



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

---

## **Rapporteur's Report on Rural Infrastructure And Growth**

**Rapporteur: Vasant P. Gandhi\***

*"India faced four major challenges...and they remain the main challenges....First, ...liberalization has begun, but key sectors of the Indian Economy remain hamstrung by systems put in place a half century earlier. Second, India need(s) to invest heavily in basic infrastructure - roads, ports, power, water and sanitation, telecommunication - to reduce production costs and deepen India's integration domestically and with the world market. Third, India need(s) to invest much more in the health and education of its own people... Fourth, India need(s) to figure out how to pay for the infrastructure and social investment."*

**Jeffrey D. Sachs**  
**India's Market Reforms: The Triumph of Hope over Fear, in "The End of Poverty" (2005)**

### **INTRODUCTION**

It is highly opportune that the Indian Society of Agricultural Economics has taken the theme of "Rural Infrastructure and Growth" for discussion in this conference. There has been a strong revival of interest in infrastructure and its role in economic development, particularly in countries such as India. Economists have been trying hard to understand and analyse why some areas and countries move ahead rapidly, while others lag behind on the path of development. The role of infrastructure factors invariably figures strongly in this debate.

The term "infrastructure" is often being rather loosely used. A commonly understood definition is necessary for communication and clarity among researchers and professionals especially for study and research on infrastructural issues. The following four conditions may be used to define infrastructure for common understanding based on the services it provides (Ahmed and Donovan, 1992):

1. The services provided facilitate or are basic to economic activity.
2. The services are usually public goods because of economic externalities.
3. The services cannot be imported.
4. The investments tend to be indivisible or "lumpy".

Provision of infrastructure by the public sector typically stem from these four conditions.

The term infrastructure was "invented" during the Second World War by military strategists to indicate wide-ranging elements of war logistics (Ahmed and Donovan, 1992). Thereafter, economists adopted the term into the literature of development economics for use interchangeably with "overhead capital" (Youngson, 1967). Soon

---

\* Professor, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad – 380 015.

distinctions such as “social infrastructure”, “economic infrastructure”, “hard infrastructure”, “soft infrastructure”, “physical infrastructure” and “institutional infrastructure” were developed to emphasise a particular aspect or attribute the word infrastructure represented (Ahmed and Donovan, 1992). Infrastructure became a popular word, often used loosely.

A common thread was sought through the definition of “public goods” since infrastructural development essentially meant creation of public capital goods (Ahmed and Donovan, 1992). Such capital goods carry the distinction of producing external economies (technological and pecuniary) and social benefits different from private benefits. The consumption by one individual of the services provided by these public goods does not prevent consumption by another individual (Samuelson, 1954).

On the supply side, production of the public goods is not free or costless. But the marginal cost of having an additional individual consume the good, once produced, is zero. No private firm would ordinarily produce a public good, since charging the marginal cost would result in no revenues, yet charging any other price would not be possible since individuals would always want someone else to pay. Provision of the public good would not occur and all would be worse-off. This is the theoretical basis for putting public goods in the domain of the public sector (Ahmed and Donovan, 1992).

Youngson (1967) attempted to make the definition of infrastructure relatively simple by emphasising that infrastructure is not a set of things but a set of attributes. Two such attributes, both of which are in accordance with the notions enunciated by Rosenstein-Rodan (1943) and Nurkse (1953), can be recognised. Capital can be viewed as infrastructure to the extent that (1) it is a source of external economies, and (2) it is provided in large units, ahead of demand.

Later there was a surge of attempts in development economics to further specify the contents of infrastructure or “overhead capital”, as it was termed. Thus, Lewis (1955) includes public utilities, ports, water supplies and electricity in the specification of infrastructure. Higgins (1959) includes transport, public utilities, schools, and hospitals. Hirschman (1958) lists law and order, education, public health, transportation, communications, power, water supply, irrigation and drainage. He makes a distinction between a wider concept of social overhead capital, as listed above, and a “hard core” which he limits to transport and power.

Figure 1 shows how we can conceptualise the effect of infrastructural development on production for a competitive market economy. In a situation of inadequately developed infrastructure, firms or farms are confronted with higher marginal cost (MCI) at every level of production, and, given the market price of their output, produce at Q1. With an improvement in infrastructure, the marginal cost curve shifts downward to the right (MC2), resulting in an increase in output from Q1 to Q2, (Ahmed and Donovan, 1992; Lakshmanan, 1989).

Further, another impact of infrastructure, such as roads and communication, is to raise the price realised by the firms or farms, see Figure 2. With an improvement in infrastructure, the price realised rises from P1 to P2, and therefore there is an increase in the output from Q2 to Q3.

Figure 1: Infrastructure Development and Growth of Production and Income (1)

