CHAPTER I

STATEMENT & OVERVIEW : IRRIGATION IN RURAL DEVELOPMENT

1.1 Introduction

The role of electricity as a technological input has long been recognised in the development debate. However recent interest in electricity has discernibly shifted from the issues of public utility economics e.g. pricing etc. to an overview of electricity in an overall energy context. In developing countries, the tasks of planning include the incorporation or modern elements into the technology used, no matter which economic activity is being considered, and electricity is contextually found to be important to both the rural economy as well as the urban-industrial one.

Electricity, as an energy input, is both a consumption good as well as a producer good. Use of energy is thus made in the household, in industry and commerce, as also in the agricultural sector. However, in developing countries, with low technology levels, the greatest potential use of electricity is in technology upgradation in industrial and agricultural production, although recognition of the latter has only come after the economics of energy-use were substantially altered by the oil crisis and the subsequent escalation in fossil-fuel prices.

A study of electricity-use in the agrarian sector, as is presently intended must involve some comparison of alternative sources of energy in irrigation technology; this is in recognition of the expansion of irrigation as being the primary technological option in the rural sector. This point of view has special relevance in a development context, especially in highly-populated land-poor countries. Since the focal impact of electricity in the rural sector will derive from augmentation of irrigation capacity, certain issues in natural resource economics must immediately be addressed.

A traditional definition of natural resources is as naturally occurring resource systems useful to human beings, either presently or under plausible technological,economic and social circumstances.In the context peculiar to the study, namely, electricity-use in the irrigation sector of a rural economy,three resource systems are encompassed: the availability of water resources, both surface and ground water; the availability of hydro-electric resources versus coal and other fuel resources which provide alternative thermal generation possibilities; and the relative scarcity of petroleum, oil and lubricants (POL) which had hitherto been the mainstays of a technology built around the internal combustion engine. Of these, surface and ground waters for irrigation use are renewable resources within the limits of precipitation and aquifer recharge,and hydel resources are renewable and clean energy resources, whereas coal and POL resources are non-renewable, with the latter being subject to the highest rate depletion.

Issues in natural resource economics pertain to existence and location of resource, a historical shift away from renewable resources to dependence on non-renewable resources, the wisdom of past patterns of resource allocation, environmental considerations in resource use and the role to be given to market policies in determining optimal allocation of resources.[1] Although the resource endowment would, by nature, be conditioned by scarcity, scarcity factors can be mitiga particularly by technological progress, by substitution of

plentiful resources for less plentiful ones, by expanded trade or discovery of new reserves and by recycling.[2] However all the factors have investment implications which escalate with time.

Earliest thinking on the resource question can be traced back to Ricardo, in his theory of differential land rents or Jevons' concern with the substitution of renewable timber resources by non-renewable coal in British industry. Although the literature and terminologies have multiplied since then, theoretical concerns remain identical. In the context of the present study they are two-fold. In the energy aspect, the study seeks to examine the justifications, if any behind continued use of expensive fossil-fuel resources in the technology-mix in place of relatively cheaper and abundant renewable ones; in an irrigation context the study relates alternative water resource systems to the cost-efficiency of their exploitation. The study is couched in terms of a regional and agrarian context which lends itself to evaluation by approximate case study.

In its design, the study first explores literature references on rural development and agrarian structures, irrigation studies in both productivity and energy efficiency aspects, questions of pricing of electricity and irrigation waters, power systems and other relevant research. The second chapter addresses spatial and temporal aspects of the power system in India, with special focus on rural electrification and the problems inherent in it. A separate section treats power data relevant to the study region. The third chapter is a comprehensive introduction to Cooch Behar, the area chosen for case study; secondary sources provide descriptive detail on the survey-blocks selected for evaluation. The fourth chapter presents findings from the empirical survey on differential aspects of the irrigation systems prevalent in the study region with special reference to systems dependent on electricity. The fifth chapter presents the subsidiary empirical findings on land and labour dynamics and on energy-use, again in the framework of alternative irrigation systems. The sixth and final chapter comprises a summary and final conclusions of the study.

The remainder of this chapter is an exploration of the literature references mentioned above and serves to place the study in context.

THE LITERATURE

1.2 Rural Transformation

In developing societies with primarily agrarian characteristics, agriculture remains the mainstay of economic activity for some time to come while transition to industrialisation is being achieved. Agriculture in such societies is of the subsistence type because of the dependence of a large population on it for their subsistence. The development process when initiated, sets two parallel moulding forces into motion. These are the transition of the merchant market-oriented urban settlement into an urban industrial one; and the transformation of subsistence-oriented traditional agriculture into a transitional market-oriented stage,with prospect of its eventual commercialisation.

Development processes engendered by planning in India have followed a similar course, and have demonstrated the fragility of the linkage between the objectives of development *per se*, and the goals of social welfare and equity. Realisation of this has been some time in coming. Initial plan emphases were on rapid industrialisation at any cost, leaving few resources to be targeted to development of the rural

community, beyond obvious social welfare measures like community health and education. Rural society and the agriculture that was its backbone was assumed to be self-sustaining, and without the need for explicit government intervention. Discrimination towards agriculture in order to fund industrial growth was accepted as a necessary evil; however the rapid transition to an industrial society was assumed to then take care of the overall goal of development, namely "to increase the economic, political and civil rights of all people across gender, ethnic groups, religious, races, regions, and countries".[3] However, experience has shown that 'transitional' problems of immiserisation and inequality tend to exacerbate because of the length of transition; compression of the two-century long path to industrial society followed in the developed countries into a mere matter of decades, such has been sought to be initiated in the newly-industrialised countries, cannot succeed without attendant distortions in economic relations and structures. It is seen that the issue of rural development in primarily agrarian economies moves beyond simplistic and broad market-oriented efficiency considerations into distributional issues with welfare connotations.

Such realisation has also attended the evolution of the planning process in India, flowing from perceptions of world development. "Rapid agricultural growth has generally been associated with successful industrialisation and sustained gains in overall output and productivity. Growth in output and productivity are usually lower where agricultural growth is low. Of sixty eight developing countries for which the World Bank has reliable data, thirty experienced agricultural growth rates of more than three percent a year during past twenty five years. All thirty had a GDP growth rate of at least 2.5 percent, and two-thirds of the countries whose agricultural sector grew fast also experienced very rapid economic growth (exceeding five percent)".[4]

1.3 The Problem

The perception of the agricultural sector in a planned economy, thus, changed from seeing it as a boundless source of resources for industrial investment, once policies designed to protect industry turned the terms of trade against agriculture and led to the growth of rural poverty. "Since development by and large [had] to depend more on the potentiality towards mobilisation of resources, their disparate resource base [seemed] to shift the emphasis of development from the mechanism for mobilisation of resources to techniques of exploitation".[5] From the period of the Fourth Plan onwards, larger plan allocations were devoted to agriculture and to rural development, with a recognition that the two are inter-related. Additional to this, a separate component of planning measures was evolved that addressed itself to poverty-alleviation.

A large number of studies have captured these aspects of rural development. Danda (1986) deserves that development has homogenisation as its explicit objective. In India "primarily due to unequal capability to absorb benefits", development is "often found to widen the gap between the rich and the poor".[6] Coupled in certain cases, with differential control over resources a tendency towards segregation of various segments of the same population can also emerge, even though the process of development may continue to contribute substantially to growth of GNP, and thus ostensibly to fulfill its objectives. But, as welfare is another primary goal of development, this can at best be termed as partial fulfilment unless

homogenisation of society takes place concurrently.[7]

Bose (1985)[8] cites estimates of number of people below the poverty line by Dandekar & Rath, Ahluwalia, and Vaidyanathan for the year 1960-61, which range from 135 million to 213.5 million. Another cited figure of the Planning Commission's estimate for 1979-80 is at 259.6 million, thus exhibiting the increasing trend of rural poverty over the planning period. Inequalities in regional distribution of rural poverty are cited from the Sixth Five Year Plan,which show high preponderances in Eastern India and in Madhya Pradesh. The author attributes this to the patterns of development initiated by the plans, identifying emerging contradictions between the elite and the deprived sections of the people, between conclaves of development versus backward regions and between development attained and its future prospects in a situation where present trends in development performances threaten the future potential for it. He then focuses on two antagonistic alternatives :

i) to take the continuation of the present developmental path as foregone, and then to ameliorate growing discontent without basically hampering current growth trends in the economy despite their leading to "further accumulation of wealth and real power in the hands of a few";[9] or

ii) to exploit the latent possibilities in the dynamics of development for transformation of the system into a new and more equitable social order where science & technology is relevant to the people.

The first approach is obviously the much debated one of 'appropriate technology' in which development is reflected as a necessary palliative to growth of inequalities instead of a primary instrument of socio-economic change, as in the latter.

The considerable development of rural areas in India since independence is seen "in terms of relatively dramatic increase in agricultural production although at a decreasing rate after the introduction of HYV phase; in extension of irrigation facility, in use of 'modern agricultural inputs' like chemical fertiliser, plant protection materials, agricultural machinery, etc.".[10] However, this is not seen to have a made a dent in the problem of rural poverty, the reasons for which are concentration of land ownership in the hands of a few and increasing landlessness otherwise, concentration of savings in the hands of the rich and inability to save and invest for agricultural production for the overwhelming majority of the poor, the growing problem of the distress-sales by the rural poor in order to meet pressing obligations and pernicious share-cropping systems that work to the detriment of agricultural performance. The solution, in the author's opinion is to look at the rural poor as "working producers who can potentially be a decisive [economic] force"[11] and to evolve a symbiotic relationship between them and technology.

