# Chapter II
# Review of Literature

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# REVIEW OF LITERATURE

Since the late 1960s Indian agriculture witnessed vast developments in technology that induced changes in cropping pattern, use of modern inputs and investments in irrigation, machinery and land development, which kept it on a steadily increasing growth path. Abundant research work has been done on land distribution, production relations, conditions of agricultural labour, factors contributing to productivity in agriculture, etc. The impact of modern inputs like HYV seed, fertiliser and irrigation on farm productivity has been widely published during the post-green revolution period. These results are available with respect to individual crops, individual states and regions. Human capital, as input in production relations came to be increasingly recognised in 1950s.

### 2.1. Human Capital

Adam Smith two centuries ago stated the basic idea, in "The Wealth Nations", that an educated man is a sort of expensive machine. As Smith put it, "when an expensive machine is erected, the extraordinary work to be performed by it before it is worn out, it must be expected, will replace the capital laid upon it, with at least ordinary profits. A man educated at the expense of much labour and time to any of those employments, which require extraordinary dexterity and skill, may be compared to one of those expensive machines. The work, which he learns to perform, it must be expected, over and above the usual wages of common labour, will replace to him the whole expense of his education, with at least the ordinary profits of an equally valuable capital. It must do this too in reasonable time; regard being had to the very uncertain duration of human life, in the same manner as the more certain duration of the machine. The difference between the wages of skilled labour and those of common labour is founded upon this principle". (Smith, 1776).

After such a promising start, however, Alfred Marshall's "Principles of Economics" (Marshall, 1890) rejected the notion of "human capital" as unrealistic, and the investment aspects of education were completely neglected by economists throughout the nineteenth and first half of twentieth century. As a matter of fact, what Marshall rejected was the idea of including the acquired skills of population in the measurement of the wealth or capital of an economy, but he accepted Adam Smith's suggestion that an educated man may be usefully likened to an expensive machine. Marshall was perfectly familiar with Irving Fisher's definition of "capital" as simply any stock existing at a given instant that yields a stream of services over time, all flows of "income" therefore being the product of some item of "capital" whose value is calculated by capitalising the income flow at an appropriate discount rate. However, Marshall held the view that while human beings are incontestably capital from an abstract and mathematical point of view, it would be out of touch with market place to treat them as capital in practical analyses. The basic principle almost forgotten for nearly two centuries, took a new vigour in the late 1950s with the works of Schultz and Gary Becker.

Attributes of acquired population quality, which are valuable and can be augmented by appropriate investment, will be treated as Human capital. The principal activities that contribute to the acquisition of human capital are health care, home and work experience and schooling. The expenditures on learning, on-the job training, medical care and health, searching for information about markets, etc. constitute investments in Human capital. These investments improve skills, knowledge, longevity, and thereby raise monetary or psychic returns (Becker, 1964).

### 2.1.2. Investment in Human Capital

The differences in population quality between two countries are as a consequence of the difference in acquired abilities. Any element of quality that a human being acquired from birth on entails a cost. Gross investment in human capital entails health acquisition and its maintenance costs, including child care, nutrition, clothing, housing, medical services and care of oneself. Education accounts for much of the improvement in population quality. Expenditures on schooling and expenditures on health, both in public and private account, should be treated as investments in human capital and not as outlays for current consumption (Schultz, 1980). Human capital contributes to labour productivity and to entrepreneurial ability valuable in farm and non-farm production,household production, time and resources allocated to education, migration to better job opportunities and better locations in which to live.

Economic modernisation has positive effect in producing new opportunities and incentives to acquire additional human capital. Schultz points out the example of farmers in Punjab in adopting the Mexican wheat variety and their experimentation with a view to obtaining needed information during Green Revolution. Modernisation offers new experiences, learning of valuable new skills and information of value.

Welch (1970) argues that, although farmers differ in their ability to perceive, interpret and take appropriate action in responding to new information for reasons of schooling, health and experience, they provide the essential human resource of entrepreneurship. Farmwomen also are entrepreneurs in allocating their time and using farm products and purchased goods in household production (Schultz 1974). Allocative ability supplied by millions of farmers and farmwomen is important and their economic opportunities matter. Their performance in the production of more foodgrains in many low-income countries was the proof of acquired ability of such farmers to transform the contributions of agricultural research oriented to their requirements. One measure of the entrepreneurial ability of small farmers is the rate at which the high yielding varieties of wheat and rice have been adopted. These farmers, along with the new technology were able to take risks and make appropriate changes in the farm practices.