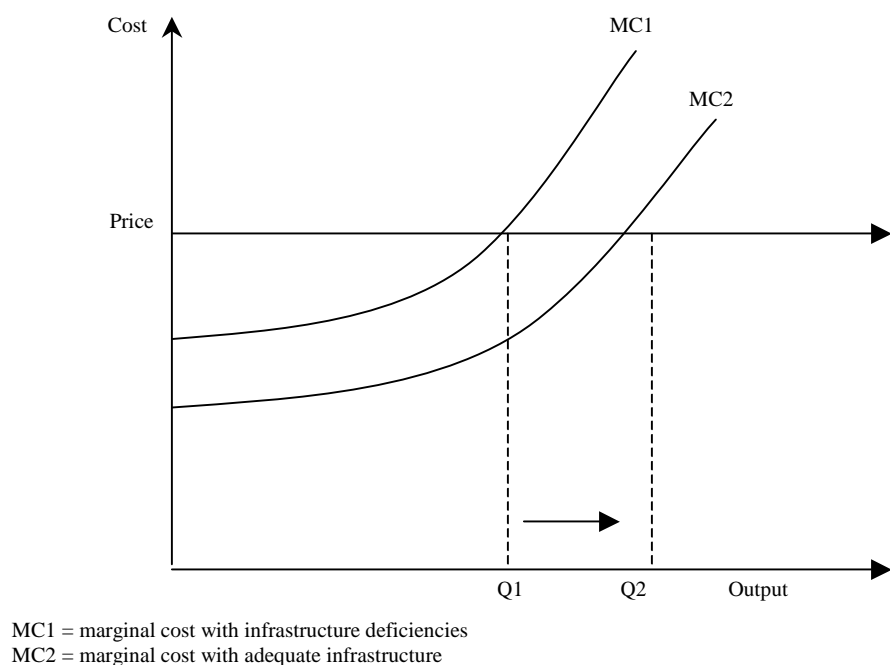
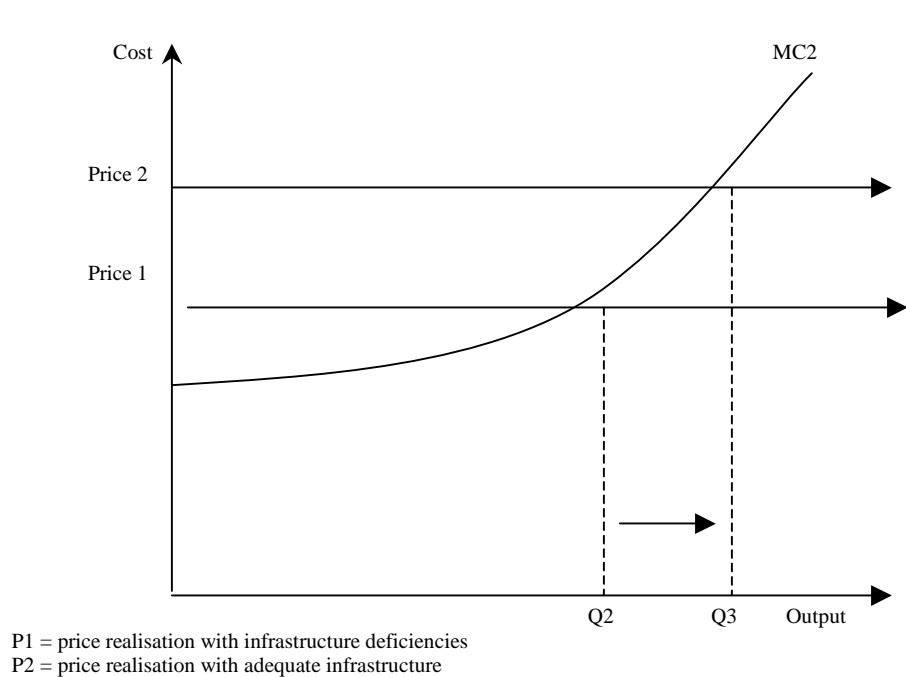


Figure 2: Infrastructure Development and Growth of Production and Income (2)



These constructs are indeed simplifications. They do not say anything about how these effects are realised, how adjustments are made, and what time dimension is involved (Ahmed and Donovan, 1992). In empirical analysis one has to dig deep into these questions of how and when, particularly when agricultural production is involved. The cost reduction occurs through the interaction of infrastructure with directly productive inputs of firms/farms. This may, however, come about in a variety of ways, such as reduction in transaction costs, improved diffusion of technology, new combinations of outputs and inputs, better input prices, increased specialisation and commercialisation, and improved entrepreneurial capacity, all realised through infrastructural investment (Ahmed and Donovan, 1992).

Moreover, the constructs do not say anything about social developments, which may produce effects outside the production activities of a society. For example, effects on consumption patterns, family planning, and health could be equally significant. Negative effects may also occur, as with possible undesirable environmental effects. Additional considerations include the technology involved in construction and maintenance and the effects on wage relationships, incomes, and consumption in the short and long run (Ahmed and Donovan, 1992).

In measuring the impact of infrastructural investment, the methodological issues surface fully in the process of benefit-cost analysis of infrastructural projects. The literature on benefit-cost analysis is rich. The works of Little and Mirrlees (1974) and Dasgupta *et al.* (1972) are classics. Most of the literature shows enormous preoccupation with the mechanics of valuation (for example, price interest rate, and exchange rate estimation), but does not shed much light on the methods for identifying and measuring the direct and indirect benefits of infrastructure. Moreover, since benefit-cost analysis is an extremely project-oriented approach, focusing on a particular element of infrastructure (transport or electricity or telecommunications), it often misses the effects or interaction among these elements (Ahmed and Donovan, 1992).

There has been substantial recent literature on infrastructure development, including Mody (1997) on East Asia, Pouliquen (1999) on rural infrastructure, Songco (2002) on benefits to the poor, and World Bank (2004) – source book. There is also a large literature in India including Thorat and Sirohi (2004) on rural infrastructure, Gandhi (1996) on investment behaviour, and Network (2001, 2002, 2003, 2004) - *India Infrastructure Reports*. These have helped considerably in progressing the understanding on needs, impact, management and challenges of infrastructure development.

The theme of “Rural Infrastructure and Growth” for this conference attracted a huge number of papers (86) which is indicative of the interest and importance of this topic today in India and justifies its selection by the Society for discussion in this conference. It also, however, made the task of selection of papers, and creation of their summary and synthesis difficult - a large number of good papers were received. The former has been predominantly based on the foundations, and letter and

guidelines provided by the Society in inviting the papers for the conference. An effort has been made below to organize, summarise and synthesise from all the inputs received on this topic.

### *Needs, Trends and Distribution of Infrastructure Development*

The need for rural infrastructure in India is huge. Swami Prakash Srivastava describes the trends in rural infrastructure development in India. He finds that there has been substantial improvement in infrastructure including rural marketing, irrigation, electrification, telephones, roads, water supply, housing and sanitation in the rural areas through various schemes of the government. Arjun Singh provides an overview of the development of roads and road transport in India. The road network including national highways, state highways and other roads aggregates to 3.32 million kilometers in India. The road network is showing a long term growth rate of 4 per cent per year. The expenditure on road construction amounts of 3.9 per cent of the total government expenditure in the Tenth plan, and rural roads have become a focus under the Common Minimum Programme in which all villages with a population of 1000 or more (500 or more in hilly/tribal areas) have been promised all weather road connectivity.

