CHAPTER II

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INTRODUCTION

Literature on the economic effects of infrastructure has emerged during the past several decades. Researchers have used various techniques that range from a simple to a most sophisticated econometric methodologies and have used different types of data in an effort to identify the relationship between output or productivity and the availability of infrastructure. One school of thought is that the incremental infrastructure investments will have only a modest effect on rural economic performance. Even in those cases where large benefits from infrastructure investments could be achieved in the past, similar expansions would generate marginal benefits that would be declining. Even situations where large benefits from infrastructure investments have been reaped in the past do not necessarily provide evidence that future gains will result from similar expansions. In this background, this chapter reviews some of the important studies which have dealt with the role of rural infrastructure in agricultural development, rural development and also reduction of poverty.
ROLE OF RURAL ROAD AND TRANSPORT IN AGRICULTURAL DEVELOPMENT

Previous research on the impact of marketing infrastructure on agriculture concludes that road quality increases the use of fertilizer and enhances total agricultural output with an elasticity of about 0.20 (Binswanger et al. 1993).\(^1\) It has been shown that lack of transport infrastructure results in low technological adoption, cropping choices and low agricultural productivity in developing countries.

Minten (1999)\(^2\) attempted to understand the level of influence of infrastructure on the prices of agricultural produces in Madagascar. Since changes in the prices of food grains do impact on the welfare of the individuals through alteration in consumption, the study investigated whether presence of infrastructure (especially the transportation) often determines the price level after market liberalization as transport costs, that is different due to distance and the quality of infrastructure, influence how the benefits (costs) from a liberalized environment are shared between producers and other economic agents, i.e. transporters, middlemen, and consumers. The study found that hard infrastructure is an important determinant of producer price levels. Price levels increase significantly as the distance to main roads increases and the quality of infrastructure decreases, and they decrease relatively faster over shorter distances than over longer distances. It is shown that distance matters more than road quality as there is no strong correlation between road quality and the decline of producer prices per unit of time, and as increased quality
decreases time travelled only marginally. Moreover, this study found that road infrastructure does not automatically lead to more competition among traders as hard infrastructure by itself does not seem to increase the possibility of choice between traders.

Fan et al made a series of studies in India (1999)\textsuperscript{3} and China (2005)\textsuperscript{4} to study the impact of infrastructure on agriculture. These studies included the infrastructure as a component of public spending on agricultural research and development, irrigation, rural infrastructure such as roads and electricity, and rural development. By analyzing state-level data, they estimated that in India and China, the government expenditures on roads had the largest impact on poverty reduction, as well as having a significant impact on productivity growth.

Dominance of poverty is more in rural areas compared to urban areas. Therefore, any investment that helps to increase rural production, income and employment is expected to reduce poverty. Ahmed and Hossain (1990)\textsuperscript{5} provided the evidence linking poverty alleviation with infrastructure development. Infrastructure leads to increase in crop income among small farmers.

Bonney (1964)\textsuperscript{6} observed that there was a direct relationship between increase in acreage of export crop cultivation and the standard of road and distance from main commercial centres. There is an enhanced entrepreneurial activity; sharp decline in freight and passenger charges and improved service as a result of investments on rural roads.
While analyzing the socio-economic impact of a new road on a small and isolated village community in Mexico, Elmondorf and Merrill (1977) found that road created inflow and outflow channels of transportation, communication and modernization as well as migration, both into and out of the community. In this sense, rural roads act not only as a bridge between urban/developed and poor/rural/underdeveloped areas, but also as agents of diffusion, contact and unification.

Improvement in rural roads affects agricultural development followed by the development of social services. It is observed that roads tend to have a greater initial impact on production where cash crops are grown, because food crops, grown by small farmers, have a lower price elasticity of supply than cash crops (USAID, 1972). Therefore, more developed the existing agricultural system, the more significant and the faster is the response to road provision or road improvements within an area. Access to better health and education usually improves more rapidly along roads than elsewhere. A study in Thailand by Moore (1980) revealed that impact of roads was more on isolated areas that were brought into the mainstream. The area under cultivation and the intensity of land use increased significantly wherever access to markets is improved.

A study of the socio-economic impact of roads on village development by Bansal and Patil (1979) based on a survey of 1662 villages in India, found that the effect of accessibility was greater for unimproved than for improved
roads suggesting that in bringing about socio-economic change, the existence of some kind of trafficable route is of major importance, its quality is a second-order consideration.