## 2.2. Contribution of Investment in Human capital to economic growth

Denison (1962) and many others have replicated the macro approach of plugging the investments in human capital in the growth accounting framework over the past 30 years with similar results. Thus, it has been established that bouts of long-term economic growth were preceded by increases in the population's literacy level. Considerable attempts have been made by economists to assess the economic contribution of education. Mainly, four approaches were used in these attempts, viz. the simple correlation approach, the residual approach, the returns-to-education approach and the forecasting-manpower-needs approach.

### 2.2.1. Simple correlation approach

The simple correlation approach consisted of correlating some overall index of educational activity with some index of the level of economic activity. It has been used for inter-country comparisons (cross sectional), inter-temporal correlations and inter-industry and interfirm correlations.

Svennilson *et al* (1961) tried inter-country correlations by correlating enrollment ratios and Gross National Product (GNP) per capita and have found that there is indeed a positive relationship, although there is also considerable dispersion, particularly among countries falling in the middle range. Comparisons of this kind enable countries to see their own educational efforts in the perspective of what is being done elsewhere, and thus, can serve to disturb complacency. Comparisons between countries in similar economic circumstances may also provide at least a rough idea of what is possible, with 'possible' defined in terms of actual educational outlays in countries having an approximately equal GNP per capita. Comparisons between countries at different stages of economic development may provide the less-advanced countries with a rough notion of what general level of educational activity is associated with a more advanced stage of economic development.

A second basic variant of the simple correlation approach consists of correlating education and GNP within a given country over time. Schultz (1961) has made a correlation of this type for the U.S over the period 1900 to 1956, and, treating education solely as a consumer good, he found that the income-elasticity of demand for education was 3.5. Attempts at inter-temporal correlations also highlight the time-lag problem that plagues many approaches. Education is long-lived asset, in that an educated man presumably contributes more on account of his education, not just one year after his graduation, but for much of the rest of his life. If a country doubled its expenditure on education in year "t", the positive economic effects ought not to be looked for in year "t"s GNP figures (which actually will be lower because students who would have worked are now in school), but in the figures for all the years from, say "t+4" on. The best way of surmounting this problem is by measuring the total stock of education at different points of time, not just the current level of educational activity. Stock measurements are better than flow measurements; in the case of cross-sectional inter-country comparisons, for exactly the same reason.

Just as countries differ in the relative emphasis placed on education, so do industries and firms within industries. While it is difficult to find an entirely satisfactory way of measuring an industry's emphasis on "education", one can think in terms of such measures as the proportion of work force that has had training beyond the secondary school level or the percentage of gross receipts spent on research and development activities. Correlations can then be made between one of these indices of educational emphasis and the profitability of the industry or a firm, on a cross sectional basis within a single country, over time, or on an inter country basis.

### 2.2.2. The residual approach

This approach consists of taking the total increase in economic output of a country over a given period of time, identifying as much of the total increase as possible with measurable inputs (capital and labour being the two measurable inputs usually chosen) and then saying that the residual is attributable to the unspecified inputs. It is because education and advances in knowledge are usually regarded as the most important of the unspecified inputs that this approach need to be examined in the context of the contribution-of-education question.

Alternative techniques can be adopted in implementing the residual approach. It is possible to proceed by calculating an input series for the labour input (based, for instance, on hours worked), a separate, constant-price input series for capital input, and then combining these two input series into an overall arithmetic index of inputs (using the relative shares of labour and capital in the total GNP as weights). Next the rate of increase in this aggregate input series is compared with the rate of increase in an aggregate output series (also expressed in constant prices); and by simply subtracting it is possible to obtain a measure of the contribution of the "residual" or "third factor". Kendrick (1961) has followed this general procedure and has found that for the US economy, over the period between 1889 and 1957, the combined input index increased at an average rate of 1.9 per cent per annum and the output index increased about 3.5 per cent per annum, leaving a "residual" increase of about 1.6 per cent per annum, which he called the increase in "total factor productivity".

Solow (1957) and others have followed a somewhat different procedure, the basic difference being that they have made explicit assumptions about the nature of the underlying production function. Dealing with a linear, homogeneous production function, and assuming that technical change is "neutral"(i.e. in and of itself does not alter the rate of substitution between capital and labour), the residual has been found to equal roughly 90 per cent of the increase in output per man-hour in the U.S. economy between 1915 and 1955 (Massell, 1960).

The study by Denison (1962) constitutes a third variant of the residual approach. Denison estimated the effect of "advances in Knowledge" by simply subtracting the rate of growth attributable to all the other inputs he identifies from the total rate of growth, and ended up with a residual that is very much smaller than any of the figures above. This was because he had made separate estimates of the contributions of factors such as formal education and economies of scale, which have been included in the residual category by most other authors.