1.4 The Agrarian Question

The problem relating to the meaning and scope of rural development has attracted the attention of several eminent scholars internationally. Three approaches appear to dominate perspectives. "In the first instance the agrarian question is a political question regarding the attitude of the peasantry and their role in the transformation of an extant social formation".[12] A "second layer of meaning .... has to do with class formation in agriculture or the differentiation of the peasantry",[13] in which productive relations between land owner

tenant farmers and the landless wage labours are exploited. "The third interpretation .... concerns the linkage between the agriculture and the overall development of the entire social formation, in particular the process of industrialisation",[14] where "the role of agriculture as a major source of surplus for primitive accumulation, prior to the self-sustaining accumulation of industrial capital"[15] comes into focus alongwith its importance as a 'home market' for industrial products. It is the third approach from which "much of the economics of development *a la* Arthur Lewis"[16] derives.

Bharadwaj (1986) traces the tradition of political economy originating from Quesnay & Ricardo as evolving into the Marxian approach of 'Surplus Based Theory', and another into the 'Demand-Supply equilibrium Theory' which is the 'mainstream' tradition usually described as neo-classical economic theory. Mainstream theory was primarily concerned with efficient allocation of resources initially through a 'markets and prices approach', later eclipsed by post-Keynesian development that recognised the inadequacy of market mechanism in overcoming some of the fundamental barriers to development. However inability of both varieties to accurately specify initial constraints, especially in agriculture have led to aberrations in the resulting development process. High or rising trends in GNP and industrial growth were observed to coexist with a rise in the number of people living at or below subsistence level in vast regions of agricultural backwardness.

Within theories of the mainstream genre follow diagnostic approaches to the problems of development wherein problems of unemployment/underemployment are ascribed to the existence of imperfect factor-markets, limited factor-substitutability in technology, and immobility of resources, that formed the corpus of the theory of development in the '50's comprising the work of Eckaus (1955), Kindleberger & Depres (1952), the 'Critical minimum effort' thesis of Leibenstein,the 'balanced-growth' paradigm of Hirschman and development literature associated with W.A.Lewis (1955), and Bauer & Yamey which drew its focuses from the de-colonisation experience.[17] Other variants of the latter are the work of Nurkse (1953)[18] and Rostow. Further manifestation of this stream is found in a slightly non-neoclassical setting (because of the assumption of availability of labour at constant wage rate to the organised sector) in theories of dualistic development where the 'pre-capitalist' backward agricultural sector coexists with a thoroughly competitive capitalist modern sector. Modern approaches that stem from the same tradition of neo-classical abstraction are the game-theoretic approaches whereby contractual systems between transactors/transacting classes are modeled e.g. Binswanger (1981).[19]

The Marxian analysis , on the other hand, has 'surplus' as its central notion. Production conditions in the economy are defined by the modes of production representing generation and distribution of surplus among the class of surplus producers and appropriators. In this approach, modes of production are considered to be influenced by a number of historical and social factors including class struggle i.e. stages of development, the changing capital-labour relation, effects of technical changes on distribution and on the reserve army of the unemployed and vice-versa.[20] As the "three sets of data (effectual demand, methods of productions and wages) in the scheme of prices of production are not independent of each other",[21] relative prices do not play the central role in a Marxian system for guiding efficient resource allocation. Instead the commanding force behind

accumulation is investment, with prices playing a secondary role in maintaining minimum viability rather than efficiency of production.

In development theory, it is in the analysis of agrarian change that problems of dealing with non-competitive and non-capitalist situations arise for which reason the Marxist approach has advanced in India; this is because of a differentiated peasantry, persistence of semi-feudal relations in productions and exchange, identification of the transacting position of a peasant by the class he belongs to, and the existence of alternative developmental strategies, each with divergent class consequences.

Byres(1986) is a historical/empirical analysis to the agrarian question within political economy, resting on the observation of the agrarian transition in England, Prussia, the United States, France, Japan, and South Korea and Taiwan in the wake of Japanese colonialism. Following the Kautsky-Lenin formulations which extended Marx's statement of the development of capitalism to the countryside, the author is of the view that agrarian question may be partly, and even fully, resolved without the dominance of capitalistic relations of production in the countryside. He categorises this "as a form of agrarian transition: the securing of an agrarian structure which, though not itself capitalist in its relation of production or not therefore in any useful sense, capitalist agriculture nevertheless does not impede capitalist industrialisation and does not block overall capitalist transformation"[22] and argues "that this can be shown to have happened in certain crucial historical instances of successful capitalistic development".[23] He says that a class of few wage labourers can be created, depeasantisation and proletarianisation can proceed, a home market can be formed, and appropriation of surplus therein renders capital accumulation outside of agricultural possible and in a capitalistic form. Of India, the author notes that successful capitalistic transformation is limited to the north-west and pockets elsewhere and has in any case been via a peasant route, requiring prior struggle by peasants, and successful action against landlords to the benefit of rich peasants but not of other strata in the peasantry or in the landless, and predicts persistence of non-capitalistic form in the Indian countryside for a long time to come.

This is inspite of the colonial attempt via permanent settlement to create a replication of British post-feudal land relations in terms of "a strange group of great landlords [zamindars], a class whose annual payments of land revenue to the state were fixed ....at sums which were to remain unchanged for all time to come".[24] Instead of the emergence of capitalist agriculture, a class of large, parasitic and mainly absentee landlords operating in semi-feudal mode was brought into being, which, as Marx observed, was "a caricature of large-scale English landed estates".[25]

Lipton (1986) stresses the appropriation of the surplus as a process via maintenance of advance terms of trade between agriculture and industry i.e. cheap food and raw materials in order to sustain the profitability of urban private production.[26] In the Afro-Asian context the author believes that these developments - analytical or 'rational-choice' Marxism; the 'neo-classical political economy' of rent-seeking behaviour; and some aspects of the theory of collective or public goods - are relevant, and may shed light on why, in the course of development, the rural sectors especially the rural poor have paid more for state action, yet have got less out of them. Other pertinent areas were the approach may prove fruitful are questions such as "why

most Asian States subsidise farm inputs yet 'tax' farm outputs; why rice is taxed, in most cases, far more than wheat; why some, but not other, irrigation systems are efficiently managed through state action".[27]

In the author's view, society, polity and economy are dichotomised into rural and urban sectors and sectoral surplus flows as well as power structures within development follow on this divide. "Bigger farmers are seen as willingly captured by (and trading benefits with) the urban alliance, thereby transferring rural surpluses townwards".[28] A feature of the way in which a state with urban priorities seeks generation of rural surplus by allocating irrigation structures to maximise the extractable surplus for urban uses. However, inability of the modern urban state to oversee detailed operations of large irrigation systems leads to persistence of elements of feudalism leading to consumption of the process of surplus extraction by rural elites, such as has been noted by Wade (1982),[29] in the case of canal irrigation.

It is true of South Asian States that economic intervention by governments "usually sought to raise the savings rate by extracting surplus from rural persons, allegedly with low savings propensities, for capital-intensive and largely urban uses".[30] Bardhan (1985) notes that in many areas, agricultural "technique has remained extremely backward and ecologically fragile, not always because easily available technological improvements have been undercut by vested interests but often because prerequisites for such improvements involve massive public investment in irrigation"[31] and other sectors. An issue to which attention is drawn is whether the economic rate of return on expanded investment in State irrigation and agricultural research is or could be made adequate in backward regions. Although the author argues that "efficient growth in agriculture requires neither capital-intensities nor large scale or, as exemplified by Punjab, state success in surplus extraction probably does require that agriculture show such characteristics. Most of the state's machinery, if dominated by persons on classes or organisations seeking primarily to urbanise the surplus, will be unwilling to steer substantial income-generating resources - as opposed to palliatives and rhetoric-towards backward rural regions, small farmers, or similar groups".[32]

1.5 Rural Development Alternatives

Mishra & Chaudhury (1979) outlines the commencement of rural development initiatives in India through community development programmes followed by the programmes for increased agricultural production and rural employment. The objectives was sectoral in nature and concentrated largely on growth of agricultural and allied sectors. Programmes launched upto the Fifth Plan comprised, for example, Intensive Agricultural District Programme (IADP), Small Farmers Development Agency (SFDA), Tribal Area Development (TAD), Hill Area Development (HAD), Drought Prone Area Development Programme (DPAP), Command Area Development Programme (CADP) etc..[33] From the Sixth Plan onwards strategy has expanded towards an integrated rural development approach where the objectives are optimum utilisation of human & natural resources of the countryside for the purpose of creating self-sufficient rural communities living above the poverty line. In order to achieve this, the programme has to overcome economic as well as institutional bottlenecks, requiring comprehensive knowledge of the dynamics of rural economy, society and power structure in its class-aspects. The rural resource-base comprises manpower resources, natural

resources, infrastructural resources (including communications, electricity and irrigation), economic resources (by the type of economic activity) and livestock resources. The Integrated Rural Development Programme (IRDP) initiated in 1978-79 is designed to mobilise internal resources towards development. Other papers touching on similar issues are Menon (1979), and Chaudhuri (1979), Mukherjee (1979), Roopali (1979), Sen (1979), Thiagarajan (1979). The main philosophical contention on which these studies are based is again mobilisation of the 'rural surplus' although ostensibly for rural rather than urban use; the opposite prescription of diverting a position of urban surpluses to rural use is not argued after. Kumar (1979) and Saha (1979) consider aspects of rural education as an instrument for rural transformation while Bandopadhyay (1979) and Tete & Ghosh (1979) examine the potential role of voluntary agencies.