Majumdar (2002),\textsuperscript{12} on the basis of regression analysis of the State level cross-section data for each of the years from 1971 to 1995 indicated that among various physical infrastructures, it was the transport infrastructure that significantly affected the agricultural output level and the agricultural development index. However, besides physical infrastructure, social infrastructure also had significant positive impact on the dependent variables. At the district level, from the regression analysis at three points of time, viz., 1971, 1981 and 1991, the study observed that agricultural and transport infrastructure are important determinants of agricultural output and agricultural development index.

In their study, Binswanger \textit{et al} (1989)\textsuperscript{13} used macro data from eighty-five randomly selected districts of India to examine the role of rural roads, among other factors, in agricultural investment and output. The study found that road investment contributed directly to the growth of agricultural output, increased use of fertilizer, expansion of commercial bank operations, etc.

A study by Moore (1996)\textsuperscript{14} examined the socio-economic impact of improvements of rural roads in Morocco. The study compared conditions in the areas of the project roads, 5 to 10 years after project completion, to the situation prior to improvements ("before-after" the project), and to the
conditions in comparison to the roads that were located nearby and were not subject to improvements during the project period ("with-without" the project). The study found that the benefits of paving rural roads extended considerably beyond the improvement of road use efficiency in terms of lower cost and higher quality. The extended benefits included major changes in the agricultural economy, including higher output, transformation of the agricultural output mix from low-value cereals to high-value fruit, and increased use of modern inputs, especially fertilizers. Moreover, improved access to education and health facilities increased enrolment rates in rural schools, which led to higher frequency of visits to health care services, and enabled the recruitment of professional personnel to schools and health facilities. The effect on poverty reduction among all cultivators, including the small and marginal farmers, was also positive and significant. This was the experience in Africa, where trading margins are much higher than in Asia, partly because of the thinness of individual surplus and partly because of lack of rural roads and transportation.

Fan et al (2000)\textsuperscript{14} found that public investment in rural roads has a large positive impact on agricultural productivity growth in India. In addition, road investments significantly contribute to agricultural growth as well as growth in the non-farm sector and the national economy.

The quality of infrastructure is an important determinant of the effects of infrastructure on agricultural growth and poverty reduction (Fan, Huong and Long 2005).\textsuperscript{15} When measured by kilometre of newly laid roads, they found
that investment in high-quality roads in China have close to 50 per cent higher returns to total GDP than investments in low-quality roads. However, investments in low-quality roads have the largest returns in total GDP (41.5 per cent higher) in rural areas, while the effects of high-quality roads were almost twice as high as those of low-quality roads in urban areas.

Mundlak et al (2002)\(^{16}\) used farm-level data for the Philippines recorded from 1948 to 1984 to estimate the effect of public investment in farm level output supply and input demand. Roads were found to have a positive effect on aggregate output per farm, as well as on fertilizer use. The output elasticity with respect to roads worked out to be as high as 0.31. But strangely enough, he found negative elasticity of output with respect to rural electrification.

Investment in rural roads and transportation results in reducing the cost of transportation of goods and passengers and tends to increase the share of farmers in the final realization of farm produce, thereby increasing their welfare. There is also general agreement among scholars that the development of physical and institutional infrastructure, like investment in irrigation, and scientific research and extension is a pre-condition for the adoption and diffusion of new agricultural technology. This in turn, increases the income of all categories of cultivators and even the landless agricultural labourers. Not only that, the existence of infrastructure like roads, communications and transportation is considered to be critical for the growth impulse generated by agricultural development through input-output linkages.
The increased income of cultivators and landless labour leads to a diversification of their consumption basket, thereby giving fillip to consumer goods industries and services (Munnell, 1992).17

The diffusion of agricultural technology is also facilitated by infrastructural development in transport and marketing. Travel by extension workers becomes much easier. Farmers can easily move to the demonstration farms and interact with the scientists. The access to modern inputs also becomes easier. Farmers can readily obtain High Yield Variety (HYV) seeds and fertilizers. Similarly, they can also take advantage of the repair facilities for the implements in market towns and other bigger towns (Tewari, 1984).18

The enhanced mobility of labour induced by infrastructural development, such as the opening up of rural roads, helps the rural poor in commuting to work and travelling to jobs where the wages are relatively higher. It also helps small and marginal farmers in moving away from their villages, where manual work is looked down upon, to faraway places where they enjoy relative freedom from such inhibitions. Transport development also helps the small and marginal farmers to grow vegetables and other high value crops on their tiny plots and to find a market for these in nearby towns (Harmatuck, 1996).19