Viewed from the standpoint of a desire to know something about the economic contribution of education, the residual approach has two main defects. Domar (1961) commented on Solow's work that, capital in this context "doesn't serve as the instrument for the introduction of technical change into the production process..... (it is simply) wooden ploughs piled upon the top of existing wooden ploughs." Another way of making essentially the same point ( or at least a very closely-related point) is by noting that available indices of capital inputs generally fail to reflect improvements in the quality, or productivity of capital. Anderson (1961) has shown that the apparent historical decline in the constant-price capital-output ratio is misleading for this very reason. The source of the problem is that, while the deflation of money measures of national income to constant-price basis is done using prices per unit of output (thus catching improvements in output per unit of input), money measures of capital are deflated on an elements-of-cost basis which cannot reflect improvements in the productivity of the capital equipment itself. If a constant amount of labour and materials goes into two capital assets produced in different years, the deflated values will be equal, even though the newer capital asset may produce much more than did the older capital asset. Consequently, the true contribution of physical capital is likely to have been somewhat greater than the figures cited earlier suggest, and the true size of the residual correspondingly smaller.

For reasons noted above, the residual, as usually measured no doubt embodies the results of some secular improvement in the quality of capital assets; it also encompasses changes in output attributable to economies of scale, to improvements in the health of the labour force, to informal as well as formal education, to changes in the product mix, to reorganisations of the economic order, etc. Abramovitz (1956) has called it a "measure of our ignorance".

### 2.2.3. The Direct Returns-to-Education Approach

An obvious way of studying the economic consequences of education is by contrasting the lifetime earnings of people who have had "more" education with the lifetime earnings of people who have had "less" education. The difference in lifetime earnings can then be expressed as an annual percentage rate of return on the costs involved in obtaining the education (Walsh,1935: Becker,1960).

### 2.2.4. The Forecasting-Manpower-Needs Approach

This approach is not really directed at assessing the economic contribution of education. The objective of all "forecasts" of manpower needs is to provide the persons responsible for educational planning with in*formation as to the likely future needs of the economy for persons with* various kinds of training. Such forecasts can be expressed in terms of broad aggregates of people (e.g. all those completing a course of secondary or higher education), or in terms of much more specific occupational categories (e.g. botanists and teachers of mathematics). A variety of methods has been used in arriving at manpower projections: (a) employers have been asked to specify how many persons with certain kinds of qualifications they will need, a given number of years in the future, and the responses have then been aggregated; (b) present ratios of trained manpower to total employment have been projected into the future on the basis of demographic information and, in some cases, assumptions about likely shifts in the relative importance of different industry groups; (c) the above method has been refined to take into account of past trends in the utilisation of manpower; (d) in projecting the manpower needs of the newly developing countries, recourse has been had to present ratios between skilled manpower and the total work force in countries at more advanced stages of economic development.

## 2.3 Human Capital and agricultural productivity

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 explain 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 engaged in agriculture.

The physical effects of education on agricultural productivity of workers include (i) 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, (ii) 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 operation, marketing, transportation, etc., (iii) worker effects such as ability to perform agricultural operations more efficiently in economic sense, and (iv) externalities (Welch, 1970; Schultz, 1975). The literature on the role of human capital on farm production has been surveyed by several researchers (Welch, 1978; Chaudhuri, 1979; Norton and Davis, 1981; Jamison and Lau, 1982; Evenson, 1989; Birkhaeuser *et al.*, 1991, Tilak, 1993).

Studies of agricultural production in both technologically advanced and developing countries have found important relationships between agricultural productivity, the use of modern inputs, and investments in agricultural research, extension and education [Griliches (1964), Schultz (1964, 1975), Hayami and Ruttan (1971), Huffman (1974), Evenson and Kislev (1975) and Petzel (1978)]. Hayami and Ruttan

(1971) mention human capital, institutional infrastructure, and physical infrastructure as important constraints to technical change in agricultural development. However, they include only human capital in their empirical analysis. Antle (1983) extends this model by including transportation and communication infrastructure as an explanatory variable and finds that infrastructure plays an important role in the explanation of agricultural productivity across both developed and developing countries.

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 agents such as high-yielding varieties (HYVs), fertiliser, pesticides, etc.

Education is found to influence significantly various agricultural practices such as use of HYV seeds, modern fertilisers, machinery, etc. besides utilisation of credit facilities, etc. Studies of farm productivity, family enterprises and wage earners have demonstrated the effects of education on output and productivity. The result at the individual level, as many studies show, is higher income. More recent research also points to a strong link between education and economic growth. In the wage sector the individual returns to education are consistently above returns to conventional investment.

