CHAPTER II
REVIEW OF LITERATURE

The importance of irrigation in the economic development of countries has attracted the attention not only of individual researchers and Government agencies, but also of international bodies like World Bank, Asian Development Bank, etc. Such studies focus their attention on functioning and performance of irrigation systems, and their impact on socio-economic conditions of people. Some of them are carried out at macro level and some others at micro level. However, an attempt is made in this chapter to review some important studies relevant to objectives of present research work.

After independence, the Irrigation Commission (1972)\(^1\) constituted by Government of India, made an in-depth review of various irrigation projects in the country and observed many serious deficiencies in the existing as well as new projects being taken up then. It pointed out that shortages of water were experienced during low stages of river flows in majority of run-of-the river schemes, which derived their supply of water solely from diversion works on rivers. The earlier irrigation systems of Northern India were designed with low irrigation intensities and cultivators were therefore given a share of water proportionate to their landholdings in the command area. Naturally, they were applying water thinly to irrigate as much area as feasible. The Commission observed that this mode of irrigation was not conducive to high

yields, particularly for high yielding varieties. The Commission further pointed out that on many irrigation systems, the channel capacities were inadequate to meet peak demands of water during crucial periods of crops like transplanting of rice, kor irrigation (first irrigation after sowing), etc., and because of these inadequate channel capacities, periods of irrigation were prolonged and there were low yields. It attributed sufferings of farmers in tail reaches of canals mostly to these inadequacies. It further observed that many existing irrigation schemes were suffering from variety of causes, viz., faulty headworks, silting up of reservoirs, seepage from canals, inadequate drainage, etc., and these could be cured only by introducing modern concepts of water-shed and water management, conservation of soil, development of proper drainage arrangement, and by modernizing and streamlining canal systems.

The National Commission on Agriculture (1976) made further study of problems besetting irrigation schemes in the country and observed that irrigation as practiced in the country was somewhat extravagant in the use of water. It observed that, on an average 0.65 hectare meter of water was utilized to irrigate one hectare of cropped area if source was groundwater, and 0.90 hectare meter if it was surface water. In many canals, supply of water was inadequate and crops did not receive required amount of irrigation. The mode of utilization of water was also wasteful in many irrigation systems. On unlined canals in alluvial tracts, only about two-fifth of water released at canal heads was utilized by crops and rest was lost in transit. It therefore advocated a need for great deal of efficiency and economy in the use of water. It observed that the basic considerations in planning of irrigation schemes in the country have been cropping pattern, intensity of irrigation and duty of water, but however, once the schemes are constructed they are hardly

enforced. The cropping patterns and irrigation intensities in reality are getting emerged from choice of crops by farmers, which are determined by profits expected from different crops and availability of irrigation supplies in canals. It further observed that methods of designing irrigation channels based on these parameters, and which are being practiced in the country are somewhat outmoded in the context of advanced technology in agriculture and irrigation practices. It also observed that some remodeling or replacement of old and decrepit major engineering structures have been taken up in some of the projects primarily to safeguard existing irrigation supplies. And in certain other projects, supplemental supplies have been provided through construction of new storage dams or by transfer of water from other sub-basins. A few old channels have also been lined to save on-transit losses. The Commission observed that all these efforts have been concentrated at improvement of existing canal systems and in the field of engineering. None of these systems have been reviewed comprehensively for improvement in all aspects of schemes, like safety and better regulation of engineering structures, augmentation of supplies if required, improvement of efficiency in conveyance of water, scientific application of water to crops, adoption of suitable cropping patterns, etc.

Murray-Rust et al. (1984) analyzed the dimensions of Head and Tail inequalities of water distribution in Gal Oya Irrigation Settlement Scheme, a major Irrigation Project in Sri Lanka. The study was based on details of daily channel flows observed in different reaches of canals during a period of crop season. They found that there were substantial differences in water delivery and water availability between Head and Tail of Left Bank system of project.

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They also observed that Head-ness and Tail-ness were multi-dimensional, and there were water deficiencies in head-end areas also, given topography, channel configurations, soil variations, social problems, etc.