Development of the transport sector like other infrastructure sectors leads to increase in fact productivity in various sectors by increasing accessibility and reducing transport costs. In general, transport development
focuses on increasing efficiency and growth, although in some cases like connecting rural link roads to tribal or remote areas it may directly focus on poverty reduction. It is however, notable that even growth oriented transport development projects make an important contribution to poverty reduction. Transport projects can be divided into (a) those focusing on poverty; (b) those focusing on efficiency and growth; and (c) efficiency-cum-poverty projects. It is sometimes difficult to measure the impact of transport on poverty reduction since it involves many links within the general equilibrium framework (World Bank, 2002). It is recognized that sustained economic growth leads to alleviation of poverty. Transport provides intermediate services which facilitate interaction between productive activities. The output prices also get reduced, thereby leading to increase in demand and promotion of regional and international trade. It also enables agriculture to commercialize, industry to specialize and the economy to enjoy benefits of scale. It also promotes diversification of the economy. Thus, the crucial role of transport development in stimulating growth is universally acknowledged (USAID, 2008).

Investment in the transport sector generates income-earning opportunities for the poor by creating jobs for unskilled labour in construction and maintenance of transport infrastructure. In addition to employment, investment in rural transport results in transport induced lower prices of consumer goods that bring relief to the poor. Further, by lowering prices of
agricultural inputs, it helps poor farmers to modernize their production pattern. It also leads to higher realized price for farmers’ output because of reduced transportation costs (Berndt, 2007).²²

Increased accessibility also leads to increased well-being through facilitating higher personal mobility and diversification in socio-economic activities those result from increased flow of information and increased use of transport services due to reduction in the cost of service delivery to the rural poor. Investment in transport, however, may have adverse impact on the poor through the environmental degradation that needs to be taken care of in transport investment planning. Lack of transport facilities result in low agricultural productivity, high transport costs, low profit margins, higher spoilage and loss of goods during transportation and, hence, lower levels of income and increased poverty (Venkataraman et al, 2009).²³

The direct effect of infrastructural investment can take place in various ways. First, during the construction phase of infrastructural projects like roads, watershed development, construction of irrigation dams or powerhouses, the poor are provided employment and income-earning opportunities. Again, the most important contribution of transport is that of improving accessibility of socio-economic activities to the rural population and the rural poor and, to that extent, they benefit (Eberts, 2006).²⁴

One of the most important aggregate studies was by Antle (2003),²⁵ who undertook a cross-sectional study of 47 less developed countries. He
used the Cobb-Douglas production function and found a strong positive relationship between infrastructure and aggregate agricultural productivity. His conclusion was that transport and communication infrastructure contributed to the expansion of aggregate agricultural productivity across a sample of developed countries.

The International Food Policy Research Institute (IFPRI) undertook a comprehensive analysis of the impact of infrastructure on poverty in rural India by looking at the relationship between government expenditure incurred on R and D, irrigation, roads, education, power, soil and water, rural development, health and family welfare, and the impact of each of these expenditures on the incidence of poverty in rural areas by employing a simultaneous equation regression model. The study is based on time series of state-wise data on poverty, rural employment, wages and government expenditure on specified infrastructures. By using a simultaneous equation regressive model, the authors bring out that the government expenditure on roads had the highest impact on reduction of poverty, followed by that on welfare, health, rural development, education, and soil and water (Fan et al, 2004).

Haggblade et al (1991) tried to find the relationship between infrastructure development and agricultural growth by using country or village level data. The impact of infrastructural investment on increasing agricultural productivity and incomes of farmers, improving their access to market and providing more employment thereby contributing to poverty reduction has also
been brought out by some country and village level studies. Most of these concentrate on the impact of the development of rural transport (in conjunction with other rural infrastructure) on increase in agricultural and other sectoral output and incomes and consequent reduction in poverty.

**ROLE OF RURAL ELECTRICITY IN AGRICULTURAL DEVELOPMENT**

In one of the early studies in this area covering the period 1960-1986, Barnes and Binswanger (1986),\textsuperscript{28} examined the impact of rural electrification through private investment in electric pump sets on agricultural productivity in India and found a positive relationship between the two.

Another study by Binswanger *et al* (1993)\textsuperscript{29} across 85 districts spread over 13 States of India and covering period 1960-80 found that the availability of electricity tended to increase farmers' investments in irrigation pumps, investments in roads paved the way for bank expansion in rural areas, and all public infrastructure works created greater fertilizer demand.

