 100. See Jamison and Lau (1982, pp. 35-36).

6. However, Jamison and Lau (1982) concluded on the basis of 39 studies that the productivity of farmers was on average 8.7 per cent higher if they had completed 4 years of primary schooling (which was the threshold level) compared with those with no education.

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