Human capital, whether in the form of basic literacy or in more advanced understanding of technical relationships and management principles, has economic value because it enables more efficient and productive farms and family enterprises. Research has shown that agricultural productivity is considerably influenced by not only physical capital, but also by human capital. The contribution of human capital to agricultural productivity works in two ways called the technical efficiency effect or worker effect and the allocative effect. While the former relates to a more efficient use of given inputs, the latter centres on better allocation decisions including adoption and diffusion of new technology. Given information on gross output of the farm (Q), land under cultivation (T), man-days of labour (L), quantities of inputs (V) and educational/training level of the household head (E), one can assess the technical efficiency effect of human capital in terms of its effect on agricultural production. The general functional form of such a production relation may be expressed as:

$$Q = f(T, L, V, E)$$

If we define dE/dQ as the marginal product of human capital, specification in cobb-Douglas or linear form can be used to estimate the worker effect. Within this framework, the allocative effect of education is also estimated (Welch, 1970).

There has been a large, measurable increase in the ability of farmers in low-income countries to modernise agricultural production. Millions of them have learned how to use land, labour and capital efficiently in response to the production opportunities associated with agricultural modernisation. According to Schultz (1964), they are a new breed of farmers, capable of doing what needs to be done and no longer bound to the long established routine of traditional agriculture.

The concept of human capital, thus, implies an environment of imperfect information that permits human ability to play a role in receiving and decoding information and using it in sound decisions towards high operational efficiency levels. Evidences suggest the existence of a gap in the best level of technology and that is in general practice (Nelson and Phelps, 1966) and the allocative ability of human capital (Welch, 1970).

### 2.3.1. International evidences

Differences in educational levels were found to explain one-quarter to one-half of the differences in labour productivity in agriculture between the US, on the one hand, and India and the Philippines in Asia on the other (Hayami and Ruttan, 1970).

Herdt (1971) estimated the aggregate production function for India's agriculture and compared these with the Hayami's meta production function estimates, with the studies by Griliches for the US and with district level analysis for India by Chaudhari (1968). The reported results are similar to those of Chaudhari indicating a small but positive effect of education on agricultural production in India while in the US the effect of education is larger than that of India. This is because of Indian agriculture in the pre-green revolution period did not have many innovation possibilities available to the farming families.

Lokheed *et al* (1980) based on a study of farmer education and farmer efficiency across different countries has reported that on an average 4 years of schooling resulted in a 7.4 per cent improvement in output, giving a measure of evidence in Less Developed Countries. However, due to the limited geographical diversity in this study, Phillips (1987) argued that the case for the positive effect of education on productivity could be made for Asia but not for other parts of the world. Phillips (1994) has, further, provided a Meta analysis on farmer education and farmer efficiency.

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. The effect of education was 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. The effect of education on agricultural productivity declines with increase in size of the farms, suggesting that the effect of education is greater for the small and poor marginal farmers than those for the rich and big landlords.

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). 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.

### 2.3.2. Indian evidences

In India, several researchers reported a strong effect of literacy and education on agricultural productivity per hectare from Chaudhari (1968) to Ram (1980). Chaudhari provided the first clear-cut distinction between the allocative and the worker effect of education among farm workers in the agricultural sector. The empirical part of the study relates to cross section data for the years 1958 to 1961 for the Indian agricultural sector at different levels of aggregation using inter-household, inter-village, inter-district and inter-state data. The study concludes that the level of agricultural productivity is significantly related to the level of education in Indian agriculture for the cross section of data examined.

Rudra (1973) has, however, doubted the allocative efficiency school of Indian farmers on grounds of methodological drawbacks. He held serious reservations about the logical consistency of the analytical tools used to arrive at the results as well as the logical soundness of interpretations made of the results. He indicated that the methodological drawbacks are so serious that he would maintain that nothing whatsoever has been proved or disproved till then about the allocative behaviour of Indian farmers.

The study by Ram (1975) suggests that schooling lowers the marginal costs of information and/or raises its marginal benefits and thus provides an incentive to the more educated producers to acquire a greater *amount of information. Such reduction in costs, rise in benefits and the* resultant increase in information are the major sources of efficiency of more educated persons. Thus, it is argued, schooling has mainly an indirect impact on productivity and in their sense it may be regarded as a quasi factor of production. From these basic postulates several implications are derived and it is shown how the proposed framework can explain quite a few well-known phenomena in regard to the effect of schooling. Some of the implications are specialised to India's agriculture of the 1960s and the predictions are tested with the district and state level data for the year 1960-61 and 1970-71.

The value of added human capital depends on the additional well being that people derive from it. Their well-being is enhanced by gains in labour productivity, by increases in entrepreneurial ability in acquiring information and adjusting to the disequilibria inherent in the process of modernisation, by the time and other resources that students allocate to their education, by migration to better job opportunities and better locations in which to live, and, by the gains in satisfaction that are an integral part of future consumption. In this context, the measurable increase in the ability of farmers in low-income countries to modernise agricultural production is worth noticing. One measure of the entrepreneurial ability of small farmers is the rate at which the high-yielding varieties of wheat and rice have been adopted.