Fabrizio *et al* (2006),\textsuperscript{30} on the basis of data from 83 countries showed that the gross product in the sectors of transportation and energy, as well as in the two sectors combined, is a significant explanatory variable of the aggregate value of agricultural production with elasticity ranges of 0.162 (for energy) to 0.281 (for transportation). Regression equations with cross-country data have found that electricity is a significant explanatory variable of both land and labour productivity, while the density of roads has a positive though non-significant coefficient.
Studies by Narayanamoorthy and Hanjara (2006) estimated the impact of individual infrastructure items on the agriculture output and productivity with district level data and found that road and irrigation were having a positive and significant impact while the coefficient of electricity was negative and significant, perhaps due to poor specification of variables.

In a study of Uttar Pradesh, Prabha et al (2009) found that the electrified villages along with fertilizer and HYV seeds had the positive and significant impact, while rural roads had an insignificant impact. However, most of the studies found, the gross agricultural output; output per unit land has a positive and significant association with the density of roads and electricity consumption in rural areas.

Binswanger et al (1992) found that regulated markets and primary education increased output, while electricity promoted investment in irrigational infrastructure. The study also brought out that the availability of electricity along with increase in agricultural output also stimulated the growth of grain mills in the countryside. With its combination of random and fixed-effects analysis, the study has contributed to a greater understanding of the interrelationships between infrastructure and agricultural production.
ROLE OF IRRIGATION AND AGRICULTURAL DEVELOPMENT

The impact of the green revolution in India has been intensively studied by various scholars. All of them have stressed the important role that irrigation and other rural infrastructure played in bringing about technological transformation in many areas across India. From their study, Braun et al (2011)\textsuperscript{34} brought that out because of sectoral linkages associated with rapid agricultural growth, several sectors of the Punjab economy were generating high input, output, and consumption multipliers. For example, in the case of dairy products, the value of direct, indirect and induced income multipliers was as high as 16.5 and for textiles 14.2.

The positive correlation between the levels and growth of agricultural development and availability of irrigation has been extensively noted by scholars. Irrigation promotes growth (i) through increasing intensity of cultivation, (ii) by leading to yield increases, and (iii) through its impact on cropping pattern. The elasticity of area increases with respect to irrigation was found to be as high as 0.5 by Dhawan (1988)\textsuperscript{35} for the country as a whole. But, most importantly, assured irrigation was considered a precondition for the adoption of high-yielding Borlaug seed-fertilizer technology.

Vaidyanathan (1991)\textsuperscript{36} found that because of extensive use of new technology under irrigated conditions, productivity was much higher in irrigated tracts as compared to unirrigated tracts. According to Prahladachar (1994),\textsuperscript{37} between 1970-71 and 1989-90, 43 million tons of additional output of food
grains could be attributed to irrigation. The uneven spread of assured irrigation across regions was the main reason for large variations in their agricultural development (Janakarajan, 1994). Thus irrigation leads to greater stability are also brought out by several scholars. Dhawan found that the coefficient of variation of yield declined during 1971-1984 for irrigated crops compared to the non-irrigated crops (Dhawan, 1993).

Rajaraman (2003) also concluded that irrigation per se led to reduction in instability. It is also argued that by generating more biomass, irrigation contributed to ecological conservation and sustainability. On the negative side, excessive irrigation could lead to submergence of forests, waterlogging and salinity. On balance, with appropriate intervention, it was possible to reap the benefits of irrigation and bring about higher sustainability.

Some scholars have also argued that irrigation serves the interest of equity. For example, Rao feels that to the extent irrigation results in higher agricultural growth and more employment, it leads to reduction in poverty (Rao et al, 2008). Rao (2004) also argued that irrigation from public sources like canals and state tube wells has been more equitable than irrigation through private tube wells which are biased towards the rich farmers.

It is also pointed out that since irrigation was essential for the adoption of new technology, it had to be developed through canals and tube wells. Tube well irrigation was credited with being less capital intensive than canals, more flexible, and less wastage of water (Singhal, 2003).
ROLE OF RURAL CREDIT IN AGRICULTURAL DEVELOPMENT

Financial institutions are also needed to provide access to credit and savings for farmers, besides the facilitation of access to output and input markets. Microcredit schemes have been successful in providing access to small amounts of credit for the rural poor mostly in Asia. However, the credit market for small holders - notably in Sub-Saharan Africa - is functioning very poorly and credit constraints are a major reason why small holders fail to increase productivity and choose more profitable production strategies. For example, credit constrains negatively influence plot size, use of fertilizer and total productivity (Freeman, Ehui, and Jabbar 1998).