Another area attracting the attention of both policy makers and scholars is rural industrialisation. Nandy (1979) makes a case of for utilitarian trade and industry located in the countryside and serving local needs. Analogies are drawn from the traditional village-base Indian economy that is non-capitalist in structure. Mishra (1979) recommends the urgency of evolving an optimum mix of productive relations, technology and input-utilisation in order to introduce a commercial element into Indian agriculture which will feed the development of rural industry, especially agro-industry; the prescription includes service sector development for meeting rural credit needs as well as providing storage and marketing facilities. The need for avoidance of competitive tendencies between rural and urban industry is stressed although the solution of confining urban industry to the production of producer goods leaving consumer goods for rural industry appears a little simplistic. Arumukham (1979) explores the evolution of the concept of rural industrialisation over consecutive plans; a strong component of traditional, handicrafts, and khadi industries is prescribed keeping the objectives of upliftment of the rural community in mind.

Harris (1986) makes a study of the diversification of rural economic activity in South India, and particularly of the effect on rural non-farm activity of agricultural growth, through backward and forward linkages with non-agriculture. It is a characteristic of Asian countries that a large part of rural labour force is employed in rural non-agricultural activities; the proportion for India was 19% in 1981.[34] Percentages in other Asian countries are even higher. However, differences in capital intensity and labour productivity differentiate traditional and non-traditional industry raising the question whether "the activities which are of growing importance and in some countries are absorbing a larger share of the labour force [are] activities of last resort, or dynamic, growing ones?"[35] Increasing capitalisation of urban non-traditional industry in the course of industrial development lowers its labour-absorptive capacity, and this, in the view of a number of scholars, accounts for expansion of rural non-farm employment.

Mellor (1976) is of the view that both agricultural and non-agricultural growth are demand-led and that growth can be effectively achieved only through labour-intensive methods of production. It is argued that the accruals of additional income to the larger cultivators, through increased food production based on cost-decreasing technology, would be largely spent on non-agricultural goods and services, thereby stimulating the growth of labour-intensive consumer goods industries and services; this is antithetical to the emphasis on

capital-intensive industrial development of producer goods industries that has been the backbone of development strategy in India. Increased rural employment in the non-farm sector stimulates demand for food and encourages further agricultural growth. Harris' findings for South India show some decline over time in numbers of men depending primarily upon own cultivation/agricultural labour and corresponding increases in their absorption in non-farm activities; for females, however, overall female participation increases in both own cultivation/agricultural labour. However, since land-dispossession is not observed, the underlying labour dynamics is that of proletarianisation rather than depeasantisation; "small landholders have gained rather than lost land".[36] Evidence is found, however, of rural-to-urban flows of resources rather than of the growth of decentralised, labour-intensive production, especially through extension of lending activities by financial institutions and moneylenders and interest payments thereon. Hence the Mellorian thesis is demolished, especially for an economy with significant concentration of wealth.

Saith (1986) extends the analysis to rural industrialisation commencing by observing that many Asian countries show co-existence of high levels of rural poverty with high rural participation rates in non-farm activity, an indication of the fact that rural industrialisation and diversification is not fulfilling its poverty alleviation function.[37] He ascribes the present popularity of rural industrialisation/employment policy to the present convergence of interests of governments, private capital, international development agencies and NGOs (Non-government organisations), observing that failure of the modern industrial sector to generate employment growth, compatibility of rural industrialisation with international agency strategies of structural adjustment, and the fact that rural industrialisation "is viewed as an alternative or substitute for any deep-rooted redistributive land reform"[38] account for this. Insofar as the strategy has no adverse effect on landed vested interests, it is free from political obstacles that militate against effective land reforms, and at the same time is viewed as being capable of pre-empting rural out-migration and inflationary pressures on the food front that would follow from this. Two approaches are distinguished: the locational approach, which aims at industrial dispersion to the countryside, and the linkage approach, which is directed qualitatively to such economic activity which has significant developmental linkages with the rural sector.

The Asian experience is varied; however wage employment emerges as the single most important category, being particularly related, directly, to the overall rate of industrialisation and, inversely, to farm-size. In most of the slow-growing poor Asian economies participation of the rural poor in non-farm activity is part of household survival strategy and is practiced at exceedingly low levels of productivity. Acharya (1983) finds, for example, that in Bihar as many as 48% of the workers are engaged in occupations which are not economically viable, although only 6% of them were underemployed in a time-sense.[39] Participation by rural rich in non-farm activity is however out of a necessity to find alternative use for their capital and thus the non-farm sector has a crucial role to play in the differentiation of the peasantry.

Success of rural industrialisation depends greatly on the existence of a vast home market whereby the Mellorian thesis might materialise in the case of sustained growth rates of both agriculture and industry. Countries like China, Taiwan and South Korea where this

has been true exhibit productivity increases flowing from augmentation of technological absorptive capacities of agriculture combined with effective rural land reforms.

In India rural diversification strategy focusing on the non-farm sector has had more of a employment-orientation and comprises both rural public works (NREP) and rural special employment programmes (IRDP). Success of the programmes has to be evaluated on the criterion of participation, returns, efficiency, magnitude & timing of the programmes, and the degree of flaws in targeting, or linkages. IRDP covers a host of activities: minor irrigation, dairy development, animal husbandry and petty services, trade & industry; claims about its effectiveness have to be juxtaposed with allegations of mis-targeting, which is measured at levels as high as 42% in Assam and 35% in Punjab.[40] Misuse of funds and leakages are estimated by NABARD as amounting to 20%.[41] NREP programmes have also been the subject of several over-optimistic estimates; the real picture is one of high leakages and low coverage, coupled with the fact that in providing one-off assistance to poor beneficiaries the programme does not create extended capacity for high income generation, whereas longer term benefits are channeled to the rural rich who are able to exploit the rural infrastructure created; this is corroborated by studies of rural public works in Bangladesh also.[42] In view of the foregoing "rural industrialisation is not likely to be the panacea it is made out to be"[43] for reasons of intransitivity accross countries of the specific factors that might lead to its success and the fact that it can neither replace the need for redistributive agrarian reform or for the lack of performance in the main sectors of the economy i.e. "the tail must not be expected to wag the dog".[44]

1.6 Transforming Traditional Agriculture

Other studies[45] concentrate on technological/spatial features of rural development. Sen (1985) is an applied quantitative study in Hooghly, West Bengal, with community minor irrigation as its point of focus, besides making observations of rural industrialisation. Mazumder 985) surveys rural education with the finding that multidi-mension educational gaps prevail between rural and urban communities. Healthcare aspects are surveyed by Nag (1985) and Balagopal (1986). Non-farm activities such as dairy-development and fish-farming are surveyed respectively by Sarkar (1985) and Haque & Ray (1985); both reveal high performances for the upper strata of rural population. B.N.Sarkar (1985) considers development prospects of rural West Bengal in terms of occupational distribution and occupational mobility and reveals unequal access to development on the part of the rural poor. Chakroborty (1986) explores basic issues relating to rural poverty in West Bengal and comes to the conclusion that any urban-rural alliance that as exists is between traders and therefore financial in nature; within the sharecropping system no feasible alliance between urban industry and rural landholding classes can evolve that might lead to the formation of industrial capital. Chattopadhyay (1986) brings out sharp differentials in foodgrains performance between the wheat-region of India and the Eastern rice-region; whereas the green revolution has led to a major structural shift in wheat, this cannot be said of other foodgrains, where cultivation is still largely rain-dependent. Evidence is found of an industry-agriculture disjunction leading to much greater inflationary pressure on food prices in Eastern India; the study traces these to low irrigation-cover and limited achieve-ments on the HYV front; the solution recommended is to revamp agriculture through specially designed mixed-cropping and introduction

of a water regimen with larger accents on conjunctive use of surface and groundwater resources.[46] Unless a suitable thrust develops food insecurity shall prevail in a rural society where market forces of commercialisation and differentiation in peasantry have been pervasive enough to result in generally declining trends of per capita real consumption of food for the bottom 20% of population and for 50% of the rural population (in West Bengal), characterising bipolarity in access to food by rural class.[47]

Review of the literature reveals the importance of the agricultural sector to rural development, both in the question of agrarian transformation and in the means of achieving it, which country-experience indicates are parallel growth of industry and agriculture. In the Indian situation avoidance of depeasantisation would require a much greater focus on agricultural expansion than has hitherto been exercised especially in the face of the adverse prognoses governing rural industrialisation. Much of this thrust shall have to come from agricultural technology and irrigation and much of it shall now have to be concentrated in the agriculturally-weaker rice-growing regions.

Studies on rice economies such as Bray (1986) bring out the importance of water control for intensive wet-rice cultivation techniques, in which South Asia has no long-standing tradition.[48] Wet-rice technology which is more developed in East Asia is linked commensurately with intensification of skilled labour inputs and reduction in farm size, and trends to improve the position of the tenant farmer vis-a-vis the landlord. "There are significant divergence between the evolution of agricultural systems like those of Northern Europe and North America, which emphasis the importance of increasing the productivity of labour, and those of the rice economies of East Asia, which stress raising the productivity of land";[49] in the latter labour is in effect substituted for land. Capital-intensive agricultural innovation encourages polarisation of rural society into entrepreneurial farmers and landless labourers; on the other hand skill-oriented agricultural systems are less capital-intensive and do not promote economic inequalities to the same extent, allowing the small holder or tenant farmer to be on the same footing as the wealthy landlord insofar as the prospect of raising land productivity is concerned. Modern technology has an entry through fertilisers and pesticides and mechanisation of irrigation, efficacy of which is borne out by cholars such as Ishikawa & Francks (1986); however mechanisation of other agricultural processes faces technical obstacles because of restricted field-size caused by the demands of terrain and water control.[50] Wet-rice cultivation is thus more conducive to high labour absorption, mostly within the household sector and intermittently of skilled hired labour.

