CHAPTER –II
REVIEW OF LITERATURE

2.1. Introduction

Impact of irrigation is studied as it is the closest and probably the most widespread association of past human activity with the hydrological balance, relief slope, and stream network of the drainage basin systems. Irrigation is an artificial supply of water to support plant life in an area where there is shortage of rainfall, if and when necessary to cater the needs of crops. Perhaps the most extensive type of environmental modification made be farmers and in turn one the most productive is irrigation. Irrigation practices however primitive have had a dramatic impact on the land use.

Realizing the importance of irrigation, government, research institutions, individual researchers both at international, national, and at local have undertaken several studies on irrigation and its impact on land use, cropping pattern, cropping intensity, economic benefit and cost ratio etc.

In this chapter an attempt has been made to present the review of past studies related to the theme on the basis of the objectives of the study, the study is done on different aspects of cropping patterns, impact of irrigation on the same, growth in area of production and productivity of crops, profitability and productivity of resources and technical efficiency.

2.2 First Objective: Efficiency and types of irrigation systems

Irrigation is a widely read subject and various aspects of it have been studied by several people working in different fields. The concepts of irrigation have been discussed by various scholars, Herodotus-(2000 years ago-) Explains the Nile valley is rainless and extremely fertile.” Egypt is the gift of Nile”. Egypt depends on the Nile in a way that no other nations does. 97% of Egyptians live on 2.5% of its area. The prosperity of Nile valley civilization has depended throughout recorded history on the efficiency with which the government has organized the best use of the river water. Janasson(1925-26) in Europe, Barkar (1926) in north America, Johes (1928) in South America, Taylor G. (1930) in Australia, Whittlese (!931-34) and Valkenburg. V. (1931-36) in Asian countries etc., have studied the agricultural regions with
reference to physical, social and Economic factors and their interrelationship with irrigation. Williamson (1931) has given a brief description of indigenous sources of irrigation in the Deccan peninsula. A year book 1955 on agriculture of the USA namely, Water aims at explaining the nature behavior and conservation of water in agriculture. It also includes some of the broad problems, facts, and basic principles of it. A synoptic view of irrigation and agriculture of the world is given by Cantor 1967. His book includes a systematic history of irrigation methods and problems of irrigated agriculture. Clark (1970) deals with economics of irrigation. Other works carried out by some of the foreign scholars on the method of irrigation and water management are Manneir (1974), Short (1974), Bengtson (1974), Andreae (1975), Schaffer (1975), Baukmann (1975), Garbrecht (1976), Garbrecht(1978), Chambers (1988) and Gooneratne (1990). L. Shanani1987 studies on Impact of Irrigation and defined it as the application of water to the land for the purpose of supplying moisture essential to plant growth. In this process, irrigation projects transform the land in two ways: (1) by direct modifications of the land surface that occur when canal networks are constructed and land is cleared, shaped and leveled for irrigation; (2) by indirect in-depth transformations that take place when the water and salt balances in the region are changed following the import of additional quantities of water and salt into the area. Most of these transformations are permanent and irreversible. He describes the dynamics of these transformations, and by using specific case studies examines the concomitant hazards that develop which may even threaten the existence of the society that created the irrigation project. Drew Johnson (2002) the primary objective of this study was to examine hydrologic impacts, including changes in stream flows, resulting from changes in irrigation practices and land use. The study area was the Salt River drainage basin (Star Valley). The methodology used incorporated comparing flows in the Greys and Salt Rivers. The Greys River, due to lack of agriculture in its drainage area, was used as a control and flows in the Greys. River was compared to flows in the Salt River where changes in land use and irrigation had occurred. Comparing flows in the Greys and Salt Rivers allowed effects due to changes in land use and irrigation practices to be quantified. The overall irrigation efficiency in the study area increased from an assumed value of 50% for flood irrigation to 70% for sprinkler irrigation. The conversion to sprinkler irrigation resulted in major hydrologic impacts to the Salt River basin, including an estimated
9% increase in average annual flow. Estimated changes in return flow timing were even greater.