To create the conducive environment for a well-functioning capital market in rural areas, public investment in infrastructure is needed. However, publicly-financed or managed financial institutions have a very poor track record. Fortunately, infrastructure improvements tend to attract private financial institutions to rural areas. For example, Mitra (2003) showed that private banks are more likely to locate in areas with better road infrastructure and marketing systems. Improved rural infrastructure also encourages marketing agents to extend credit to farmers at reasonable interest rates, because of lower risks.

RURAL INFRASTRUCTURE AND AGRICULTURAL DEVELOPMENT

In a study by Deno and Eberts (1989), it was found that a significant increase in personal income was appropriated when infrastructure (of all types)
was created in rural areas. However, the authors concluded that most of the effect lasted only for a short span of time – usually less than one year. The installation of physical infrastructure has the potential to generate employment as workers are used in the construction process.

The pioneering study of Antle (1983)\textsuperscript{47} used aggregate agricultural production data for 1965 from 47 developing and 19 developed countries and included infrastructure to explain differences in agricultural productivity across countries. He found that infrastructure had a strong positive impact on agricultural productivity in all categories of countries. The other independent variables were represented by the factors of production available at a national level and comprise agricultural land, active population in agriculture, consumption of nitrogen, phosphate and potash fertilizer and a good live-stock animal. Antle followed this up with a similar study in India (1984) and came to the same conclusion. The econometric methods adopted in these studies, did not answer the fundamental question of extent of impacts.

Later on, Diamond (1990)\textsuperscript{48} measured the aggregate effects of village-level infrastructure (measured as a composite index) on a number of welfare and level-of-development indicators in Bangladesh and found that infrastructure development increased agricultural production by 32 per cent, and increased household income by 33 per cent.

Bhatia (1999)\textsuperscript{49} in his study established the positive relationship between composite index of rural infrastructure in 15 states of India and level
of per hectare yield of food grains is also value of output from agriculture. It may be better to take the individual infrastructure and use log values for estimating elasticity.

According to Chand and Chauhan (2002), the availability of rural infrastructure such as irrigation, road density, market density, supply of institutional credit and electricity has been an important factor in promoting agricultural diversification. They pointed that though the initial incentive for diversification comes from demand driven factors, the success and speed of diversification depends on access to infrastructure which embodied the available technology.

Bansal and Patil (2006) estimated with the district level data of five states viz., Bihar, Haryana, Punjab, Uttar Pradesh and West Bengal. The study found that road density has non-significant impact on agricultural state domestic product per gross cropped area (GCA) of all the states except west Bengal. Village electrification was positive and significant in Haryana and Punjab only while bank branches per GCA are not significant in any of the states. It may be again due to inappropriate specification as Sangwan (2011) found that bank branches per lakh population are positive and significant in Maharashtra.

It is estimated that 15 percent of crop produce is lost between the farm gate and the consumer in the world because of poor roads and inappropriate storage facilities alone, adversely influencing income of farmers (World Bank
1997).\textsuperscript{53} Strengthening rural infrastructure can lead to lower production costs which can further augment agricultural output and income for rural farming community.

Improved infrastructure also leads to expansion of markets, economies of scale, and improvement in fact market operations. The development of rural infrastructure helps to enlarge markets with greater access to factors of production. The female labour participation rate increases as traditional taboos against it are overcome (Rahman, 1994).\textsuperscript{54} Easier access to markets allows an expansion of the production of perishable and transport-cost-intensive products. It can also lead to a conversion of latent demand into effective commercial demand. These effects of infrastructure accentuate the process of commercialization in agriculture and rural sector (Jaffee and Morton, 1995)\textsuperscript{55}. There is increased scale of trade too and helps in reduction of trading costs per unit owing to economies of scale.