The above distinction on the basis of presence or absence of water control, between agricultural in East and South Asia is borne out in Vaidyanathan (1983). In the absence of water control techniques wet rice can often be grown using natural rainfall but crops are much less reliable, multi-cropping is seldom possible and output is relatively low. Contrasting agricultural growth in coastal Andhra Pradesh to South Korea. Rao (1986) observes forced commercialisation in both but land dispossesion in Andhra only - Korea with its rapid industrialisation was insulated.

Van Schendel (1986) takes a divergent position to that of Bray in attributing the absence of agrarian capitalism in South Asia to class factors rather than ecological and technological constraints. Making a

case study of Bengal (both West Bengal & Bangladesh) he observes that although double-cropping of rice without irrigation is possible because of an extended monsoon, productivity of land and usage of modern technological inputs has lagged behind other Asian societies, attributing this to extreme poverty of most of the cultivators. Commercialisation took place in the form of cash cropping; however because of ecological factors, this was based on indigenous crops that found new markets such as jute. Consistently low labour costs discouraged the introduction of labour-saving technology and an expanding rural proletariat was employed intermittently at low wages by smaller & larger cultivators, with its freedom of movement restricted by lack of well-paid non-agricultural employment. Penetration of external capital was confined to jute-producing tracts of east and central Bengal with little dynamic impact on the rice-surplus areas of North and West Bengal.[51]

Patnaik (1986) extends the analysis of agrarian classes into Indian agriculture using a Factor Analysis framework. Defining a Marxist hierarchy of resource endowments relative to production capacities over peasant households, she defines the exploitative linkage in terms of the 'distribution of poverty'. Keeping the resultant coexistence of multiple modes of production in mind the author states that there cannot be just one production function for the agricultural sector; there will instead be "a range of production functions attributable to a cross-sectional sample of households"[52] rendering all attempts at estimation of production functions quite meaningless. Similarly farm size groupings that are the basis of obtaining class-classifications of the rural population are also questioned inasmuch as they tend to gloss over qualitative difference of land and the degree of capital investment involved in each holding. "It is the labour-hiring holdings which show the largest relative use of modern equipment and highest application per acre of modern purchased inputs";[53] thus productivity is higher for such holdings than for poorer peasantry. Patnaik's findings are that with the help of a labour-exploitation index evidence of capitalist differentiation of agriculture emerges that is obscured by more conventional analyses.

Class considerations apart, the chances for rural development's success rests on the agricultural success rate. This is particularly so of West Bengal where an egalitarian land reform policy was initiated as far back as 1978 through 'Operation Barga' (recording the tenancy rights of sharecroppers) and revision of agricultural ceilings to 25 acres (10.12 ha), which have substantially altered rural land-relations and class structures. Adhikari (1985) identifies agricultural transformation with irrigation while pointing out that interaction of farm and non-farm sectors is indicative of the health of both. Confining the empirical part of his study to Nadia district, the author finds evidence of all-round agricultural progress. Another study by Das & Bhattacharyya (1985) in districts falling under the Indo-British Fertiliser Education Project shows credible results regardless of spatial separation of the districts covered; since the project was executed in conjunction with minor irrigation schemes the findings have special bearing on the present study. Mitra (1985) studies Cooch Behar district itself and stresses the importance of easy access to irrigation and electricity along with other technical and other service inputs in being able to spur "job-cum-production-oriented rural self-employment schemes (JPORSES)".[54]

Another important study from the standpoint of agricultural growth and its promotion is that of Ray & Bora (1986) which is directed

specifically towards marginal farmers in Nadia district of West Bengal and makes the point that slowness in agricultural development because of the preponderance of small holdings can be overcome by increasing the managerial ability of marginal farmers. Again using a Factor Analysis framework, with Principal Components being used to extract factors, highest factor loadings are found for use of pesticides, fertilisers and manures, accounting for 25% of total data variability. A further 18% of variance is explained by use of HYV, proximity to agricultural support systems and close monitoring of crop production. 13% of variance was explained by irrigation and timely supply of inputs, with the observation that the impact of irrigation is two-fold: besides directly expanding agricultural production it also provides opportunities for effective use of modern technological inputs such as fertilisers, pesticides, improved seeds etc..[55] A further 13% variance was explained by cropping intensity. Linked to these where other strategy-factors such as entrepreneurship development, credit support and agricultural extension.

IRRIGATION & RELATED ISSUES

1.7 Irrigation Technology

There are certain well-defined problems of choice associated with irrigation technology. In a situation where land and other factors of production can be assumed to be unconstrained, the irrigation potential of a water source depends on the demand for water, on one hand, and the supply of water on the other. Technological choices on the supply-side,depending on availability suitably-situated water sources, are between run-of-the-river (without storage), storage involving impounding of river/rain waters, and groundwater technologies. Water loss in the irrigation system can alternatively be treated as a subtraction to supply or addition to demand; however, both demand and supply of irrigation water have highly seasonal characteristics, with their peaks not necessarily being coincident.

A number of studies on technological aspects of irrigation are readily available. Hazlewood & Livingstone (1982) particularly considers the economics of irrigation in poor countries. It has to be noted that seasonal demand patterns are affected by crop combinations, differences in planting time and agricultural methods and practices. Two agricultural production models obtain; there are the Peasant Producer Model (PPM) and the Large Mechanised Farm Model (LMFM) of which the former is based on small farmers. Seasonal water demands of PPM fit seasonal water availability patterns much better than LMFM. While PPM is technically less efficient than LMFM because of higher seepage losses and less effective control of field applications as far as canal-oriented irrigations are concerned, economic efficiency in the former is greater because of concentration of water demand at times when it is most abundant. In practice the two production modes are complementary, rather than competing, alternatives. The introduction of storage irrigation schemes obviates the economic advantages of PPM, but in the general mix of all available irrigation technologies including groundwater, the dichotomy between technological and economic efficiency would persist and PPM emerges superior in terms of maximum area irrigable because of extensive rather than intensive water use. In the interests of optimality an efficient irrigation system requires a considerable degree of water management.[56] And in an objective appraisal of storage irrigation schemes, the cost of water storage will often exceed by far the costs of storage of grain that could be produced by non-storage irrigation technologies.

In the rural development perspective, PPM has the social benefits of economising on scarce management, in using cheap family labour and in dispersing the benefits of irrigation and is therefore conducive to a poor-country scenario. Although LMFM has pronounced technological advantages, its benefits are more private in nature and do not offer the "low-technology" solution appropriate to the more populous LDCs. Thus in a study of alternative irrigation systems the viewpoints of the irrigation engineers may often run counter to those of economists.

This point is also conceded by Withers & Vipond (1980): "there is a temptation for engineers to become engrossed in their engineering and to lose sight of the broader system within which it is destined to function. The purpose of irrigation is agriculture, not water conveyance. An effective water distribution system must be designed to overcome the limitation and take advantage of the virtues of the farming system for which it is to function. To determine the value of a proposed project one must make some measure of its benefits to the country".[57] Thus the choice of technique itself is cross-linked with the stage of development and infrastructure available to that community.

The design and implementation of irrigation systems is guided by a number of well-defined technical parameters that are common knowledge to the engineer. Flow characteristics of river waters and geological investigation of groundwater aquifers are primary to the assessment availability of water resources. There are often large areas of land so situated that available water can not be brought to them by canals, or else the cost of construction of gravity-assisted surface irrigation systems is prohibitive.

In many such areas, lift irrigation, whether of groundwater or surface water, is the practical alternative which requires pumping for irrigation and very often also for drainage purposes. Considerations of pumping loads and efficiencies thereof are thoroughly discussed in Israelsen & Hansen (1962). A major component of engineering design is the choice of pumping plant with its efficiency being defined as the ratio of power output to power input, where the latter may be electricity, diesel, etc. Another factor in pumping efficiency is the vertical distance that water has to be lifted i.e. water-head. There is thus a limit to maximum economic height of lift which is determined, in practice, by cost limitations rather than mechanical or power limitations. In the case of electrically-powered motors frequent power interruptions and variations in line voltage can prove to be major disadvantages. Another factor that has to be contended with is the practice often followed of staggering irrigation loads into the night hours both because of low demand and lower off-hour tariffs, where these apply.

The amount of water required for irrigation is itself dependent on weather, climatological factors and soil characteristics, not the least of which is soil permeability. In highly compacted soil this is low and as a result such soils may not be conducive to irrigation, regardless of climatological aridity. Soils can be characterised as saturated or unsaturated, and in all irrigation methods, water applied to the surface of the land subsequently enters the soil and is stored for later use by the plants. Water intakes of sandy unsaturated soils are generally high, whereas clayey soils, or soils that have become finely-textured because of excessive working and/or salinity, intakes may approach zero. Any soil that is highly compacted and saturated in nature is subjected to the risk of salinity if over-irrigated and

poorly drained. Thus the irrigation system has to provide for a water intake rate not detrimental to local soil quality.