K.V. Deshmukh provides an overview of the status of socio-economic infrastructure in the state of Maharashtra. He indicates that there has been good development but there is need to address infrastructure development in health, highways and railways, and this could be very beneficial for the state economy. S.S. Kalamkar describes the status of rural infrastructure development in the state of Maharashtra. It is found that Maharashtra is ranked sixth in the country on infrastructure and has the highest number of primary rural markets. However, on many counts such as railway density, road density and electricity used in agriculture, the state is lagging substantially behind.

K.S. Birari, *et al.* examine the changes in rural infrastructure in Maharashtra from 1960-61 to 2004-05. They find that village roads had expanded by 458 per cent and the proportion of village roads to total roads reached 42 per cent. The agriculture electricity consumption also expanded rapidly at a growth rate of 17 per cent but remains half of the industrial consumptions. The irrigated area has grown by 198 per cent. Substantial growth in rural infrastructure as well as production and productivity of crops is found.

E.R. Patil *et al.* examine infrastructure development in the Vidharbha region of Maharashtra in comparison to the state as a whole. It finds that there is more rapid development of most kinds of infrastructure in Vidharbha between 1990 and 2004 as compared to Maharashtra as a whole. This includes irrigation projects, electric pump sets, agricultural credit co-operatives, government warehouses, railways and roads. However, a large number of projects remain incomplete. M.S. Jadhav, *et al.* describe the indicators of change in agricultural development in Maharashtra, with a focus on

infrastructure. They find that there has been considerable increase in the gross cropped area, the production of major crops, such as rice, pulses, cotton and sugarcane, the consumption of electricity, road length, irrigated area, and the number of co-operatives.

U.K. Pandey *et al.* examine the trends and growth rates of rural infrastructure in the state of Haryana from 1982-83 to the recent years. They find that there has been rapid growth in surfaced roads, regulated markets, warehouses, cold storages, safe drinking water, irrigation and electricity. However, despite tremendous progress, regional disparities continue to exist in the state. R.S. Nandal and Ram Singh describe the rural development in Haryana. Near 100 per cent coverage has been reached in electrification, surface roads, safe drinking water, and high coverage for primary health.

K. Srinivas and L.R. Kumar profile the growth in production, agricultural inputs, and rural infrastructure in Uttaranchal. They find that there is considerable variation across the districts and crops in terms of the inputs and production. There is reasonably good availability of social infrastructure, but the physical infrastructures, such as rural markets, storage, transportation, communication, and energy are highly inadequate and require substantial improvement. S.K. Singh describes the infrastructure development in the state of Uttar Pradesh. There is considerable growth in transport, power, irrigation, agricultural research, extension and education institutions, storage facilities, and regulated markets.

R.P. Singh describes some features of rural infrastructure in different zones of Bihar and Jharkhand. Even though the coverage of some facilities is good, there is great need for improvement in infrastructures such as dispensaries, banking services, post offices, animal services, and co-operatives. Sneha Nalla describes the state of rural infrastructure in Andhra Pradesh across three regions of the state. The differences appeared to be substantial across the regions, with coastal Andhra Pradesh generally having a better coverage followed by Telangana, and then Rayalaseema. However, there is some variation across different kinds of infrastructure. The role of infrastructure development to reduce the imbalances has been highlighted.

Amit Kar *et al.* describe the features of agriculture and rural infrastructure in the coastal ecosystems in India in comparison to non-coastal eco systems. It finds that the productivity of cereals and oilseeds is higher in the coastal regions and the use of modern inputs such as high-yielding varieties (HYVs), fertiliser and irrigation is also higher. It also finds that the development index representing infrastructure is higher in the coastal regions. This includes, generally, higher levels of bank coverage, market coverage and road length coverage, but there is substantial variation from state to state.

R.B. Singh examines the distribution and demand for tractor power across the states. The growth rate of tractors is found to be quite high, but has varied over time. The tractor population per hectare varies substantially across states with Tamil Nadu

and Punjab being at opposite extremes. A substantial increase in tractor demand has been projected based on various determinants.

*Infrastructure Impact on Economic Development,  
Employment and Poverty Alleviation*

A. Narayanamoorthy and Munir A. Hanjra examine the linkage between rural infrastructure and agricultural output through analysis of data across 256 districts of 13 states in India at three different time points, spanning from 1970s to the 1990s. The study finds that irrigation, roads, and rural literacy show a significant association with the output in each of the three time points. The impact of irrigation appears to have increased over time. In the 1970s, rural roads appear to play a dominant role, whereas in the 1980s literacy shows the strongest role. By the 1990s, irrigation emerges as the strongest factor amongst the three. The descriptive analysis also shows that the better districts show better infrastructure including irrigation, road, literacy, schools and electrification.

Maya Kant Awasthi examines the impact of the Assam rural infrastructure agricultural services project on various aspects of agricultural development in Assam through a before-after study. The project covered the development of rural roads, small scale irrigation systems, technology generation, extension, education and training. There was substantial backwardness with respect to these in the state. The project shows positive impact on the cropping pattern, farming systems, crop productivity, cropping intensity, diversification, nutritional intake, employment, and incomes.

Ranjit Kumar *et al.* examine the relationship between rural infrastructure and agricultural growth in the Indo-Gangetic plain covering the states of Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal, which show much disparity. There has been substantial growth in the net agricultural state domestic product per hectare of gross cropped area in all the states, except for Bihar, between 1982-83 and 2003-04. There has also been considerable growth in the road density, per cent villages electrified, and percent gross irrigated area, except in Haryana and Punjab, where it was already high. The study finds that electrification for Punjab and Haryana, gross irrigated area for Punjab, Uttar Pradesh and West Bengal, capacity of warehouse for Uttar Pradesh and West Bengal, and regulated markets for Uttar Pradesh and West Bengal are the major determinants of the net agricultural state domestic product per hectare of gross cropped area. The projection indicates a rising trend for Uttar Pradesh, West Bengal and Haryana, and decline for Bihar, unless infrastructure factors are corrected and improved.