The study by Fan et al (2002)\textsuperscript{56} on a survey of 129 villages in various parts of Bangladesh categorized the villages into two groups based on an aggregate index developed to reflect the ease of access of a village to various services such as markets, schools, banks, and local administrative offices. Villages with better access were found to be significantly better off in a number of areas including agricultural production, household incomes, and wage income of landless labourers, health, and the participation of women in the economy.
Gulati (1997)\textsuperscript{57} observed a positive impact of 'social development' and irrigation intensity factors on the composite index of economic development, at the district level. Within the 'social-development' factors, the surfaced road length and electricity turned out to be the crucial indicators. In a state level analysis for two-points of time, viz., 1970-71 and 1980-81, inadequacy of infrastructural facilities has been seen as a major obstacle in the path of progress of developing states (Tewari, 1984). He observed a positive impact of infrastructure on development; at least in six states while in another five, low development levels were associated with poor infrastructure development.\textsuperscript{58}

Singh (1983)\textsuperscript{59} found positive correlation between infrastructure and agricultural development. Among the various infrastructural facilities, agricultural development was strongly correlated with agricultural infrastructure index, followed by index of transport and communication.

Thorat and Sirohi (2002)\textsuperscript{60} attempted to analyse the impact of infrastructure on agricultural development using larger data set, both in terms of time period (pooling the data for four time periods, viz., 1961, 1971, 1981 and 1991) and coverage of infrastructural variables to include ten explanatory variables, viz., transport, power, irrigation, tractorization, research, extension, access to primary agricultural credit societies, regulated and wholesale marketing infrastructure, access to fertilizer sale points and commercial banks covering physical, financial and research infrastructure. The results indicated that transport, power, irrigation and research infrastructure are four critical
components, which affect the agricultural productivity in a significant manner. However, between transport and power, the former emerged as a more dominant variable. There was complementarity between the transport and power in the sense that the accessibility to roads is normally followed by accessibility to power. With improvement in access to power, the irrigation infrastructure also improved particularly through energization of pumpsets. In turn, improved irrigation facilities coupled with research input enhanced agricultural productivity. The other infrastructural facilities like credit infrastructure, extension services, access to fertilizer sale points and markets, etc. also developed with development of transport infrastructure.

A large share of subsistence and semi-subsistence agriculture has been transformed through the adoption of new technology, investments in rural infrastructure and markets, and the design and implementation of appropriate policies. This transformation leads to an increase in productivity of land and labour and results in increasing incomes for farmers and farm workers and enhanced purchasing power for consumers. Low food prices achieved by reduced unit-costs of production contribute to lower wages in non-agricultural sectors and thus facilitate industrial growth (Hazell and Röell 1983).  

In one of the technical background documents for the World Food Summit, it is concluded that roads, electricity supplies, telecommunications, and other infrastructure services are limited in all rural areas, although they are of key importance to stimulate agricultural investment and growth (Food and
Agriculture Organization [FAO], 1996). The document further argued that better communications are a key requirement. They reduce transportation cost, increase competition, reduce marketing margins, and by this way, it can directly improve farm incomes and private investment opportunities.

Insufficient infrastructure is one of the key bottlenecks for successful utilization of agricultural Research and Technology (R&T) because it limits farmers’ options and agricultural output. Where the rural infrastructure provides a facilitating environment, economic returns to R&T are usually high. On the basis of data from 44 developing countries of three regions (Africa, Asia and Latin America), Thistle et al (2003) found high rates of return to agricultural research and technology. Reporting by region, they found that Asia (12 countries) had the highest annual return (31 per cent), followed by 22 per cent in Africa (18 countries), and 6 per cent in Latin America (13 countries). The annual returns were especially high (40-50 per cent) in Ethiopia, Morocco, Uganda, Philippines, and Pakistan. On the other hand, returns were negative in Lesotho, Senegal, Tanzania, and Sri Lanka.

Market integration over space and time requires good infrastructure and effective market institutions. Where spatial market integration is poor, favourable local growing conditions, improved production practices, or adoption of modern technologies that result in increasing marketable surpluses may result in drastic drops in local prices, while other areas may suffer from deficits and rapidly increasing prices. Such large spatial price differences and
abrupt inter temporal price changes are common in low-income countries with poor infrastructure and/or poorly functioning markets. For example, prices of Maize in Ethiopia tripled from 1997-98 to 1999-00 followed by an 80 per cent drop from 1999-2000 to 2000-2001. In Malawi, the price of maize quadrupled between April 2001 and April 2002 (Pinstrup-Andersen 2002).64

The supply response by small farmers is also seriously affected by the state of infrastructure and market. Chhibber (1988)65 found that a one percent increase in output prices would result in a supply response of 0.3-0.5 percent in areas with poor infrastructure and 0.7-0.9 in areas with good infrastructure.

The farmers’ willingness to adopt productivity-enhancing technology depends very significantly on the infrastructure and market situation which they face.