Climatological factors in irrigation design appear in the influence of relative humidity on evaporation and transpiration, on which the type of crop is cultivated. The stages of growth have further influences. Water delivery by the irrigation system is therefore subject to tradeoff between evaporation loss and consumptive use. The tradeoff is subject to day-to-day variations on account of changing weather. Seasonal factors also predetermine consumptive requirements and thus the three major considerations which influence the time of irrigations and how much water should be applied are "(a) water needs of the crop, (b) availability of water with which to irrigate, and (c) capacity of the root-zone soil to store water".[58] Growth of most irrigated crops is stimulated by moderate quantities of soil moisture and retarded by either excessive or deficient amounts. Porosity of the soil is also essential to its moisture-retentive characteristics. Besides meeting immediate water needs of the growing crop, irrigation during the dormant season is often an economical means of storing water in the soil for future use. In places where winter precipitation is scanty, irrigation during the autumnal months is a means of saving water and of getting the land in favourable condition for the subsequent cropping season (in India, irrigation during late kharif, after the monsoon rains have subsided, is usually done with this object i.e. to stimulate early rabi cropping). Similarly, winter and spring irrigation serve the dual purpose of meeting the water needs of the crop in the field as well as maintaining soil-moisture for subsequent seasons. Besides, the nature of the crop sown determines the water requirements through the depth of the plant root zone and the length of vegetative, flowering and fruiting seasons; the requirement is highest during the vegetative stage when nitrogen is particularly essential and light, frequent irrigations are generally desirable especially for shallow-rooted crops; during the flowering stages the emphasis is more on maintenance of moist conditions in the soil that are conducive to the maturing of flowers into seed; at the fruiting stage, the root system reaches its maximum depth and consumptive water needs are at their lowest, except in the case of wet-fruiting crops like tomatoes, green peas etc. Tuber crops like potatoes, groundnut etc. however require uniform irrigation at all stages, although they thrive better in sandy, well-aerated soils. It is thus seen that the overall water needs of irrigation and its timing and frequency is determined by a complex of factors, all of which can lead to changes in cropping patterns as and when irrigation becomes available.

1.8 Irrigation Systems

Keeping in mind the indubitable importance of irrigation to agricultural development and agrarian transformation of the rural countryside in India, one must move on to questions confronting the choice of an appropriate technology. There has been an increasing debate on this in recent times, which has arisen both from environmental and cost-effectiveness considerations. The state of debate is summarised by the exchange between Dhawan (1989 a & 1989 b), Iyer (1989), Mitra (1990 a & 1990 b) and Jairath (1990). Dhawan makes out a case for big dams citing cost-efficiency criteria in their favour and questioning the apprehensions of their critics. While the critics are concerned about displacement of people and poor prospects for their rehabilitation, seismic hazards, environmental & ecological costs and 'exaggerated' claims of superior performance on the part of

big dams, Dhawan's position has consistently been to question the veracity of such objections as well as to demonstrate higher benefit-ratios for major irrigation projects. His argumentation on the cost aspects involve the contention that critics of that major irrigation works often tend to inflate the 'real' costs of major irrigation while discounting the full cost of minor irrigation. Capital costs are undoubtedly high for the former but they have the advantage of low recurring costs coupled with the absence of operational costs in the form for energy drawal for gravity-assist distribution networks. Minor irrigation, on the other hand, as Dhawan states is often shown to be effective on false cost premises, since the capital cost of rural electrification, the need for water-lift mechanism and operational & maintenance costs relating thereto tend to be ignored in the imputation of costs for minor irrigation schemes. Thus, Dhawan is convinced that major irrigation works cannot be excluded in an irrigation regimen designed to make conjunctive use of surface and sub-soil waters. Regarding seismic and environmental objections he takes the position that except when dam-locations are decided at fault-prone areas, documentary evidence of seismic risks is lacking, and that greater ecological damage is caused by deforestation and over-grazing. The other argument of minor irrigation proponents which he finds himself in disagreement with is the claim that smaller schemes account for better utilisation of irrigation potential; he is of the view that this is essentially a non-issue where uneven distribution of water resources in any case makes minor irrigation a complement to major irrigation, and not its substitute. Dhawan's position in his more detailed study of irrigation impact in Dhawan (1988)[59] is however less polemical since his empirical study does bear out higher cost-efficiency of minor irrigation in certain situations and states. This obviously would point to a choice of irrigation technology appropriate to circumstances where the absence of perennial groundwater resources in arid/semi-arid regions would imply greater dependence on the larger surface water schemes and the absence of perennial supplementary irrigation needs in other regions would imply the appropriateness of minor irrigation.

Mitra (1990b) is a rejoinder to Dhawan (1989a) and thus highlights the elements of the 'big dam' controversy. He states that although Dhawan's contention of underestimation of capital costs for minor irrigation works because of the exclusion of the private investment component in the cost-imputation process is welltaken, he is critical of the argument that long gestation of major irrigation works divorces the costs and benefits accruing from them on a time-scale, thus indicating lower cost-effectiveness; Mitra invokes the opportunity-cost argument to show that explicit imputation of interest cost of investment in major irrigation works would raise their capital costs even further. He also states that recurring costs on major irrigation are much larger because of the need for reservoir de-siltation etc.; Dhawan's analysis also overstates operational costs of minor irrigation. Thus in Mitra's view the cost-based argument in favour of big dams cannot offset the human and social costs of displacement and rehabilitation.

Iyer (1989) takes a more evenhanded view of the controversy emphasising conjunctive aspects of major and minor irrigation. The argument in favour of big dams is scale-economies in water storage and hydel generation, which cannot be replicated if the irrigation scheme in question is broken down into smaller-sized units. However, minor irrigation is more suited to a capital-scarce situation, is less prone to cost and time overruns, potential utilisation is better as also

water-economy, and considerations of distributional equity between head-reached farmers and tail-enders are peculiar to large canal networks and thus do not arise under minor irrigation. Thus the two systems are not competitive and need to be implemented in conjunction.

Extant literature on irrigation impact e.g. Dhawan (1988) decomposes gross irrigation impact into a number of quantifiable irrigation impact-categories: these are impact on cropping intensity, impact on agricultural yields, impact on crop patterns, and area & output impact. Of these the first is measured by a rate at which multiple cropping replaces mono-cropping, the second by increase in productivity of other inputs on provision of irrigated water and the third by changes in cropping pattern following on introduction of irrigation. Besides these, area & output impact result from increased acreage and expanded output. Dhawan's own observation is that where rainfall is concentrated, output impact of irrigation generally tends to be low specially since acquisition of supplementary irrigation water often leads to a switch from low irrigation-intensity crops like coarse grains to fine grains that are irrigation intensive. Relations between irrigation intensity and crop intensity as well as dynamics of fertiliser use are well understood by now and are commented on by recent studies like Raju (1990) and the study on agricultural productivity by Dev (1991).

The recent papers by Dhawan address the problem of irrigation impact in high rainfall areas more specifically. Commenting on the study of Kannan & Pushpangadan in the context of Kerala. Dhawan (1988)[60] states that in high rainfall areas irrigation is not a highly complementary input to chemical fertilisers, water-needs of which can also be met by rainfall and moisture-preservation in such areas. Irrigation in such areas can thus acquire a seasonal characteristic. Thus for irrigation development in high rainfall areas, irrigation must possess the following attributes:

"i) it is mainly oriented towards the non-monsoon period;
ii) it is flexible enough to be deployed for kharif crops in the event of a big break in the monsoon;
iii) if in the public sector, it is well-managed by the state. If it is in the private sector, the state must manage well the infrastructure like power generation and rural electrification that have a close bearing on the success of private irrigation based on electric pumpsets."[61]

Dhawan (1988 b) makes another study of irrigation impact in the high rainfall areas of the Konkan region falling within the Kal irrigation project. In such regions, Dhawan states that because crop yields are already high because of monsoon rain, the yield-impact of irrigation is lower. Study of the Kal command area indicates less water-drawal during the wet season along with switching from crops with low irrigation requirements to those with high requirements - because of these changes in cropping, irrigation waters thus end to be fully utilised even when crop area benefits happen to be low. "Thus in the conventional paradigm for high rainfall areas the main impact of irrigation would come via the intensity of cropping effect, and far less from the yield and crop pattern effects".[62]

Another aspect of the impact of irrigation is its stabilising influence on agricultural output between normal and drought areas. This is addressed by Dhawan (1987) which shows that the degree of stabilisation achieved is inversely related to rainfall. Thus in high rainfall areas farm instability may persist despite irrigation. The

author however qualifies this by stating that stability is also conditioned by the extensive development of reliable private tubewell irrigation, citing Punjab & Haryana as examples. In states where there is considerable dependence on tanks the stabilising effect of irrigation is lower because of the high sensitivity of tank-based irrigation to variations in rainfall.

1.9 Irrigation Impact Studies

Vaidhyanathan (1987) is a comprehensive survey of literature on irrigation and agricultural growth. Salient developments have been rising plan outlays on irrigation, a shift towards minor irrigation works (particularly groundwater development) and better water-management including conjunctive use of surface and ground water. On the other hand, common concerns are the cost-effectiveness of the investment particularly in terms of agricultural productivity, the potential role of irrigation in accentuating agrarian disparities, finance of irrigation works and cost recovery against them, and the environmental impact of irrigation. The study highlights the persistent gap between irrigational potential and its utilisation. Conjunctive surface and tubewell systems however are the major source of improvement in irrigation quality. Productivity studies show that besides raising crop yields irrigation also permits more high-valued crops to be grown and increased cropping intensity, and that this is highest where conjunctive systems operate. Better performance of wells vis-a-vis tanks and canals is also supported; however agrarian disparities are multiplied by the former. Another conceptual problem alluded to is that, with most irrigation-impact studies being micro-economic in formulation, it is often difficult to measure the direct impact of irrigation on productivity because of strong complementarity between water and other agricultural inputs, especially fertilisers. This problem that has detracted from the utility of micro-level surveys needs to be tackled methodologically.