Making use of secondary sources of data, Joshi and Agnihotri (1984) made an attempt to examine magnitude and economic consequences of soil salinity and waterlogging due to canal irrigation in 11 selected irrigation projects in India. They observed that waterlogging in some projects was as high as 48% in Sriramsagar project in Andra Pradesh and 33% in Ramganga project in Uttar Pradesh. The annual increase in soil salinity and waterlogging was as high as 50 hectares and 27 hectares respectively in the above projects. They estimated that the social costs resulting from the problems of soil salinity and waterlogging was more than Rs. 6000 million in the eleven selected irrigation projects. The rice production in these projects declined by 970 thousand tonnes during 1980-81, amounting roughly to Rs. 1,804 million. They concluded that canal seepage and mismanagement of irrigation systems had adversely affected growth of crops and hence decreased productivity and production of rice in all these projects.

Mitra (1984) in his study on Mula Irrigation Project in Maharastra made an attempt to examine actual availability and use of water against projected coverage and use in the command area. He collected details of irrigation potential created and utilized, actual yearwise and distributarywise area irrigated, etc., from official records for the period between 1969-70 to 1980-81. He collaborated these details with primary data he collected from sample villages in the command areas of distributaries. He observed that there was

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sharp discrepancy between cropping pattern adopted by Upper reach and Tail end farmers. In upper reaches, farmers were growing water intensive crops like Sugarcane, etc., by using their influence, while in tail-ends only dry crops like Jowar and Bajra were grown, as these areas more often than not, did not get any water or got very inadequate quantity. Thus, the study concluded that inequality in distribution of water between upper reaches and tail-ends had resulted in underutilization of potential to a large extent.

Based on primary data obtained from a sample of 150 farmers, Palanisami (1984)\(^6\) made an attempt to evaluate water distribution performance in Lower Bhavani Project in Tamilnadu. He observed that there was no control over supply of water in the project and farmers in the command area were experiencing high degree of uncertainties. Hence, once they received their supply, they tried to irrigate as much area as they could. The tendencies of farmers for over-irrigation at top-ends and under-irrigation at tail-ends had resulted in both inefficiency and inequality in the distribution system.

Malhotra, et al. (1984)\(^7\) undertook a study to determine availability of water, its utilization, agricultural yield, etc., in the command area of Pabra Distributary of Bhakra Project in Haryana. They observed that design adopted in the project provided for very low intensity of irrigation and water supply in the system was enough to irrigate only a small percentage of landholdings (normally around 30%). The gross area irrigated was lower in chaks located at the tail of distributary, which was attributed not only to losses occurring on

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account of seepage, evaporation and other such natural causes, but also to possible pilferage and tampering of outlets.

In the conference on, "Investment Decisions to Further Develop and Make Use of Southeast Asia’s Irrigation Resources", held at Kampangsaen, Thailand, **Asnawi and Shand** (1985)\(^8\) presented a paper on impact of improving irrigation systems on the rice production in West Sumatra of Indonesia. They used empirical estimates of rice production functions to calculate relative contributions of different factors to West Sumatra’s rice production from 1969 to 1978. They observed that Irrigation improvement or rehabilitation was relatively more important in increasing rice production than other factors like intensification of agricultural area, use of fertilizers and pesticides, etc., and this would be a profitable means of increasing productivity of rice in the province.

**Moya** (1985)\(^9\) selected three tertiary areas in Lower Talavera River Irrigation System in Philippines and tried to study patterns of water distribution in the command area. His study was based on measurement of total irrigation water supplied daily to each sector of tertiary areas, and agronomic information regarding varieties of rice planted, dates of sowing and transplanting, etc., collected through interviews with farmers. He observed that the water distribution among farms was quite variable, with relative water supply ranging from 0.3 to 2.5 in different sectors of canals. The farmers frequently checked water in ditches or provided unauthorized outlets in order

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to increase supply of water to their fields during critical periods. The study found that this was mainly due to inadequate design of farm ditches, without taking into consideration various physical factors and topographic details.