The choice of technology can also be considered as a function of human capital. In the context of adoption of green revolution technology by the farmers and the technology as such, although it is widely accepted that the green revolution strategy in India has worked exceptionally well in increasing food production and food security, view is also widely held that the achievements of the green revolution technology were largely confined to the well endowed and irrigated regions, such localised impact of bio-chemical technologies accentuated disparities between irrigated and dry land areas and the environmental consequences of agricultural technologies and the institutional arrangements governing the management of natural resources to adopt these technologies have received little attention (Marothia, 1997). Environmental issues are at the forefront of the debate over the sustainability of Indian agriculture without depleting the natural resource base. These concerns include land degradation, water pollution, farm workers' safety, food contamination from chemicals and climatic changes.

The rising trend in pesticide use experienced since 1958-59 got a further boost with the onset of green revolution technologies as the high-yielding varieties (HYVs) of cereals and other crops were relatively more susceptible to insect pests and diseases attack and required higher amount of pesticides for control. Other factors such as *increasing incidence of mono-cropping, insect pest sensitive crop* rotations, closer plant spacing, etc. also have induced pest problems resulting in higher use of pesticides (Chand and Birthal, 1997). Cases of rise in water table and soil salinity in some command areas of Punjab, Haryana, Uttar Pradesh, Maharashtra, Gujarat, Tamil Nadu and Andhra Pradesh have been reported due to inadequate provision of drainage and shift in the cropping pattern in favour of water intensive crops like rice, sugarcane and wheat (Joshi and Agnihotri, 1984; Gangwar and Toorn, 1987; Joshi and Singh, 1991). Nearly one-fourth of the cultivable command area under all canal projects in India is suffering from water logging and soil salinity (Dhawan, 1995).

According to Dandekar (1967), education of the farmer would help in changing his attitude to nature. Once education is used to explain the working of nature and indicate possibilities of modifying and harnessing it in the interests of man, much of his traditional attitudes towards nature would get modified automatically. Secondly, education will clarify the distinction between traditional knowledge and modern science wherever it influences production ability. In particular it will emphasise the fact that modern science is experimental while traditional knowledge is largely authoritative. Lastly, education will emphasise the difference between a traditional and the modern attitude to certain aspects of human life and endeavour. This would explain the existence of relations between man and man in the process of production and how and why these need to be changed in the interests of production efficiency. According to him these three aspects of education would prepare the farmer for a transition from traditional agriculture to modern agriculture.

Many farm-level production function studies had used education of the farmer as one of the explanatory variables. These studies had shown that the level of production is significantly higher on farms where the decision maker is literate than where the decision maker is illiterate. This was reported by Singh (1974) for Haryana where it was found that the impact of the level of education on farm production is relatively, strong with secondary education and weak, though positive, with both primary and middle level education. The study also found that the education of the head of the household or decision maker is to be measured to ascertain the effect of education.

Profit functions for farm level data for paddy in Tamil Nadu also showed that the educated farmers are technically and allocatively more efficient and that the contact with the extension service significantly increases profit (Duraiswamy, 1988).

Singh *et al* (2000) observed that educated persons adopted cultivation of modern rice varieties in the Bakhtiyapur – Malinagar village of Samastipur District of Bihar. However, the result of multiple regression analysis with proportion of area under modern varieties to total rice area as dependent variable and type of land, caste and education level and farm size as independent variables revealed that the type of land influenced the adoption of modern varieties significantly. The socio-economic variables like farm size, education level and caste did not have any significant influence on adoption of modern rice varieties.

Agricultural productivity is strongly determined by the level of technology adoption. Technology adoption by the individual farmers in turn and its diffusion on a large scale are influenced by the education of the individuals and of the society. The rate of education and information in technology adoption and agricultural productivity has been widely researched. Malik *et al* (2000) based on a study of sources of information on improved crop production and its valuation in Haryana has observed that input dealers, followed by extension agents, radio, television and visit to kisan melas were the important sources of new information. The cost incurred by the farmers in acquiring knowledge from the input dealers was the highest, followed by extension agents and visit to kisan melas.

Pant *et al* (2000) found very high knowledge gap with respect to rhizobium culture seed treatment and plant protection methods, so was the adoption gap of related technology i.e. in pigeon pea production in the tribal areas of Rajasthan.

Tilekar and Nimbalkar (2000) reports that nearness of zonal Agricultural Research Station, Pune and also the liaison of the personnel of Department of Agriculture coupled with high irrigation and better educational status of the producers, resulted in the adoption of modern inputs, i.e. fertilisers and plant protection chemicals.