P. Nasurudeen and N. Mahesh seek to capture the impact of infrastructure on agricultural output through estimation of relationships with capital, labour and government capital using a translog production function specification. They find that the impact of infrastructure on the agriculture sector is much higher in the post-



liberalisation period as compared to the pre-liberalisation period. However, the analysis is unable to show that infrastructure directly reduces income disparities.

Madhusudan Ghosh has sought to examine the impact of rural infrastructure on agricultural development and rural poverty. Cross sectional data across 15 major states at four time points is used. Rural poverty is found negatively related to the state domestic product in agriculture per head, the average value of output per hectare, and the average value of output per male agricultural worker. These three explanatory variables are in turn found to be positively related to irrigation, rural literacy and credit. Irrigation, rural literacy and credit are found to be negatively related to rural poverty.

N.V. Namboodiri examines the relationship between agricultural net state domestic product across 30 states with variables representing agricultural research and extension, rural marketing infrastructure, rural roads, storage facilities, communication facilities, electricity consumption, and input sale point. The relationship is also examined with intensity of land used and rural poverty. In most cases the relationship is found to be positive and it is statistically significant for agriculture extension rural market infrastructure and rural co-operative godown facilities.

Kuldeep Kaur and Paramjeet Kaur Dhindsa examine the relationship between the net state domestic product across the major states at three time points with infrastructure variables such as telephones, electrification, roads, rail, post-offices and primary health centres. The relationships seem to vary substantially in sign and significant. A large number of them may not be significant due to multi-collinearity.

K.N. Rai *et al.* examine infrastructure development in its impact in the state of Haryana. There has been good growth and improvement of infrastructure in the state of Haryana including surfaced roads, literacy, technical training, hospitals, inputs sale points, electrification, institutional finance, marketing, storage and agro industries. The study finds a strong association between food grain output and five variables including number of tube wells, number of credit societies, number of agricultural electric connection, number of villages connected by roads, and number of organised markets.

R.S. Tripathi *et al.* examine the impact of infrastructure on economic growth in rural areas of Haryana over time between 1966-67 and 2004-05. There has been remarkable progress in development of basic infrastructure in the state of Haryana, and also in agricultural production in Haryana. 38 infrastructure and other variables were co-related with food grain production, capital formation and gross state domestic product, and it was found that good relationships exist with irrigated area, number of tube wells, canal length, power availability, storage facilities, bank branches, Krishi Vigyan Kendras, regulated markets and health and education institutions.

*Impact of Roads and Transport Infrastructure*

G. Gopakumaran Nair and Ashutosh Kumar examine the impact of roads on rural agricultural economy in Tamil Nadu. They seek to identify how improvement in rural road connectivity helps the economy, through a study in a district under RIDF funding of NABARD. They find that better road connectivity reduces the cost of cultivation of the crops by substantially reducing the cost of various inputs, such as seeds, fertilisers, pesticides and farm power. The road connectivity brings about a change in the cropping pattern and activity towards higher income crops leading to considerable increase in the income. It also leads to realisation of better prices for a large number of crops by facilitating timely marketing and reducing transportation time. Besides this there are savings in transportation costs and reduction in wastage. As a result of these benefits the investment in roads leads to a healthy and high economic rate of return for the investment.

Arobinda Kumar Sarkar studies the impact of six rural road projects in West Bengal. He finds that the widening and strengthening of roads results in savings in vehicle operating costs, shift in the mode of transportation, increase in the frequency of travel of rural households, and increase in job opportunities of the skilled and unskilled. It also enhances the attendance of government servants, teachers and students.

K.C. Badatya examines the impact of investment in rural roads under the RIDF finance of NABARD. The study covers four states: Gujarat, Punjab, Rajasthan and Tamil Nadu. The projects benefited the farm sector through improved access to input markets, reduction in transport costs, better extension, and improved access to markets, especially for high value and perishable products. The projects also benefited vehicle operators through reduction in operation and maintenance costs, increased speed of transportation and reduced losses. The overall net benefit was estimated to be Rs.4.25 lakhs per kilometer per year, and was found to be the highest in Tamil Nadu followed by Punjab, and the lowest in Gujarat. The recurring cost of investment was found to be the lowest in Gujarat and the highest in Tamil Nadu. The economic rate of return averaged 26.1 per cent, and was found to be the highest in Gujarat, and the lowest in Tamil Nadu. Additional resource allocation for supplementary infrastructure support such as for agri-business centres, coal chain, school and health centres can further boost the return to the road projects.

Samir Samantara examines the impact of roads and bridge project financed under RIDF of NABARD in the Raipur district of Chhattisgarh. The impact particularly on employment and wages is examined. It was found that the employment increased from 91-127 days per year to 120-154 days per year in the two blocks after the road construction. The daily wage rate increased from Rs.35-50 per day to Rs.50-80 per day. The economic rate of return was found to be 15 to 18 per cent. The infrastructure index across districts in Chhattisgarh was significantly related to the yield of food grains and value of agricultural output.

B.K. Gupta and D.S. Azad examine the impact of a rural road project in Uttar Pradesh through a before-after study of 100 households. The study finds that road development is associated with higher use of inputs such as HYV, fertilisers and irrigation, and higher percentage of marketed surplus. It has resulted in higher price realisation for different crops and increased availment of institutional credit by the farmers.

### *Impact of Irrigation and Water Management Infrastructure*

H. Shivappa examines the role of irrigation in agricultural development with reference to Karnataka. The impact is examined based on primary data from a before/after study in two talukas across two districts one with canal and one with ground water irrigation. There is a shift towards high value crops such as sugarcane and the income across talukas and farm sizes increases by about 350 per cent. The yields and employment also increase sharply and the land prices increase by 460 per cent. Thus, a huge impact is evident from irrigation development.

Satyendra Prakash Gupta examines the national water shed development programme in the state of Chhattisgarh, and its impact on income and employment. One water shed and six villages in the project area are selected for study in project water shed and non-water shed areas. The project has resulted in creation of small structures for soil and water conservation in the area. The activity has resulted in doubling of irrigated area, increase in labour days of employment and reduction in the migration of labour. The project covered water shed areas are showing 45 per cent more income per farm, as compared to non-water shed areas.