An important bloc within the literature on the economics of irrigation relates to micro-level studies on the impact of irrigation projects. These studies cover planning, execution and management of irrigation projects, the benefits accruing from them, as well as social costs, and studies inefficiency by irrigation-type, including comparative studies. Conceptual problems emergent are the increasing gap between "irrigation potential" and "actual utilisation", definitions of "small farmers" when evaluating irrigation impact, and the precise nature of "costs" and "benefits" to be included in evaluating irrigation impact. The first confusion is on account of the manner of presentation of statistical information whereby potential is reported to have been created even when distribution works are incomplete, and utilisation is reported on the basis of applications received rather than area actually irrigated, leading to overestimation of both. Because of the form of the loan programmes for small farmers, farming out of landholdings within the family is not uncommon in order to gain eligibility. Questions also pertain to whether the costs of works other than headworks should be included, whether costs of older projects should be notionally revalued to present levels, and relating to the treatment of interest charges on capital investment, as also the treatment of direct versus indirect benefits.[63]

The methodology commonly used in micro-level impact studies is the 'before' and 'after' approach although the alternative of comparing farms with irrigation to those without irrigation also exist. Thakur &

Kumar (1987) decompose the output growth resultant on irrigation into that directly attributable to increased availability of water itself and that resultant on increased utilisation of other inputs. Their study reports in the context of western U.P. that privately owned tubewells exhibit better water-management whereas government tubewells and canal irrigation projects report irregularity and inadequacy in water availability, and waterlogging with consequent depletion of soil fertility in the case of the latter. Private tubewells also show maximum cropping intensity and much more diversified cropping patterns along with more intensive use of other farm inputs, chief of which is fertiliser. Since private schemes are of a low-cost nature, these advantages are even more tangible in the cost-benefit perspective. Similar results are reported for Punjab in Sankhayan & Singh (1987).

Sidhu,Chand & Kaul (1987) make a comparison between performances of alternative irrigation systems in Punjab. Yields are generally found to be higher under tubewells compared to canals and are highest for such farms where both diesel and electric installations are available because of better control over water on an "as and when needed" basis.[64] Complementarity between irrigation and fertiliser use was also borne out, bringing out the higher economic efficiency of tubewell farms compared to canal farms, with electrical sources proving superior to diesel sources.[65] Kalita & Rajbangshi (1987), in investigating management efficiency of deep tubewell efficiency in Assam show that the viability of DTWs can only be established where more than 50 percent coverage is provided to the command area by the irrigation facilities created. This also brings out the intrinsic advantage that private tubewells have. Concurrence on the general superiority of lift to canal irrigation is also found in Singh (1987), Joseph (1987) and Devi & Seetharaman (1987).

Giri & Mallik (1987) make a more pointed comparison between private and public irrigation sources in Nadia in West Bengal. While DTW beneficiaries are dominated by small and marginal segments, the lower size-groups exhibit proportionately higher land acquisition after becoming beneficiaries, financing it if necessary from secondary income sources. Land utilisation around the DTWs is fullest during the kharif season and poorest during the pre-kharif. However, cropping intensity is found to increase with landholding size, with a particularly large amount of leasings to agricultural labourers and marginal farmers during the rabi season. Performance of private STWs is found to exceed significantly that of the DTWs, although greater inequalities characterise diesel-operated STWs where irrigation costs are higher. The authors recommend encouragement of private irrigation with a focus on electricity to minimise land inequality. Mishra & Gupta (1987) find similarly high cropping intensities in the case of electric irrigation installations in Ratlam in M.P. and maximum change in cropping patterns during the rabi season. A high rate of labour absorption is also reported for electric pumpsets. Extending the studies in a West Bengal context, Misra (1987) finds a positive impact of irrigation on kharif paddy, both in terms of extended cropping and increased use of modern inputs, in the case of canal-irrigated areas in Birbhum. Chaudhury (1987) is of the view that sufficient consideration has not been given to tapping of groundwater resources in both North Bengal and South Bengal. Technical operational advantages of DTWs are nullified by numerous administrative and other problems, chief of which are high installation cost, long gestation period, exorbitant rabi and summer water-rates and long duration of repair work. Thus STWs are to be encouraged to achieve desired objectives. Ghosh (1987) in his analysis of canal irrigation in

Burdwan shows rise in cropping intensity, shift to a paddy-based cropping pattern and sharp increases in farm incomes and labour absorption. Similar findings with respect to labour utilisation are found in Charan (1987) and Patel & Patel (1987) in Gujarat and Adinarayana (1987) in Andhra Pradesh.

Patel & Singh (1987) in a study of the utilisation of irrigation potential in Mehsana in Gujarat show the highest utilisation in the case of the electrified tubewells. For both electrified and diesel dug-cum-bore-wells the reason for under-utilisation were scarcity of fuel and electricity and water wastages because of the lack of underground pipelines. Similar wastage problems in the case of canal irrigation because of the transpirational loss and unlined distributional channels are reported by Dangat & Rahane (1987) in Maharashtra and Puttanna & Hema (1987) in Gudamgiri in Karnataka.

Hiremath (1987) is of the view that in the face of their complementarities, "the new direction of research must focus on the conjunctive use of water- both surface and underground. In the wider sense, an integrated policy of scientific management of water should meet the requirements of not only of crop production, but also of industry, human and livestock consumption, flood control, hydropower, electric generation, recreation and navigation. Such studies have been attempted abroad and may be taken up for further analysis of efficiency of water use in an integrated fashion".[66]

1.10 Extended Issues

Given the status of thinking on "big-dam" irrigation of the surface type versus minor, particularly, groundwater-based irrigation, a review of the literature on the energy aspects in Indian agriculture is called for. Most studies on agricultural energy-demand in India have so far been based on aggregated macro-level data and overall national averages and trends[67]. However, with energy demand in agriculture being dependent on a complex of factors such as trends in agricultural growth and technologies thereof, efficiencies in energy utilisation, agro-climatic conditions etc., disaggregated studies are often more instructive and hence more appropriate for utilitarian and policy purposes focusing, as they do, on inter-crop and inter-zonal variations as also between farmers with unequal access to technology.

Recent studies on hand stress different aspects. Parikh & Kromer (1985) models energy-agriculture interactions in a linear programming framework contextually in the case of Bangladesh. The study covers all sources of energy, both of commercial and non-commercial varieties and study is made of the energy implications of a switchover to HYV. Babu & Hallam (1989) particularly considers the case of electricity in the context of irrigation in cotton farms in the Coimbatore region in Tamil Nadu, in the form of a theoretical model under uncertainty. In a situation where both diesel and electrical alternatives are available for irrigation purposes, no farmer exclusively depends on electricity alone, mainly because of the highly subsidised nature of rural electricity and higher costs involved in diesel installations. Classifying small farmers as most risk-averse and large farmers to be least risk-averse, because of disruption in electricity supply, an elements of stochasticity is introduced into resultant crop-yield patterns. Crops like cotton and fine foodgrains are subject to greater yield uncertainty because larger amount of water is required; coarse crops are less risky. Risk attitudes change in the face of a hypothetical scenario of enhanced and more regular supply of

electricity, with greater inclination of farmers to switch to risky crops. However, attitudinal shifts are different by farming class: small farmers increasing the usage of animal energy in complement to electrical energy, whereas medium and large farmers recourse to mechanical alternatives. However, existence of strong complementarity between the demand for electrical energy and demand for human labour results in across-the-board increases in labour absorption in the agricultural sectors in response to increased availability of electricity. Electrical energy thus proves to be a marginally risk-reducing input and its increased use decreases yield uncertainty. Correlations of crop yield variance is particularly high for cash crops in comparison to coarse crops.

Dhawan & Mittal (1990) relate cropping demands for energy to renewable/non-renewable nature of the energy source. Results obtained show that yield uncertainty is higher for regions with a rain-fed agricultural profile, both because need for irrigation and consequent energy demand is less and fertiliser use is lowered by monsoon uncertainties. Furthermore, a tendency is revealed for agriculturally-advanced states to depend much more on non-renewable direct energy sources like diesel, petrol, etc. and indirect ones like fertilisers, pesticides, etc. than rain-dependent agriculturally less-advanced states where dependence on renewable energy is higher and that on modern agro-inputs is lower. The mix of factors explains the high complementarity between irrigation and fertilisers as well as greater degree of yield stability in such rain-scarce states as are already highly irrigation-dependent.

Moulik, Dholakia & Shukla (1990) treat the problem of energy demand forecasting in agriculture at length. The study confines itself to electrical versus fossil-fuel energy-sources and to six major crops. Differences in agro-climatic conditions etc. between states are taken account of. With specific reference to pumping irrigation which is the second most important energy input in Indian agriculture after fertilisers, diesel requirements are based on the assumed average of 6.5 HP pumpsets consuming 1.5 litres of HSD per hour of pump operation. Electrical pumping operations use an assumed size of 7.5 HP per electrical pumpset with 4 kwh of electricity being consumed per hour of pump operation. Highest crop requirements for irrigation were found to be for paddy followed by sugarcane, wheat and cotton in serial order; pumping requirements verge on nil for pulses and are quite small for oil-seeds. Even where mechanisation in ploughing/threshing operations is in evidence, the bulk of energy requirements in agriculture (ranging from 60-95 percent) is on account of fertilisers and irrigation. Technology variables enter into the study though its subdivision into three technological categories viz. traditional, transitional and modern; of the six crops considered, modern technologies have penetrated to the largest extent in foodgrains & cotton and least into pulses. Highest energy demands come from modern technologies. Elasticity of energy demand is uniformly greater than unity especially under the projective assumption of greater penetration of modern technology. Thus "an attempt to accelerate the rate of growth of agricultural production through adoption of modern inputs and technology would necessarily result in a more than proportionate acceleration in the total energy demand in the agricultural sector".[68] However, no significant rank correlation between rates of growth of production and corresponding rates of growth in energy demand across different crop is observed, particularly in the face of gradual modernisation of technologies.Thus high growth rate of production is not correlated with high growth rate

of energy consumption and hence the crops to which each of this rates pertain are non-identical.