Jaulkar *et al* (2000) estimated a regression equation taking adoption gap as the dependent variable and age, education, size of holding, annual income, social participation, extension contact, occupation and knowledge as independent variables on data of 120 sample wheat and mustard farms in 9 villages of Gwalior district, Madhya Pradesh. The study revealed that approximately 86 per cent of the variation in the adoption gap of wheat and mustard technology was explained by the eight variables, the level of knowledge and education alone accounted for 76 per cent of the variation.

**2.4. Extension service and agricultural productivity**

Extension service is one factor to promote productivity, primarily by disseminating knowledge regarding cultural practices, new varieties, optimal use of agro-chemicals, irrigation, etc. The literature on organisational efficiency has been very critical about the usefulness of extension services (Moriss, 1966; Rahim, 1966; Moore, 1984; Jaiswal, 1983; Howel, 1982). Major criticism in this area focuses on institutional and logistic difficulties encountered by agents and inappropriate economic incentives to them that lead to lack of motivation. Also weaknesses in other support institutions like credit availability, easy access to the recommended inputs, inequitable distribution of land, etc. have resulted in limiting the potential of extension services. One approach, which has been used to evaluate the impact of extension services on productivity, is to estimate production functions. These studies use the farmer as the unit of observation with special variables included in the production function accounting for the difference in productivity due to extension services (Patrick and Kehrberg, 1973; Moock, 1973; Hong, 1975; Halim, 1976; Baidya *et al.*,1980).

The yield differential between project and non-project areas could be due to increase in the use of the quantity of inputs - embodied productivity *differential and because of the improvement in the knowl*-edge of the efficient use of the inputs - disembodied productivity differential (Feder *et al*, 1987).

Sharma and Rajkumar (2000) indicate that demonstration of technology under farmers' field conditions is considered the most effective method to convince them about the usefulness of technology in the case of conventional extension educational approach. But for this purpose, the selection of the farmers' fields is usually and mostly made on the basis of convenience or compulsion, for e.g. the big farmers are selected because of socio-economic reasons as they are easily approachable by extension agencies, and the small farmers are approached as it is mandatory because of certain special programmes meant exclusively for them owing to the priority considerations. The medium class of farms do not get due attention of extension agencies in connection with transfer of technology while this class of farms is the most appropriate to adopt the technology due to the better combination of factors of production.

Kapse *et al* (2000) in a study of farmers' behaviour in adoption of fertilisers and plant protection technology generated under National Agricultural Research Project (NARP) in Solapur district of Maharashtra observed that the main sources of awareness about fertiliser and pesticide related technology were agricultural exhibitions and visits by the farmers to research stations.

Major sources of information on hybrid cottonseeds in Pollachi Taluk of Coimbatore district of Tamil Nadu were friends/neighbours followed by radio/T.V., agricultural institution and private dealers (Rao and Venkat Narayanan, 2000). Among the various factors influencing buying decision of hybrid cottonseeds, friends/neighbour farmers ranked first, followed by pest and disease resistance, high-yield, private dealers and seed availability. Similar results were reported by Srivastava and Raj Vardhan (2000) for pesticide use, and Pant *et al* (2000) for adoption of pigeon pea in tribal areas.

Based on a study conducted in four villages of Lucknow city (Uttar Pradesh), Brahm Prakash and Sushila Srivastava (2000) reported that 47 per cent of the radio listeners and 42 per cent of the T.V.viewers perceived the Regional Rural Telecast/broadcast programmes as useful to get new information related to agriculture, animal husbandry, fisheries, poultry, sericulture, piggery, cottage industries, newly launched schemes by the government regarding upliftment of rural people, self-employment and women empowerment. About 23 per cent of radio listeners and 25 per cent of T.V. viewers found rural programmes helpful in acquiring additional information about production technology.

Sarangi *et al* (2000) based on data collected from 50 tomato growers from 5 villages in Satna district of Madhya Pradesh indicated that a large number of tomato growers had high knowledge but low extent of adoption, while the extent of economic performance was high. There was significant association between different attributes, viz., education, economic motivation, scientific orientation, innovativeness, contact with extension personnel and other sources of information and the extent of knowledge of recommended tomato technology.

The study of Ajjan and Dayalene (2000) on rice farmers in Tamil Nadu revealed that peer group farmers formed the prime source of information on pesticides, followed by dealers, agricultural extension personnel and mass media (radio, newspaper). Private dealers and co-operatives formed the major sources of purchase of pesticides by the farmers as these agencies extend credit facilities to the farmers. Nearly 56 per cent of the sample farmers adopted pesticides after the success of other farmers is known to them and 26 per cent according to peer group suggestions as against dealers' and agricultural extension personnel's recommendations.

**2.5. Credit and agricultural productivity**

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).