Rural infrastructure development, like irrigation, electrification, credit, roads and communication, regulated markets and agricultural research and extension are essential prerequisites for modernization and growth of agriculture in developing countries. The growth of agriculture, in turn, results not only in increasing the productivity and income of all categories of farmers, but also in providing greater employment to rural labour. The employment elasticity of agricultural growth was found to be positive and quite high in almost all states of India during the post-green-revolution phase. Agricultural growth induces growth of labour-intensive manufacturing activities in rural areas that provide employment to the poor in allied and non-farm occupations.
There is sufficient evidence to indicate that the growth of agriculture has a significant impact on reduction in poverty (Shah, 1993).  

The second aggregate study was carried out by Byerlee et al (2005) which involved a cross-country analysis of annual data (1969-1978) collected from 58 countries. The authors found positive and significant correlation between aggregate and crop production functions and the two road variables in the pooled country analysis. The elasticity of fertilizer demand with respect to road density was found to be quite high and roads were also found to have directly contributed to both growth of output and use of fertilizers.

Electrification also led to improvements in processing and technology transfer. The study by Binswanger et al (1987) used data from 85 selected districts of 13 states of India to examine the role of rural infrastructure like rural roads, banks, and education in agricultural investment and output. The authors used a reduced form regression model with fixed-effects technique to avoid simultaneity and measured the impact of various factors on agricultural productivity and growth. Their results confirmed the conclusions arrived at by many scholars that, whereas prices did have a positive and significant impact on increase in aggregate agricultural output, the impact as measured by the elasticity was too small. On the other hand, the impact of infrastructural variables like credit, irrigation and education was much greater. Improved road investment enhanced agricultural output quite significantly (elasticity of about 0.20). Availability of education infrastructure and rural banks played an
overwhelming role in determining investment. Availability of banks was found to be a more important variable that determined fertilizer demand and crop output than the interest rates.

Many empirical studies have brought out the contribution of infrastructure to agricultural transformation and the consequent impact of new agricultural technology widely adopted during the 1960s and the 1970s on the growth of income, income distribution and poverty reduction in the green revolution regions in many Asian countries. One of the earliest studies was by Ether on the experience of Malaysian development, which brought out that infrastructural development had direct effect on increasing income and also led to large indirect benefits through the operation of multipliers. The multiplier effect, in the context of a Malaysian rural area, was equivalent to 75 cents out of a dollar’s worth of incremental income that was the indirect effect of an original investment in infrastructure (Ethier, 1982).69

In a detailed study of Indian agriculture, Kumar and Rosegrant first computed the growth of total factor productivity (TFP) and then decomposed the growth of TFP into several components like infrastructure, canal irrigation, balanced use of fertilizers, terms of trade and research and extension (through a regression analysis). Market infrastructure, research, canal irrigation and balanced use of fertilizers were found to be the most important sources of growth of TFP. The marginal returns to public investment in research on
various crops like rice were found to be very high, particularly in the eastern and southern regions (Kumar, 2006).\textsuperscript{70}

Munnell \textit{et al} (1990)\textsuperscript{71} brought forward a hypothesis that improvements in physical and institutional infrastructure were the best vehicle for achieving self-sufficiency in commodity production in the long run. Since they require large investments and long gestation periods, subsidies and price support may appear to be attractive alternatives. Important steps in the prescription of Munnell \textit{et al} for improving physical and institutional infrastructure were technological improvements, easing credit constraints in the case of small holders and dissemination of scientific knowledge through research and extension.

**ROLE OF INFRASTRUCTURE IN RURAL DEVELOPMENT**

While there is some evidence of high rates of return to infrastructure investments in general (World Bank, 1994),\textsuperscript{72} a few estimates have been made of the rate of return to investments in rural infrastructure. The contributions of rural infrastructure are measured by the impact on aggregate output of an economy. All estimates are significantly higher than one, thus signalling underinvestment. In particular, investments in roads and telephone lines have high returns.

The findings of Canning and Bennathan (2000)\textsuperscript{73} provide some indications of relative profitability of investments in rural infrastructure. They estimated the rate of return to electricity generating capacity and to paved
roads at the national level for 51 and 41 countries respectively over the past four decades. They find that investments in electricity generating capacity and paved roads are more profitable than other public investments in 20 out of 51 countries and in 22 out of 41 countries, respectively. While the rate of returns to electricity generating capacity tends to be high in low-income countries, that to paved roads tends to be high in middle-income countries. Unfortunately, these findings are not specifically for investments in rural infrastructure.