Pasandarn (1985)\textsuperscript{10}, in his research report provided insight on how farmers built and operated tertiary systems in major irrigation systems in Indonesia. His report was based on water management and cropping pattern practiced by farmers in Cirebon Irrigation Systems of West Java in Indonesia. He observed that local communities developed their tertiary canals quite differently from the process used by technical agencies. These differences stemmed as local communities used their water management traditions instead of technical traditions perceived by irrigation agencies. The actual canals were developed by local community based on meeting needs of irrigation from all possible sources and through alternative means of distribution.

Based on data culled from a detailed techno-economic investigation of Mula Irrigation Project in the State of Maharasta carried out by Water and Land Management Institute Aurangabad, Dhawan (1987)\textsuperscript{11} studied economics of canal seepage, and observed that transmission losses in the command area was twice the contemplated. Only about 52 cm out of 211 cm of water released per hectare of land released from headworks reached farm gates. i.e., about 75% of water released from reservoir was getting lost in transit and only 25% of it was reaching farm level. He identified two main factors for this phenomenon, namely (i) crop pattern deviating from


contemplated one and, (ii) in-transit losses in the canal network being much more than expected levels considered while working out project design.

In an article, "Water Resource Management: A case Study" in Yojana, Balasubramanian (1989) analyzed water problems and economics of water resources management in the State of Tamilnadu. He observed that a policy for attaining irrigation efficiency in water resources management through an adequate and timely application of irrigation water is being accepted, in place of traditional practice of spreading available water to as many hectares as possible, which is frequently adopted in the hope of achieving far more extensive benefits. He further observed that full benefits from irrigation resources can be derived only when integrated operational programmes envisaging simultaneous activities in agricultural and allied fields are planned and undertaken on an area to area basis in their command areas.

Singh (1989) in his study tried to assess efficiency and effectiveness of administrative systems established for water management in two irrigated districts of Shri Ganganagar and Kota in Rajasthan. The study was based on interviews he conducted with 322 respondents covering politicians, administrators and farmers. It revealed that the organizational structure in the districts was mainly geared to protective irrigation which did not suit modern agriculture. It was not designed for optimum use of water. The water supply was not planned and programmed in relation to agriculture. It was also not coordinated with activities of other departments resulting in total uncertainty of water supply and a feeling of distrust in administration. Most of the decisions were taken at the level of Executive Engineer and above, with no system of

feedback, and this had resulted in a formalistic and bureaucratic supervision over field staff. In practice, most of the cases regarding distribution of water were getting converted into criminal or police cases as farmers had lost their faith in the system for redressal of grievances. It was observed that politicians did not have any recognized role in water management. The study concluded that water was not utilized properly and farmers were actively anxious to get inputs. They did not care for any scientific devices as they were not confident of getting required supply of water. Big farmers were able to manipulate services and small farmers were oppressed by unholy alliance with irrigation officials. The rural institutions were formalistic and no co-operative and co-ordinative functions were performed in the environments.

Reddy (1990)\textsuperscript{14} studied status of water availability and relevance of theoretically assumed water duty in the command area of Ghataprabha project in Karnataka. His study was based on both macro and micro level data. The secondary data of quantity of water delivered in each season during six years from 1980-81 to 1985-86 were collected from gauge records. He collaborated these details with actual discharge of water observed every day in three distributaries of project. He observed that design of canals was not suited for segregating Khariff and Rabi irrigation blocks, as envisaged in the project. There were not enough regulators and control structures in water conveyance systems to enforce an effective system of water management. Even the 'duty' assumed in the project design was proved unrealistic. The farmers also did not show readiness to observe irrigation discipline and those in head reaches were not averse to utilize more water than their fair shares. The small farmer received scant consideration in sharing of benefits. Violation of cropping pattern was also common. The combined impact of all these factors

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was serious and a shortage of water was already experienced, though only half the command area was developed.