R.K. Khatkar *et al.* examine the impact of the Bhakra Dam project on agricultural development in Haryana. Between 1953-54 and 2001-02, because of the dam the irrigated area has increased from 8 lakh hectares to 29 lakh hectares and the food grain production has increased from 5.4 lakh tonnes to 140 lakh tonnes. There has been considerable increase in the food consumption and literacy rate. However, due to non-judicious use of water the water table is rapidly declining in some areas and rising in other areas due to poor drainage.

A.K. Vitonde *et al.* examine the economics of an irrigation project in Washaim district of Maharashtra comparing beneficiaries and non-beneficiaries. Irrigation leads to substantial increase in soyabean area and net returns to soyabean. Other crops such as wheat and grain also benefited. The beneficiary farmers were better-off in food consumption and labour utilisation. R.D. Khodaskar examines the impact of a lift irrigation co-operative near Pune in Maharashtra. It is found that the activity has resulted in a significant increase in productivity, income and employment. The farmers are able to take more profitable crop and livestock activities. However, there is scope for improvement in proper distribution of water and other inputs.

K.U. Viswanathan and Yogita A. Khandge examine the economics and impact of tank modernisation projects under RIDF in Karnataka through a before-after study.

They find that the modernisation leads to increase in cropping area and changes in cropping pattern and variety of use. It leads to more water in the wells in the area. These changes lead to substantial increase in employment, and a good economic rate of return for the project. For greater benefits, adequate funding for maintenance of tanks is required.

Vijay Kumar Choudhary and Prafull K. Katre examine the impact of lift irrigation projects on agriculture in a village of Chhattisgarh. They find that lift irrigation leads to growing of a second crop in the rabi season, and substantial increases in net returns to the farmers, but there is much scope for improvement by encouraging multiple uses of water, better distribution, and better maintenance. N.S. Lohar *et al.* comparatively examine the economics of lift irrigation schemes in Maharashtra, across operation by co-operatives, sugar factories, and private initiatives. They find that the schemes run by co-operatives show the best benefit-cost ratios, and those operated by private initiative shows the least cost. The schemes operated by the sugar factories are found to be the least efficient mainly because of poor management and slow decision-making.

Sitesh Bhatia examines the impact of dams on the possibility of earthquakes. He finds that dams and reservoirs increase the frequency of earthquakes. The frequency depends on the water level in the dam, the volume of water stored, and the proximity to geological faults and earthquake epicenters. B. Sambasiva Rao, B.V. Raghavendar and K.M. Kumar describe the watershed development approach for rural development in India. It indicates the need for a comprehensive and sustainable approach.

K.N.S. Banafar and Rajveer Singh examine the impact of a micro water shed development project, under an employment assurance scheme, on agriculture through a before-after study. They find that there is increase in cropped for all farm sizes, increase in cropping intensity, adoption of new crops and increase in non-farm employment-due to urbanisation in the surrounding area. There is a decline in the livestock population and income. A.K. Koshta and M.R. Chandrakar examine the impact of tube well irrigation in the state of Chhattisgarh by comparing irrigated and rainfed locations. The study finds a substantial impact for both small and large farmers in crop, agricultural labour, and livestock incomes.

J.S. Amarnath and P. Karthik Raja examine the performance of tank irrigation in the Madurai district of Tamil Nadu for tanks which have been rehabilitated under core management regimes; Panchayat tank rehabilitated with community well, PWD rehabilitated, Panchayat tank rehabilitated, and Panchayat tank not rehabilitated. It finds that the Panchayat tank rehabilitated with community well shows the highest net income over total cost, and the Panchayat tank without rehabilitation shows negative income. It shows that rehabilitation can substantially increase the irrigation intensity and employment but the outcomes vary with the management regime.

R.S. Poddar *et al.* examine the viability of a barrage project in Karnataka in the Krishna basin. It was found that the project was highly viable, giving an IRR of 34 to

49 per cent depending on the assumed project life. There were also substantial anticipated returns to both large and small farmers. T.R. Singh *et al.* provide an assessment of the returns to different methods of irrigation in the state of Uttar Pradesh. The methods cover canal, diesel, electric, diesel and canal, electric and canal, diesel and electric. They find that the wheat crops are the highest in diesel and electric and the lowest in canal. The gross income and the net income are also the highest in diesel and electric. The difference is because of better water management due to timely and adequate water supply. The benefit cost ratio is however the highest under canal irrigation.

Ramesh Chandra Mondal and D. Majumder examine the benefits of tube well irrigation in West Bengal across owner and purchaser beneficiaries. The study finds that small and marginal farmers are major beneficiaries and *kharif* and summer paddy dominate. Owners overuse water while purchasers show greater efficiency. The average yields do not differ very much between the two groups and the net returns also do not differ very much. Overall, smooth functioning water markets will enhance the efficiency of water use. B. Malathi *et al.* provide an appraisal of tube well investment in an area of Krishna district in Andhra Pradesh, based on a sample of 90 farmers and 175 tube wells of depths ranging from 40 to 160 feet with water table depth of 12 to 32 feet. They find that the benefit cost ratio is 2.56, the internal rate of return is 28.8 per cent and the payback period is 2.65 years. Sensitivity analysis indicates that the investment remains viable under 10 per cent variation of costs or benefits.

S.M. Mundinamani *et al.* examine the benefits and impact of drip irrigation and other methods of irrigation for sugarcane cultivation in the context of tank irrigation in northern Karnataka. The farmers typically follow whole-furrow irrigation method in which excessive amount of water is consumed. This was compared in the study to alternate furrow, paired raw, drip and paired raw drip methods of irrigation. The paired raw drip method of irrigation was found to be the most efficient, consuming the least quantity of water (70 per cent less) and gives the highest gross and net return. It requires an additional investment of Rs. 36,250/- per hectare.