Linkages also help the richer sections to divert their investment from limited credit markets to non-agricultural activities in rural areas or in towns. This also helps in providing additional employment to rural labour. The reduction of marketing margins has far-reaching consequences for the comparative advantage enjoyed by a country and for its competitive strength in the world economy. Again, access to institutional services like health care, education and credit becomes much easier. This helps not only in increasing productivity but also in reducing credit constraints which are the main instrument of exploitation in the rural setting. Thus, by increasing the income of the rural people, infrastructural development can also be instrumental in breaking the stranglehold of moneylenders and reducing the impact of intricacy of land, labour and credit markets (Ahmed and Hossain 1996).74

RURAL INFRASTRUCTURE AND POVERTY REDUCTION

Poverty reduction requires economic growth which, when accompanied with sound macroeconomic management and good governance, results in
sustainable and socially inclusive development (ADB, 2005). Two schools of thought emerged in the 1990s regarding physical infrastructure and poverty reduction. On the one hand, great importance was attached to physical infrastructure in the poverty reduction efforts of developing countries; on the other hand, many in the international development community viewed assistance for infrastructure with considerable skepticism on three grounds (DFID 2002). First, though important for economic growth, infrastructure investment had little relevance to poverty reduction. Second, actual benefits from infrastructure were significantly less than anticipated.

Estache and Fay (2002) brought out a significant impact of roads on poverty reduction through economic growth. There was increased labour mobility and labour markets became less fragmented owing to infrastructure development leading to enhanced commercial transactions in labour markets and reduced dualism between family and hired labour.

Kwon (2000), analyzing Indonesian data, estimated a growth elasticity with respect to poverty incidence of 0.33 for good-road provinces and 0.09 for bad-road Provinces, implying that poverty incidence falls by 0.33 per cent and 0.09 per cent, respectively, for every 1 per cent growth in provincial GDP.

Fan and Zhange (2004) in a study of China found that the roads significantly reduce poverty incidence through agricultural productivity and non-farm employment. The estimated elasticity with respect to road density are 0.08 for agricultural GDP per worker, 0.10 for non-agricultural employment,
and 0.15 for wages of non-agricultural workers in rural areas. The estimated elasticity with respect to irrigation level is 0.41, implying that a 1 per cent increase in irrigation is associated with a 0.41 per cent rise in agricultural output per worker, resulting in a 1.13 per cent drop in poverty incidence. In the same study, they estimated an elasticity of 0.42 with respect to electricity. They worked out that every 10,000 Yuan spent for investment on roads and electricity development brought out 3.2 and 2.3 persons, out of poverty while irrigation has indirect effect through increasing productivity and lowering prices. The case of Nepal suggested that establishment of extensive road access to market would confer substantial benefit on average, much of these going to poor households (Jacoby, 2000).  

Singh (2004) in her study examined impact of infrastructure on agricultural development and rural poverty through a cross section study of 16 major states of India by preparing composite indices of rural economic and social infrastructure for 1980-81, 1990-91 and 2000-01 covering 16 indicators of economic infrastructure and 7 indicators of social infrastructure. A strong correlation between ranks of states in economic and social infrastructure has been observed. Indicators such as irrigation, rural roads, institutional credit and rural literacy were identified as being most critical in enhancing agricultural productivity; while in case of rural poverty, infrastructure facilities, particularly irrigation, rural roads, post offices, bank credit, electrification and literacy were identified as more vital.
Chowdhury and Torero (2005)\textsuperscript{82} established on the basis of Bangladesh household data that households living in a village connected to a paved road earn a higher proportion of their income, on average, from non-farm activities compared with households living in villages not connected to paved road.

**CONCLUSION**

The review of the important studies indicates that many scholars have attempted to examine the role of different types of infrastructural facilities in agricultural development, rural development and also poverty reduction. While it is accepted that provision of infrastructural facilities influence agricultural development, the extent of such impact and that too on different segments of the farming community have not been brought out by these studies. It is not clear whether rural infrastructure is 'scale neutral', i.e., whether it benefits large, medium, small and marginal farmers alike. However, such a study cannot be done on the basis of secondary data, since data pertaining to different segments of farmers are not available. Hence, this study makes an attempt to fill this gap by collecting primary data from different segments of farmers about the role of infrastructural facilities on the extent of agricultural development in the study area.
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