Another area of research in irrigation studies is the economics of irrigation rates and tariffs. Since the irrigation thrust in the country has required massive injections of investment, questions have arisen as to whether there has not been over-investment in this one area, relating to investment in, say, production of complementary inputs such as fertiliser. This has lead to a focus on recoupment of costs on those irrigation projects largely financed by governments.

A study addressing the issues from this standpoint is Ansari (1968). As an exercise in price theory, the provision of services like irrigation have so large a component of invisible costs that marginal cost is relatively insignificant, remaining always below average cost, and precluding marginal-cost pricing. The welfare concept involved has led to the practice of state subsidies. Ansari's study is contextually on Uttar Pradesh & Punjab and brings out the importance of the pricing versus welfare equation.

One of the reasons why the subsidies have been prevalent is because of under-utilisation of irrigation capacities, particularly in large canal irrigation projects. This is however simplistic: very often construction of distribution channels is tardy and inadequate, the changes in cropping pattern needed to make optimal use of irrigation are slow in coming, and there may be constraints on the availability to the farmers of complementary inputs such as fertilisers. In the light of this, little can be done to resolve the problem of under-utilisation by mere manipulation of water rates to low levels. The study picks up all the main threads of the debate. In favour of state subsidies are the arguments of marginal-cost, pricing in the case of decreasing-cost industries, where losses are necessarily incurred on the marginal-cost pricing principle, and the argument of the large indirect benefits that derive from irrigation, as first defined by Gadgil.[69] The author's view is that these arguments are insubstantial and subsidies can be obviated by allowing for sufficiently long gestation periods. Since agricultural policy in the 1980s has used monetarist tools such as price subsidies on foodgrains and fertilisers, the findings of Ratha & Sharma (1992), which show that a rolling-back of these subsidies, with parallel increase in investment on irrigation may prove to be the most effective way of expanding food supplies, is relevant here. However in conceding that the costs of irrigation should be recovered, certain definitional problems arise as to what these costs are - the simple commercial principle of discounting capital investment at appropriate interest rates is inappropriate in the case of irrigation because interest charges are the bulk of irrigation costs and because of long discounting horizons. Another question which arises is whether the valuation of initial capital investment should be scaled up with subsequent rises in price levels. Irrigation also has a dual impact: besides immediate augmentation of yields and crop output, it has protective attributes that stabilise cultivation and farm incomes. Hence in addition to actual water rates there is a case for levying agricultural cesses etc. on irrigation beneficiaries to cover this aspect as well as to recoup the cost of excess capacity that has to be borne during years of normal and good rainfall. In respect of the rates themselves, volumetric tariffs are scientific and inculcate an efficient water management regime, but are difficult to implement except in tubewell irrigation where water discharge is at a metered rate; the alternative crop-wise fixation of rates is often found to be

an encouragement to wasteful water-usage practices.

More recent studies on these lines e.g. Sangal (1991) or Shah (1991) extend the analysis to questions of economic pricing on irrigation waters and to the emergence of water markets at the micro-level especially in dry drought-prone areas. Sangal's study derives from a concern for restoring financial viability to the SEBs/Irrigation Departments/Minor Irrigation Corporations. Irrigation waters, as a commodity, are subject to the influence of an increasing general price index insofar as irrigation costs escalate; however no corresponding upward revision in irrigation rates takes place. The 1987 National Water Policy specifies that "water rates should be such as to convey the scarcity value of the resources to the users and to foster the motivation for economy in water use",[70] and that at least a part of the capital cost of irrigation works should recouped from water charges. Similarly, annual operation and maintenance charges that now vary between 11 percent to 22.5 percent of capital cost should be recovered. What the study stresses is the need for a uniform policy on fixation of water rates applicable to all states, to remove the present inter-state variations.

Shah's study is on the newly-emerging capitalist institution of water markets whereby private investment in irrigation mechanisms is undertaken with a commercial profit inclination beyond actual user-benefits. Particularly in the case of tubewells, evidence is found in regions as diverse as West Bengal, Andhra Pradesh, Gujarat, Tamil Nadu and Bihar, Assam & Uttar Pradesh of the emergence of water markets that develop from an initial system of payments for water-drawal being rendered in kind, to more exploitative crop- and profit-sharing arrangements, with crop shares in lieu of water being as high as one-third. Cash-sales of water are also increasingly common. Water markets are natural oligopolies with benefits of raising effective irrigation potential and utilisation but the drawback of leading to possible over-exploitation of groundwater resources. The degree of monopoly power enjoyed by individual oligopolists and hence the water prices charged depend the normal extent of rainfall, watertable drafts, cropping patterns, high cost of modern irrigation technology, absence of canals and alternative irrigation sources and poor progress in rural electrification, with the result that the most aggressive water markets operate in the most arid regions of the country. From the point of view of these water markets, a flat, horsepower-linked water tariff (FR) proves to be superior to pro rata (PR) or volumetric tariffs, as it reduces oligopolistic tendencies in the water market. For the SEBs "FR may become attractive for its administrative simplicity, elimination of metering costs and hassles, and reduction in the intentive to pilfer power"[71] besides helping the SEBs to break even on agricultural operations by marginally reducing power subsidies. However this has to be concomitant with provision of high quality, uninterrupted and reliable power supply. Other studies which document the emergence of water markets are Kolavalli & Chicoine (1987), Pant (1988), Shah (1986), Shankar (1989), REC (1985) and Saleth (1991). The role of water markets in influencing water-use patterns as also that of electricity pricing is also covered in Moench (1992) which focuses on the risks of overdrawal of groundwater otherwise. The new NABARD guidelines relating to spacing etc. and scope for management reform are also covered by this study.

As a tangential reference is made in the findings of the present study to the labour impact of irrigation schemes, some exploration of existing literature on rural employment and agricultural labour

utilisation is warranted. In scope, the study of rural labour use by Vaidyanathan (1986) is widest. Citing NSS statistics for 1977-78, more than 60% of the rural labour force (both male & female) are seen to be self-employed or employed in the family enterprises with the rest constituting wage labour; further, 80% of males and 86% of females are employed in agriculture and allied activities. From NSS information on the break-up of agricultural work by major operations, marked differences in the relative importance of female labour to different operations emerge; women figure pre-eminently in transplantation, weeding and harvesting, outnumbering males in the casual-labour category in the latter two operations, but play minor roles in other operations, notably ploughing and non-manual works.[72] Regional variations however exist. Participation rates in the labour force vary between 55% in Kerala to over 70% in Andhra Pradesh for males; and for females from 13-14 percent in Assam to 54 percent in Rajasthan.[73] Ishikawa's distinctions between land-augmenting technological change and labour-substituting technological change are found useful in explaining varying labour intensities in agriculture. Bardhan's analysis of the same variations across farms in Bengal also emphasise differences in technology and institutions; irrigation, multiple cropping, fertilisers and HYV are the major technological factors in his analysis, while farm size, leased-in acreages and burgaining strength of labour are prominent institutional factors.[74] Consensus exists that irrigation is land-augmenting and therefore conducive to the absorption of more labour. Agarwal's and Binswanger's evidence for India however indicates that all other forms of mechanisation are labour-saving.

The special importance accorded to by Ishikawa and others to irrigation is because its assured and timely availability increases the scope for using other agricultural inputs; also extension and diversification of cropping is facilitated, which have labour implications. Vaidhyanathan's linear multiple regression analysis of the inter-state cross-section shows that, *ceteris paribus*, high rainfall regions have high labour intensity, and the higher the proportion of irrigated area, the higher the labour intensity - these relations are all statistically significant. Statistical significance is also found from the multiple regression for the finding that states with a higher proportion of wage labour in total agricultural labour input also have higher total labour input per unit of land. This order of relationships can safely be assumed to persist as long as there is no large-scale resorting to farm mechanisation.

Kurian (1990) tackles the problems posed by the declining employment elasticity of agricultural output, visible since the mid-60s, in response to which the agricultural worker gets only around 130 days of employment in irrigated double-cropped areas and 80 days in dry areas.[75] Evidence from other related studies is also cited that reveals the decline in the real wages of agricultural labour in many states, aggravating rural poverty. Part of the problem has originated from the marginalisation of holdings. Three-fourths of marginal holdings are accounted for by just six states in the country; of these West Bengal accounts for a high 32.3%. For states where high marginalisation coincides with a high percentage of rural poor, the problem is acute. However the prevalence of rural poverty is also found to coincide with the lack of development of irrigation and thus "the success of employment generation and poverty alleviation programmes critically depend on the development of assured and controlled irrigation";[76] this the author says is particularly true of eastern India. Findings on labour utilisation by crop in the study

show that on the whole low labour absorption is associated with low level of technology and non-irrigated farming and plan priorities on the generation of rural employment have a natural ally in the development of irrigation.