**Wade (1990)** in his research paper, "Employment, Water Control and Water Supply Institutions – India and South Korea", made a comparative study of irrigation management in South Korea and India. He observed that the water supply institutions in two countries are based on two very different models. The Indian case presents a "Department" model, in which canals are managed by a centralized government hierarchy. Staff moves from one project to another during their careers, and at professional levels these projects may be anywhere in the State. This naturally would make them less interested in their designated works. Irrigator's prescribed role in the operation and maintenance of canals is confined to 'below the outlet', and they have no role at all in 'above the outlet' decisions. On the other hand, the South Korean case represents an 'Irrigation Association' model, in which case each canal system is managed by a staff paid for, and perhaps appointed by beneficiaries. The beneficiaries cover maintenance costs and also have formal role in running of associations. Staff normally stays with one association for most of their career. He thus made an attempt to present differences in effective functioning of projects in the two countries with the help of above models.

**Gunadasa (1990)** tried to examine causes and consequences of low performance of irrigation systems in Sri Lanka, by a detailed study of one of

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the largest irrigation resource projects in the country viz., Gaint's Tank System. The study which was mainly based on information collected from a field survey observed that, the prevailing system of water management had resulted in severe under-utilization of irrigation water resources. This had also resulted into very serious consequences on the level of output realized, employment generated and on the overall utilization of very important national capital stock. He advocated a need of broad based and comprehensive programme of reorganizing the operation and management of systems to tap full production and employment potential.

Asawa (1994) compiled various studies on performance of 12 Major Irrigation Projects in India, and found that actual irrigated area was as low as 17% of planned area in Sri Ram Sagar Project in Andra Pradesh, 31% in Kosi Canal and 37% in Nagarjunsagar Right Bank Canal. There was more intensity of Irrigation in Head reaches than in Tail reaches in all the projects and, crop yields and farm income also declined. The average yields have also been less than potential. He concluded that majority of irrigation projects in India are performing very poorly.

In their article in “Water International”, Hamdy et al. (1995) examined agricultural water demand management in Mediterranean countries. They observed that more than half the amount of water withdrawn in the Irrigation Projects of these countries do not reach fields. They observed that factors like leakage, percolation, evaporation, etc., have been major causes for the low irrigation efficiencies and these are mainly linked to deterioration of

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irrigation distribution networks. They further observed that there is a necessity to find appropriate means to achieve greater efficiency and equity in the irrigation systems. Such an approach will not only help to achieve greater levels of agricultural production with lesser amount of water, but also will address some of the major environmental problems of waterlogging and salinity, declining groundwater tables, and shrinking lakes and seas. They concluded that this requires much greater imagination and flexibility on the part of irrigation policy-makers, managers and planners, and technological, managerial and policy innovations and adoption.

The World Bank (1995)\textsuperscript{19} recently made an evaluation of 192 Bank supported Irrigation projects all over the world, and rated 67\% of them as satisfactory with an average estimated economic Internal Rate of Return (IRR) of 15\%. The satisfactory or unsatisfactory rating was considered based on whether project was good thing for borrower or whether, on the whole, it met its objectives. This, it was interpreted that one third of Bank supported Irrigation projects had unsatisfactory outcomes. Since the evaluation economic IRR was 15\% as against 21\% expected at the time of their appraisals, it was also interpreted that one third of expected net benefits failed to materialize. However, the bank observed that a 15\% return on investment after allowing for inflation was quite impressive, as most of these irrigation projects had large initial investments and long gestation periods before net benefits were materialized.

The Government of Karnataka (1996)\textsuperscript{20} undertook a farmers' opinion survey in 4 selected Major and Medium Irrigation Projects in the State

including Upper Krishna Project. The main objective of the survey was to know adequacy and timeliness of water supply in the command area of projects. It found that about 35% of farmers in all projects put together did not get irrigation water in time. The reasons reported for not getting water in time were no proper water allocation and distribution (37%), head reach farmers taking more water (35%) and inadequate water supply (21%). Majority of farmers in Upper Krishna Project (54%) reported that they did not get timely supply of water on account of head reach farmers appropriating more water and absence of proper water allocation and distribution system. In Tungabhadra Project, majority of farmers (84%) felt that lack of proper water allocation and distribution procedure had lead to untimely supply of water.