Based on a study of productivity of short-term credit used for wheat production in Uttar Pradesh hills, Tripathi *et al* (1994) have found that the impact of credit on the returns from the crops were highly significant.

The study has concluded that there was scope for increasing production with higher use of credit.

Gupta (1994) indicated that there was higher adoption of new technology among the beneficiaries compared to the non-beneficiaries of institutional credit in a block in Raipur district of Madhya Pradesh.

Gaonkar (2000) found that there was a direct relationship between education and technology adoption by the farmers. The study revealed that credit is an important factor, which influenced the technology adoption.

**2.6. Infrastructure and agricultural Productivity**

A relationship has long been recognised between a country's agricultural development and its investment in infrastructure capital, such as transportation and communication facilities, that is not directly related to the agricultural production process. The relevant literature spans Adam Smith's proposition "that the division of labour is limited by the extent of the market"; numerous studies by historians and economic historians and the work of economists such as Schultz, Kuznets, Wharton, Owens and Jhonston and Kilby, to mention a few .

Antle (1983) utilises 1965 aggregate agricultural production data from 47 less developed countries (LDCs) and 19 developed countries; and the concept of aggregate production function to study the effects of transportation and communication infrastructure on aggregate agricultural productivity.

The use of inter-country comparisons for development studies dates to Clark and the pioneering work of Kuznets, and Chenery has explained it econometrically. An important contribution to the study of international agricultural productivity was made by Hayami and Ruttam, who showed that an aggregate agricultural production function that accounts for inter-country differences in resource endowments, technical (modern) inputs, and human capital can explain a large proportion of the variation in agricultural output across more or less developed countries. Evenson and Kislev modified Hayami and Ruttan's model by including a variable measuring each country's investment in agricultural research. Antle uses, essentially the same model with the addition of a variable measuring the transportation and communication services produced by each country's infrastructure capital.

Hayami and Ruttan (1970) estimated the cross-country production function of the Cobb-Douglas type for thirty-eight developed and under-developed countries. The analysis was conducted in gross output (net of seeds and feed) terms in order to include the effects of current intermediate inputs such as fertiliser. Individual agricultural commodities were aggregated by the farm gate (or import) prices of the US, Japan and India, to produce three different output series. The series were then averaged geometrically into a single composite output series, which was used as the dependent variable.

The independent variables used in the study include labour, land, livestock, fertiliser, machine serve as proxy variables for internal resource accumulation, machinery and fertiliser for technical inputs and general and technical education in agriculture for human capital. Land (measured by hectares of agricultural land) used for agricultural production cannot be regarded as a mere gift of nature. It represents the result of previous investment in land clearing, reclamation, drainage, fencing and other development measures. Similarly, livestock (as measured by livestock units) represents a form of internal capital accumulation. Thus, in one's perspective, land and livestock represent a form of long-term capital formation embodying inputs supplied primarily by the agricultural sector. Both high inputs of land and of livestock per worker tend to be associated with low levels of labour and high levels of land per unit of output. In contrast, fertiliser (as measured by the N+P+K in commercial fertilisers) and machinery (as measured by tractor horsepower) represent inputs supplied by the industrial sector. Technical advances stemming from both public and private sector research and development are embodied in or complementary to these modern industrial inputs. Mechanical innovations are usually associated with larger inputs of power and machinery. Biological improvements, such as the innovations embodied in high yielding varieties are typically associated with higher levels of fertiliser use. In this analysis, these two industrial inputs represent proxies for the whole range of inputs, which are modern, mechanical and biological technologies.

The proxies for human capital include measures of both the general educational level of the rural population and the specialised education in the agricultural sciences and technology. Alternative measures of the level of general education are attempted : a) The literacy ratio and b) the school enrollment ratio for the primary and secondary levels. Both sets of data are deficient in that they apply to the entire population and are not sensitive to differences in the quality of rural and urban education. Education in the agricultural sciences and technology was measured by the number of graduates per ten thousand farm workers from agricultural faculties at above the secondary level. These graduates represent the major source of technological and scientific personnel for public sector agricultural research and extension and for research development and marketing in the private agri-business sector.

Studies have also shown that the large farmers have higher productivity because they have better access to factors of production, irrigation water, credit, technical knowledge, etc. (Falcon and Gotsch, 1968; Khan, 1979).

Several studies on Indian agriculture have reported that technical change is significantly influenced by the non-price factors like government investment in agricultural research, extension education and infrastructure like rural roads, regulated markets, etc. (Evenson and Jha, 1973; Rosegrant and Evenson, 1994; Kumar and Rosegrant, 1994).