Some aspects peculiar to female labour are brought out in Bhalla (1989) and Chen (1989). Bhalla cites the experience of the three pioneering states in the field of irrigation i.e. Punjab, Haryana and Uttar Pradesh where the initial response to green revolution technology was a sustained rise in labour use per hectare, followed by peaking in the mid-70s and than a subsequent decline as a result of adoption of mechanised farming; even in these states however total employment levels in agriculture have been sustained by expansion of gross cropped area as well as cropping shifts to relatively more labour intensive crops. With reference to female labour it is found that in times of absolute labour scarcity demand for female labour, both of the unpaid family variety and the hired variety, goes up as a method of buffering the sharp increases in wage rates that would otherwise take place during a peak activity period. Thus, even though the major employment season provides more employment to women, this is conditioned by the existence of male labour supply bottlenecks which result in a female 'peak season shift'. High absorption of female labour is accounted for both by small farms and very big ones. Despite this most women labourers belong to the casual labour category. Chen's study is on women's role in agriculture by agro-ecological zones because of intrinsic differences in cropping by region. Incidence of female agricultural labourers is higher in irrigated paddy regions, as well as those with low fine cereal-cropping, low agricultural growth and high inequality in land ownership; in the rain-fed paddy areas however participation of women labour is not as high. A very large part of this female labour is unpaid and drawn from the family in the case of irrigated paddy, and consists of landless agricultural labour in the case of rain-fed paddy. In areas where wheat predominates however there are lower female labour intensities overall.

1.11 Area Studies of Relevance

A study which closely parallels the present one in its irrigation aspects is Palmer-Jones (1992), which explores groundwater irrigation and the growth of agricultural production in the region of Bangladesh (contiguous to the present areas for case-study). The similarity extends to common demography, ecology and socio-economic conditions "despite abundant ground and surface water resources apparently favourably climate",[77] Bangladesh has lagged behind, like eastern India in the development of agriculture and in poverty alleviation. Part of the malady is ascribed to the existence of policies more attuned to circumstances where groundwater is scarce and its use needs to be regulated. These conflict with the priorities of exploitation of groundwater in groundwater-abundant regions where the incidence of poverty and its magnitude is severe.

A debate has centered around whether private sector exploitation of groundwater is likely to lead to excessive and socially undesirable watertable draw-down. Criticism of the State-sector, on the other hand, points out that it strengthens monopolistic elements in the emerging water markets. The experience of Bangladesh however shows that private sector irrigation has generated few negative externalities, and has supported high growth especially of <u>boro</u> rice. Crops, with some cereal-substitution for jute, oilseeds and pulses. Rising competition between traditional <u>aus</u> paddy areas and HYV <u>boro</u> areas is

also evident. Amam paddy however remains more or less stable because of high rainfall. The positive trends in boro production have, since the late 1980s, been supported largely by spread of private sector STWs. Although DTWs in the State-sector have also increased, their operability and command acreages are subject to greater uncertainty. Among the problems particularly associated with DTWs have been low capacity utilisation and fears of water-lordism (through water markets).

All these are in contradiction with thinking in government and academic circles, and even in the World Bank, that the obstacles to economic development in this region lay predominantly "in the malign influence of the agrarian structure and of the rural elites in particular";[78] this was interpreted as an obstacle to irrigation-led agricultural growth. Modern irrigation technologies which have significant economies of scale, were not considered suitable for an agrarian economy with small and highly fragmented farms. Against this, Palmer-Jones conclude that it has been the STWs, which had previously been perceived as inappropriate, that have generated agricultural growth in Bangladesh, and this has been without the negative draw-down externalities that had been anticipated. Although the rise of water markets was somewhat unanticipated, a positive feature in their existence has been their impact on poverty alleviation through extending irrigation support to holdings previously considered to be too small for irrigation to be viable. Another point to be noted is that, with the existence of water markets, any low-technology solution for small holders, such as manually-powered dug-well irrigation turns out to be infructuous because in the face of its effort-intensiveness, buying and selling water from STWs is considered more advantageous.

From the same criterio of close similarity to the field chosen for the present study, although methodologically and qualitatively divergent is the status report of Choudhury,Mukhopadhyay & Subba (1986) which has covered existing irrigation schemes in North Bengal. This study is from the sociological standpoint, in the context of the Ministry of Agriculture, Government of West Bengal sponsored project. And covers, on a sample-basis, three districts where the project in operation, including parts of Cooch Behar. Under scheme-classification for the minor irrigation schemes, the majority of schemeholders, although private STWs revealed a smaller percentage of marginal farmers. STW dominance is also noted in terms of seasonal irrigated areas, as also concentration of State-sector scheme-activity only during the rabi season. A swing to cultivation of HYV crop varieties is also noted under the influence of irrigation. Land transactions also reveal some interesting features, with irrigation beneficiaries marginally increasing purchases and reducing sales of unirrigated land after getting the benefit of irrigation. Purchases of other rural assets show marginal increase. However irrigation also appears to have contributed to indebtedness. Irrigation demand is observed to peak during the rabi season and to be at an extreme low during kharif when rainfall is maximum.

POWER

1.12 The Literature on Power

Literature on power and energy is briefly focused on here as it is the subject of a separate chapter. Most of the studies extant are from the technological rather than the economic standpoint indicating that the economics of power generation and distribution is an area of

relatively recent interest.

Pachauri (1977) is a detailed study of the energy linkages of economic development of India, covering the gamut of energy resources available to the country, both commercial and non-commercial in nature. Problems of energy-demand forecasting are alluded to and different methodologies adopted are compared, particularly that of the NCAER (1965),[79] Fuel Policy Committee (1974)[80] and Parikh (1976);[81] sectoral aspects of the growth of energy demand are also considered. It is pointed out that the forecasts which exist are based on rigid end-use coefficients and constant prices and incomes and hence discount substitution effects that stem from economic development and with increasing availability of commercial fuels.

From the point of view of electricity, the natural endowments of coal and hydro electric resources in the country are important; the hydel potentials are highly dispersed and can thus become good supplements to thermal generation. The inherent advantages of hydel generation that are cited are renewable nature of hydel resources, less adverse environmental effects, instant start-up and loading which makes this particularly suitable for meeting peaking demands, low operating and maintenance expenses and less frequent break-downs.[82] Parikh's analysis, using a multi-region, multi-period linear programming model, argues for the economically viable nature of fastbreeder reactor nuclear power generation technology as a solution to the problems of coal movement; in its absence the country would have excessive dependence on coal-based generation. The viability of non-conventional energy sources e.g. solar photovoltaic panels, biogas and wind energy is also explored, as also the organisational problems of administering such a large energy sector.

Power occupies a unique position in economic development; average annual growth in generation over the plan period has been near 10 percent.[83] However, rational planning of power development in the country is inhibited by adherence to outdated forecasting methods. Of these the CEA uses the most sophisticated methodology comprising the trend method, the end-use method by sector/industry of use, and Scheer's formula which is based on the thesis that for every 100-fold increase in per capita generation, the rate of growth of generation will be reduced by half. These macroeconomic methods are supplemented by micro-level studies in Andhra Pradesh in Pachauri (1975).[84] Econometric forecasts in the latter are found to be log-linear in type. The plight of the State Electricity Board (SEB) in the face of inadequate revenues is discussed and the need for revision of tariffs, particularly in rural sector, as well as reduction in operating expenses, transmission and distribution losses and cost-overruns in projects is stressed. In this context the significant impact expected from the Rural Electrification Corporation (REC) is mentioned alongwith the schemes that it assists, this need being emphasised by the fact that "it is obvious that rural electrification can have social benefits greatly in excess of private benefits to the direct users of these schemes. The availability of power in rural areas opens up the possibility for the implementation of various types of schemes, which would lead to overall development of the rural sector in the country".[85]

Tariff problems are also alluded to in Venkataraman (1972). The practice of differing rates for different user categories is a historical outgrowth that has little rational basis, often leaving open the question as to whether the rates cover the actual costs of

services rendered. World Bank appraisals in 1962 and in recent times have been critical of the lack of a clear-cut tariff policy in the Indian sector. For the most part, power demand over all states is largely for the industrial high-tension loads. Domestic consumption is around 10 percent or less but "it is this narrow section that has to bear a considerable burden by way of rates".[86] Although power consumption in the rural sector, particularly for irrigational purposes is often accused of being responsible for the deficit financial positions of most SEBs, great variation is found between states in this category of consumption. It is mainly industrial power (both HT & LT), which consumes 73.8 percent of total sales but contributes only 50 percent to revenue, that is culpable; if industrial rates are low the burden on the others is bound to be heavy.[87]

In respect of rural electrification, the basic problem of low agricultural load growth is encountered. However rural electrification may actually help load development by diversifying this load, although subsidy element may initially be necessary as is the case in most other countries. This point is taken up more specifically in Paliwal (1985) which also relates rural electrification to rural development particularly in the agricultural sector. Where rural electrification has resulted in large losses, the reason has generally been non-materialisation of loads, for which other infrastructural lacunae are equally responsible.[88] The positive results of well-energisation are however well evident. [A more detailed reading of this literature is made in the next chapter, which also has references to studies in power engineering and development in India e.g. Narayan (1990), Kati (1990), Naidu (1990), Varma & Rao (1992), Dasgupta (1992) and in West Bengal e.g. Ghatak (1985) and Chakraborty, Sanyal & Sikdar (1991). Other literature references which supplement this chapter are on the power scenario in general e.g. Puttaswamy(1984), Jain (1984), Sah (1984), Desai (1987), Rajagopal (1988), Bami (1988); and rural electrification in particular e.g. Kochar & Dua (1978) and Verma (1978). With the help of these as well as published official statistics and reports, the problems and prospects of the power sector are explored, to lay a foundation for the present study.

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