#### *Impact of Marketing, Storage and Agro-Processing Infrastructure*

R.K. Grover *et al.* describe the growth in agricultural commodity markets in Haryana between 1986-87 and 2004-05. There has been growth in the number of regulated markets and sub-market yards in Haryana and considerable growth in the state warehouses and cold storage capacity. The market arrival of sub-crops such as wheat, rice and cotton has increased rapidly but of others such as gram and rapeseed has reduced. This is partly related to the trends in production. The growth in the arrivals has been more rapid in the last decade. The incomes of the market committees have increased substantially and this has been ploughed back for infrastructure development.

R.N. Yadav and M. Ram examine the impact of IDA funded investment in regulated market infrastructure on market arrivals in Uttar Pradesh. Seven years before 1979-86 the investment period 1986-93 are compared to seven years after 1993-02 for five selected markets. The investment is mainly in shop-cum-godowns in the regulated markets and this totals to Rs.103 lakhs. The study finds that the period after the investment in market infrastructure shows a higher growth rate in the arrivals for most markets and crops including wheat, cotton, groundnut, paddy and jaggery. It is also associated with increase in the growth rates of production and productivity in the areas of these markets for most of the crops.

Brahm Prakash and V.P. Tyagi describe the growth of marketing infrastructure in Uttar Pradesh under the state agricultural production market board. This has resulted in growth in market yards and sub-yards, rural godowns, roads, farm storage, drinking water provision, and communication. There appears to be a positive impact on market arrivals and the incomes of the markets. Mahesh Singh examine the results of improvement in marketing arrangements for minor forest produce in the Bundelkhand region of Uttar Pradesh-particularly by pooling arrangements through cooperatives. Mates and assemblers are engaged in collection and pooling of minor forest produce including tendu leaves, sal seeds, tassar cocoons and sabaigrass. The activity has generated substantial employment, improved collection and better prices.

A.K. Gauraha describes the performance of regulated markets in Chhatisgarh between 2000-01 and 2005-06. The number of markets are showing some increase and the market arrivals of some crops such as soyabean, peas, rice and wheat are showing a tremendous increase. There is substantial increase in the incomes of the market yards but needs to be ploughed back to further improve the infrastructure facilities. M.N. Waghmare, V.G. Pokharkar and A.V. Deogirkar describe the development of a particular agricultural produce market committee area in Maharashtra. Significant facilities have been provided, and there is substantial growth in the arrivals and prices of most crops, with some variations across time periods.

Manoj Gupta and K.D. Sharma describe the role of marketing, storage and processing facilities for strawberries in the state of Himachal Pradesh. Strawberry cultivation would be very profitable provided there is development of marketing, storage and processing facilities in the state. Khem Chand *et al.* examine the availability of marketing and processing infrastructure for the crop of henna in Rajasthan. There is large increase in production and marketing of henna leaves and this can benefit from further improvement in storage, proper evaluation and quality testing.

M.S. Jairath describes the rural godown scheme of the central government, its implementation, and possible improvements. Under the scheme over 9000 godowns have been promoted across 22 states/UTs. There is considerable geographic variations in the godown availability. The impact of the scheme will depend on improving awareness and know-how, improving banking facilities and procedures, and involvement of NGOs and entrepreneurs. H. R. Shinde and B.K. Mali describe

the storage infrastructure in the state of Maharashtra. It indicates that a total storage capacity of about 2500 thousand tonnes has been created in Maharashtra. However, given the level of agricultural production in the state, this is highly inadequate, and the growth in storage capacity is not keeping pace with agricultural production, leading to losses and marketing difficulties.

A.R. Verma examines the marketing cost structure and farmers' share in the consumer rupee for potatoes with cold storage facilities in Indore district of Madhya Pradesh. There has been an increase in the marketing cost per quintal of potato from 1991-92 to 2005-06. However, the farmers' share in the consumer rupee has also risen and the cost of storage has increased from Rs.50 per quintal in 1991-92 to Rs.135 per quintal in 2005-06. The cold storage facilities are inadequate and most of the advantages of the facilities are taken by traders and large farmers.

S.S. Wadkar and S.R. Bagade describe the role of mango and cashew processing units in employment generation in the Konkan region. Substantial employment potential is estimated. A.C. Deorukhakar *et al.* study the economics of processing of kokum fruit (*Gracinia indica*) and its impact in the south Konkan region of Maharashtra. The processing leads to good value addition, returns and employment generation in seasonal employment. J.P. Singh *et al.* examine social and other factors in the economics of mint oil production in eastern Uttar Pradesh. It was found that the producers received a share of 74 per cent of the exporter rupee when selling directly to the processor and only 59 per cent of the exporter rupee when selling through the local traders and distant traders to the processors.

Ram Bhushan Trivedi *et al.* examine the status of contract farming in agricultural development of Uttar Pradesh. They review the experience of contract farming under different companies including Hindustan Lever (tomato), Pepsi (potato and chilly) and Nijjer Agro (tomato). It finds that the kind of contract varied substantially with the company and activity. The findings indicate that the farmers are generally happy with contracting, though they have some problems. The companies are also generally continuing this system though they face some problem of default. The problems faced include poor coordination, poor technical assistance, delayed payments, cheating and manipulation by the companies. 62 to 80 per cent of the farmers wanted to continue with contracting.

#### *Need and Impact of Research, Extension and Developmental Services*

B.V. Pagire *et al.* describe the research expenditure on agricultural and other sciences in the state of Maharashtra. The largest amount of expenditure in research is found to be in engineering and technology, followed by natural sciences, and then agriculture. There has been considerable growth in all research expenditure, and a substantial part of the agriculture research is through state agricultural universities.

V.A. Thorat *et al.* examine the impact of horticulture research on development in the Konkan region of Maharashtra. The Employment Guarantee Scheme Linked

Horticultural Development Programme leading to increase in research and investment is found to be positively associated with the growth rates of horticultural crops including cashew, coconut and mango. S.K. Chauhan examines the impact of bee-keeping in the state of Himachal Pradesh. Bee-keeping was promoted in the Apple Valley of Kullu under a project sponsored by ICHIMOD. The project has popularised bee-keeping among apple growers and this has resulted in an increase in 70 to 118 per cent in employment and 120 to 132 per cent increase in income. There is increasing competition from migratory bees.