Pandey (2000) based on a study about the yield gap between the attainable yield on experimental area and actual yield realised by the bulk of farmers in plateau region of Bihar indicated that there existed a big gap in the yield of wheat in the two situations. The yield of wheat on farmers' field was of the order of 14, 15 and 18 quintals per hectare on marginal, small and medium size-groups of farms, respectively. The wheat yield, varied from 38 to 51 quintal per hectare in the experiments conducted under All India co-ordinated Wheat Improvement Project at different levels of technology and the wheat yield also varied from 25 to 42 quintal per hectare under cropping system project. Lack of capital, irrigation facilities, knowledge of the new technology, soil conditions, storage facility and timely supply of inputs were responsible for the observed gap in yields of the crop under study.

### 2.6.1. Education, productivity and infrastructure

Leonor (1976), after examining the results of four studies from four continents, which related education and productivity, concluded that education (particularly, schooling) significantly influences productivity in a dynamic condition but not in a static setting.

Out of the four studies, three studies related to education productivity relationship in agriculture, one in manufacturing industry. Studies in agriculture in United States (Welch, F.1970) and in India (Chandhuri, D.P. 1974) provided ample evidence to the effect that schooling of population engaged in agriculture did positively influence farm output. The relationship was found in a technologically dynamic environment. The study on Bazil agriculture (Patrick and Kehrbeg, 1973) indicated that the relationship was observable in modernising areas. The one study on British Electrical Engineering Industry involving sixty factories (Layard and Sargan, 1971) revealed that schooling of personnel did not statistically show any systematic effect on factory output. However, newness of product seemed to be associated with factories having a concentration of personnel with advanced schooling. A further scrutiny of those factories showed that this observation was true where there was substantial research and development, particularly in sophisticated technology such as in advanced electronics.

*Commenting on the study findings, Leonor argues that the study findings of* American agriculture and British industry were opposite. While positive and statistically significant relationship between schooling and productivity was evident in American agriculture, such relationship was virtually zero in

British industries study. Because, the circumstance under which each was operating was different, American agriculture was operating in a technologically dynamic environment but not the British factories, which operated in a relatively stable technology. However, among those factories that engaged in substantial R&D, a relationship between qualified manpower and economic performance was apparent.

The study on Indian agriculture was also in areas, which experienced the Green Revolution. Schooling of cultivators and farm workers had a positive effect on farm output. The states of Punjab and Haryana, where the study was placed were having technologically and socially dynamic environments. But an earlier analysis of similar data from another state of Uttar Pradesh, whose conditions were not as brisk as those in Punjab and Haryana, the positive effect was hardly detectable. Similarly, the study on Brazil agriculture showed weak relationship between education and agricultural development, but the relationship was observable in modernising areas.

## 2.7. Conclusions

The review of literature above has cited various studies using human capital as one of the explanatory variables for measures of economic development in general and agricultural production in particular. These studies have used various measures of human capital, like school enrollment ratios at the macro/aggregate level or number of years of schooling of the entrepreneur at the individual level. The evidences are cited from studies in India as well as from other countries. Studies have also measured the relationship between various physical inputs, institutional factors like credit, extension service, etc. , infrastructural factors like availability of road, electricity, etc. and agricultural productivity. The results indicate that human capital, either as the education level of the farmer or average education level of the farm household, enters the production function by way of the farmers ability to receive and decode new information and adopt modern technology in his production process. Few studies have also explored the impact of other modes of dissemination of farm technology information like demonstration trials, kisan melas, mass media, etc. on the adoption of appropriate technology by the farmers.

**2.8. Approach to the present study**

The present study employs various alternate measures of human capital relevant in a farm situation and attempts to identify the best among them. In other words, the various measures of farmer education, like number of years of schooling of the farmer, average years of schooling of all the members in the farm household, maximum number of years of schooling attained by anyone member of the farm household, etc. are used in alternative models so as to identify that measure which explains productivity variation among farm households the best. Unlike past studies on impact of human capital on productivity of crops, the present study uses data from a sample of cotton farmers whose cultivation pattern are more or less uniform with regard to the crop season, variety of seeds used, number of irrigations given to the crop, pattern of input use, etc. In such a setting, majority of the variation in productivity among farms would result from the variations in timeliness of farm operations, balanced use of fertiliser nutrients, use of appropriate pesticides for pest/disease control etc. which are essentially the functions of better human capital.

Apart from the formal education of the farmer, the study also explores all possible sources of farm information, both in the form of one-way communication as well as two-way communication, available to the farmer and the impact of the same on his farm production. Another merit of this study is that, along with the various measures of human capital, the model also includes various alternate measures of physical inputs as well as infrastructural variables, which are relevant in the Indian farming context. Further, the study focuses on cotton, an important commercial crop that has got tremendous importance in our international trade. The fact that the competitiveness of agriculture in the emerging international agricultural scenario in the post WTO era would depend on the information and knowledge base of the farmers, add to the contemporary importance of the study.