Asrar-Ul-Haq et al., (1997)\textsuperscript{21} in their article on problems faced by irrigation systems in Pakistan, identified that waterlogging, salinity, over-exploitation of ground-water, low efficiency in delivery and use, inequitable distribution, inadequate maintenance, and insufficient cost recovery have become main problems of Pakistan's irrigation systems. In addition, overall scarcity of water, its low availability during winter and at the beginning and end of summer, and small reservoir capacities have also become the constraining factors. Pakistan's irrigation systems are under tremendous pressure due to growing needs of water. Over time, there has been a substantial increase in the number of users due to rapidly growing population and consequent fragmentation of land holdings. The irrigation intensities have increased beyond design values. In Upper Indus Basin, for instance, cropping intensities have increased to over 120% as against an average design intensity of 63%. They observed that there is a need for review of irrigation systems in the context of design parameters and objectives. They finally conclude that only

addressing of root causes for shortage of water supply, complemented by institutional measures implementable in local environments would be able to solve the problems of irrigation systems in the country.

Hugar (1997) evaluated performance of Canal Irrigation in Tungabhadra Project at system level as well as at different regions (Head, Middle and Tail), during year 1993-94. His study was mainly based on primary data, and it revealed that supply of water resources in the project was less than 23% of its demand as per existing area and water use level. The violation of localized cropping pattern especially in paddy both in Kharif and Rabi/Summer season, coupled with higher level of water use have contributed for wide gap in supply and demand of water. The distribution of water is not only unequal over regions, but also varies from farmer to farmer. The reliability and timeliness of water supply is not ensured particularly in tail regions. The command area of project is heavily plagued by waterlogging and the study anticipates that by 2047 AD, the whole command area would be under waterlogging with complete salt affected soils.

With the help of a stratified sample of 154 farmers spread in the different districts of Karnataka, Venkataramanan et al. (1998) made an attempt to study management of irrigation projects in the State. They estimated that there is a wastage of 41% in the utilization of irrigation water in paddy, 52.5% in wheat, 44.6% in jowar and 48.3% in sugarcane. They observed that a strange paradox of irrigation practice exists in the project in the sense that water is used indiscriminately for the first crop, and an acute

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shortage of water is felt in growing a second irrigated crop. This is also reflected in poor overall intensity of land use. They concluded that there is large wastage of water in the project and it calls for an urgent action to conserve scarce water resource.

The High Level Committee (1999) set up by Government of Karnataka to suggest appropriate water management strategies for the irrigation projects of State, observed that a total indiscipline has been developed in the use of water in all the projects of State and farmers are raising crops according to their wishes, violating prescribed cropping patterns. It has therefore become difficult to distribute water equitably to all parts of command areas and thereby tail-end farmers are put to losses. It also observed that additional areas other than notified areas are irrigated in many projects. While in Tungabhadra project, such unauthorized irrigated area is 17.44% of notified area, in Malaprabha project it is as high as 41.51%. These irrigated areas outside notified command areas, have resulted into large areas within notified command areas getting inadequate or no supply of water. Such suffered area is as large as 42.5% in Tungabhadra project and 50.9% in Malaprabha project. There has been shortage of irrigation water in almost all irrigation projects. The irrigation staff is put to heavy pressure, especially in rabi/summer season, to find water for maturing crops which would otherwise dry up. The Committee found that the unauthorized atchkats and violation of cropping patterns have become root causes for the situations. It therefore recommended for amendment of Irrigation acts to empower irrigation officers to prevent unauthorized use of water, patrolling of canals with greater vigilance and various other measures, for effective distribution of water.²⁴

RESEARCH GAP:

A review of studies undertaken on planning and management of irrigation projects reveals that majority of them highlight deficiencies in the operation of projects, and make certain suggestions and recommendations, which are generally in the form of modifications in canal operations. But, though such attempts as generally suggested in the studies are made, they have not found to be very successful. This is mainly because of failure to review and revise old policies, procedures and design principles as a full package, at macro and micro levels. Only a thorough review of all the planning and management concepts considered in the design of projects would be able to throw light on the deficiencies existing in projects and also on the corrective measures to be effected. The present research work is an humble attempt mainly to fill up this research gap. The project selected for the study is one of the major irrigation projects in the State of Karnataka, and it represents problems faced by majority of irrigation projects in the region.