Jag Mohan Singh Katiyar examine the economics of fish production in Uttar Pradesh, with a focus on inland fish breeding farms. A large number of farms have been set up. Human labour and manures/feeds are found to be major determinants of production. Increase in farm size from the small farms would result in better profitability. Poor marketing and infrastructure are major reasons for latches. The farms receive 58 to 71 per cent of the retail price depending on the channel and season.

Aftab Uddin Ahmed and Kanak Kanti Bagchi examine the factors and constraints affecting the adoption of new agricultural technology in Barpeta district of Assam. The study finds that the adoption of technology is positively related to farm size, farmer income, irrigation, credit availability, education, information and prices of output. It is negatively related to tradition orientation. B.L. Jangid *et al.* examine the impact of a centrally sponsored scheme to promote farm mechanization. The study finds that the promotion of mechanisation has improved the timeliness of various firm operations, and has reduced the time and labour requirements by 13 to 96 per cent. V.B. Jugale describes the benefits of precision farming infrastructure for agriculture in Maharashtra, including use of GIS, GPS, mapping sensors and monitors of various kinds. Large benefits may be expected.

R.V. Sujatha *et al.* examine the impact of women self help groups in the state of Andhra Pradesh. These self help groups have been formed under the Development of Women and Children in Rural Areas (DWCRA) and are engaged in various activities such as vegetable vending, milk vending, pickle and sweets making, small business, tailoring and embroidery, country buffaloes, hotel and others. The decomposition analysis indicates that increase in productive assets is highest in small business activity, increase in income is highest in hotel activity and increase in employment is also highest in the hotel activity. The income of the beneficiaries increased by 34 per cent, mainly because of the programmes' effect, and among the determinants, mainly because of the number of days of employment. There is need for training to improve the awareness, skills and competence to run the enterprises.

Hemanta Kumar Dash *et al.* examine the impact of women dairy projects in two district of Orissa. The projects were sponsored by Ministry of Women and Child Development, Government of India, and included formation of women dairy cooperatives, marketing infrastructure, physical inputs and training. The study finds that the project had a good impact. The milk production went up by 81 per cent, the



dairy cattle population increased by 22 per cent and the share of cross breed animals increased to 30 per cent. The project also contributed to capacity building through greater awareness, knowledge, skill development and women leadership.

Shalander Kumar and N.P. Singh examine the implications of privatisation and regulation of veterinary services in India. With the rising demand for livestock products there is a sharp increase in the demand for livestock services, increase in willingness to pay for livestock services, and increase in demand for private services. There is an urgent need to reevaluate and reorient the government's strategy for delivery of livestock services. In the long run, the private livestock service sector will develop and the government may dedicate itself to public good type of veterinary services. The cooperatives and NGOs should also play a significant role.

Vijay Laxmi Pandey and S. Chandrasekhar examine the awareness and perception of the people regarding government programmes in three districts of Maharashtra. It was found that only 45.5 per cent of the households were aware of drinking water projects of the government. People were willing to participate in programmes related to health, cleanliness, employment and primary facility development, but often expressed inability due to lack of integrity, awareness, literacy and economic resources as well as indifferent attitude.

#### *Need and Impact of Communication and Information Technology*

V.P. Mehta *et al.* surveys the provision information and communication technology (ICT) in rural India, particularly through some important government projects such as Gyandoot, Nai Disha and Drishtee. The benefits are many, including reduction of transaction costs, increase in operating efficiency and enabling new transactions, and the cost of information technology is falling. Some critical success factors include citizen-centric service delivery mechanisms, appropriate technology, cost-effective delivery stations, re-engineering back-end processes, transparency, and private participation.

Veena Goel describes the need for improving information and communication technology for better returns to farmers in the Ludhiana district of Punjab. Nearly 100 per cent of rice production is being marketed by the farmers and most of it is being sold at the regulated markets. There is lack of market information including minimum support prices, demand-supply situation and lifting by public agencies. Information-communication technology would help in bridging this gap.

#### *Need and Impact of Drinking Water Supply, Housing and Sanitation*

M.B. Belavatagi, B.S. Naregal and S.C. Matapati describe the rural water supply in the state of Karnataka under various schemes for supply of safe drinking water including piped water schemes, mini water supply schemes and bore wells with hand pumps. Bore wells constitute the most important source but other schemes are more

common in some of the districts. However, 43 per cent of the households still face severe water scarcity during the summer months and a large number of schemes are not working properly. This is because of the depletion in the water table as well as inadequate operations and maintenance in the schemes, which can be improved through local level organizations. Chaya Degaonkar describes the provision of drinking water in two talukas of Gulbarga district in Karnataka. It finds that the available infrastructure is highly inadequate, and a large number of schemes are not working. This increases the threat to public health in these areas.

J. Cyril Kanmony examines provision of drinking water and sanitation in the rural areas of Kanyakumari district. Even by 2001, only 33 per cent of households had piped drinking water, only 39 per cent had access to hand pumps/tubewells and the overall supply of drinking water is only 4 litres per capita per day in the rural hilly areas. Only 30 per cent of people have access to toilet and safe drinking water facility. This is leading to many health problems and there is great need for improvement.

H.S. Nanaware examines the sanitation facilities at the high school levels in a tehsil of Maharashtra. The school sanitation programme has been implemented by district rural development agencies through the Panchayat Samitis. The study finds that the grantable high schools have toilet facilities but these are not used by most students particularly girls. The non-grantable schools have no sanitation facilities for teachers, boys or girls. The rating of the facilities on the Likert Scale is negative overall. There is great need of improvement.

S.V. Hanagodimath *et al.* describe rural housing programmes in the state of Karnataka. Five different housing schemes have been undertaken. The largest number of houses have been constructed under the Ashraya Scheme which has been in operation since 1993-94. In 2003-04 about Rs.550 crores were allocated for housing in Karnataka and about 29,000 houses were constructed. Thus substantial effort has been made but complaints about the quality of the houses, the lack of other infrastructure and corruption/misuse have been there and required attention.

### *Schemes and Financing of Infrastructure*

K.G. Kshirsagar examines the experience of financing post harvest infrastructure for horticulture by the National Horticulture Board (NHB). He writes that the development of post harvest infrastructure (PHI) is crucial for India to reduce the huge losses and facilitate domestic and overseas trade. The study finds that the NHB soft loans were mainly disbursed in the states of Andhra Pradesh, Karnataka, Maharashtra Gujarat, Haryana, and Punjab. The extent of financing was very limited and funded only 26 per cent of the projects. The processing time was very long and the repayment performance very poor. A substantial policy and institutional review have been recommended.

Deepak Shah describes the provision, assistance and schemes of infrastructure for the horticulture sector. He indicates that a large number of schemes exist through

various organisations, such as NHB, NCDC, APEDA, NABARD, commercial banks, and other funding agencies. The cumulative assistance sanctioned for post harvest infrastructure amounts to Rs.3000 crores. However, this amounts to only 10 percent of the required investment, and substantial further efforts are required.

Smita Sirohi examines the financing of road and power infrastructure in rural India. The study finds that even though rural roads and electrification are infrastructurally crucial for agricultural development, their financing is plagued with many problems such as shortage of funds, non-utilisation of funds by some states, overlapping financing schemes and regional imbalance in fund allocation. Encouraging private funding is desirable but rural infrastructure is characterised by low and uncertain economic returns. Various other alternatives such as income-tax incentives, output based aid scheme and other sources of revenue need to be explored. Experiences from China and Lesotho show possibilities of tapping non-governmental sources through community participation.

#### ISSUES FOR DISCUSSION

The papers have covered a vast number of aspects and issue of infrastructure development pertaining to the rural areas of India. In the light of these we may wish to discuss the following issues in the conference:

1. What level of resources must be allocated to infrastructure vis-à-vis directly productive activities?
2. How much of resources should be allocated to different kinds of infrastructural development? How should this be decided so that we do not seem to be responding only when bottlenecks and pressure for services become acute?
3. What should be the sequencing of investment in infrastructure? How should this be determined?
4. To maximize the total impact, what kind of package of infrastructure and services is desirable? What considerations should determine this package?
5. How should questions of appropriate technology, location and environment be addressed?
6. How can implementation be expedited? Who should build the infrastructure?
7. How should infrastructure development be funded?
8. How should the operation and maintenance be handled once infrastructure is created?

9. Is there an interaction between policies and infrastructural investment? What policies must accompany infrastructural investment?
10. What institutional developments (such as development of local institutions) are critical for the construction and maintenance of infrastructure, particularly rural infrastructure?
11. How can the lack of information available to policy-makers and decision-makers concerning the actual use and need of various forms of infrastructure, and its status/condition be tackled so as to better guide the creation and maintenance of infrastructure?

#### REFERENCES

- 3i Network 2001, India Infrastructure Report 2001: Issues in Regulation and Market Structure, Oxford University Press: New Delhi.
- 3i Network 2002, India Infrastructure Report 2002: Governance Issues for Commercialization, Oxford University Press: New Delhi.
- 3i Network 2003, India Infrastructure Report 2003: Public Expenditure Allocation and Accountability, Oxford University Press: New Delhi.
- 3i Network 2004, India Infrastructure Report 2004: Ensuring Value for Money, Oxford University Press: New Delhi.
- Ahmed, Raisuddin and Cynthia Donovan (1992) Issues of Infrastructural Development: A Synthesis of the Literature, International Food Policy Research Institute, Washington D.C.
- Dasgupta, P., S. Margulin, and A. Sen. (1972), Guidelines for Project Evaluation. New York: United Nations.
- Gandhi, Vasant P. (1996). Investment behaviour in Indian Agriculture, *Indian Journal of Agricultural Economics*, Vol.51, No.4, Oct.-Dec., p.543-559.
- Higgins, B. (1959), Economic Development. New York Norton.
- Hirschman, A.O. (1958), Strategy of Economic Development. New Haven, Conn., U.S.A.: Yale University Press.
- Lakshmanan, T.R. (1989), Infrastructure and Economic Transformation, in *Advances in Spatial Theory and Dynamics*, ed. A.E. Anderson et al., New York: Elsevier.
- Lewis, W.A. (1955), Strategy of Economic Growth. London: Allen and Unwin.
- Little, I.M.D., and J.A. Mirrlees. 1974. Project Appraisal and Planning for Developing Countries. New York: Basic Books.
- Mody, Ashoka (ed.), (1997), Infrastructure Strategy in East Asia: The Untold Story: The World Bank, Washington D.C.
- Nurkse, R. (1953), Problems of Capital Formation in Underdeveloped Countries. New York: Oxford University Press.
- Pouliquen, Louis Y., (1999), Rural Infrastructure from a World Bank Perspective: A Knowledge Management Framework, The World Bank, Washington D.C.
- Rosenstein-Rodan, P.N. (1943), Problems of Industrialisation of Eastern and Southeastern Europe. *The Economic Journal* 53 (June), pp.202-211.
- Sachs, Jeffery D. (2005), The End of Poverty: Economic Possibilities for Our Time, Penguin Press: New York.
- Samuelson, P. (1954), The Pure Theory of Public Expenditure. *Review of Economics and Statistics*, Vol.36, No.4, pp. 387-89.
- Songco, Jocelyn A. (2002), Do Rural Infrastructure Investments Benefit the Poor?: Evaluating Linkages: A Global View, A Focus on Vietnam: The World Bank, Washington D.C.
- Thorat, Sukhdeo and Smita Sirohi (2004), State of the Indian Farmer: A Millennium Study-Rural Infrastructure, Academic Foundation: New Delhi.
- World Bank (2004), Agriculture Investment Sourcebook, Agriculture and Rural Development, World Bank, Washington D.C.
- Youngson, A.J. (1967), Overhead Capital: A Study in Development Economics. Edinburgh: Edinburgh II.