The earliest study on irrigation aspect was that of the Famine Commission constituted at the fag end of the 19th century. The commission, on studying the problem of the then Madras province, felt that the development of minor irrigation works could be more relevant for the province. It also observed that the financial results of expenditure on minor irrigation works had been satisfactory.

Irrigation has long been the concern of many researchers among the Indians. Ramamurthy (1949) has described the different sources of irrigation in Tamilnadu. Committee on plan projects (1959) has made a report on minor irrigation works in Tamilnadu state and mentioned the number of tanks district-wise. Programme Evaluation organization of the planning commission (1961) has studied the problems of minor irrigation in Tamilnadu and Kerala. Department of Mines and Geology, Karnataka has published a report on ground water potential and number of wells existing in each one of talukas of the state and the number feasible for further development. Varadachari (1961) has explained the importance of tube wells in the delts region. Ramasaran and chawla (1967) have given a historical review of measures taken by the government in the growth of irrigation. Chaturvedi (1968) has described the origin and development of tank irrigation in peninsular India. Vyas (1968) has discussed the importance of irrigation. Irrigation Commission (1972) has discussed the existing irrigation development in the Cauvery Basin and the irrigation projects undertaken on Cauvery and its tributaries. It has also given statistics on source-wise irrigation under state wise study but no details on distribution have been given. Government of Tamilnadu (1974) has given a description of sources-wise irrigation. Commerce annual (1975) gives statistics on irrigated area in the various states and potential and utilization of major irrigation schemes in Tamilnadu, Karnataka and Kerala. Kandaswamy (1975) has described irrigation development in Tamilnade, The concepts of irrigation has been discussed by Sharma (1976) and Gopinath (1976). Vyas (1968) has discussed the importance of irrigation. Rao (1980) has studied the irrigation development in India. Ramasaran and chawla (1967) have given a historical review of measures taken by the government in the growth of irrigation. Water resources Development organization, public works Department, Government of Karnataka (1976) has described briefly the irrigation systems and
practices in the Cauvery basin and has given source-wise irrigation statistics. Nadkarni Metal (1980) has studied irrigation development and its association with the level of normal rainfall in Karnataka. Puttaswamy (1980) has described irrigation development in Karnataka. Rao (1980) has studied the irrigation development in India.

Generally the studies of irrigation are at district level or state level. The basin-wise studies have no detailed description at micro-level. Taluk level studies specifically related to irrigation development are lacking. Narayananamoorthy(1997) compared the advantage of drip irrigation over the method of surface irrigation and indicated that the latter has problems like cost escalation, inefficient use of water, water logging and salinity and low recovery rate. The use of water in the surface irrigation systems is very low-30.0 to 40.0 per cent due to reasons like large seepage, evaporation, distribution and conveyance losses etc. which affect cropping pattern and lower reach farms. Karunkaran and palanisami (1998) have analyzed the impact of irrigation particularly different sources of irrigation on cropping intensity for the period 1969-70 to 1993-94 in Tamil Nadu. The results revealed that canal tank and dug-well irrigation had more impact on cropping intensity. The coefficient of canal irrigation ranged from 0.63(1969-70 to 1973-74) to 0.38 (1989-90 to 1993-94). It is clearly shown that the impact of canal irrigation on cropping intensity was gradually reducing in the last 25 years, but it has comparatively higher impact than tank system. Yargattikar (1998) conducted a study to test various water management technologies under on farm conditions from 1987-88 to 1992-93 in Malaprabha command area of Karnataka. Study reveals that farmers have been growing hybrid cotton on large scale continuously year after year resulting in lower yields, unequal distribution of canal water, built up of pest and soil infertility are the main problems.

2.3 Second objective: Land use

The study of land use is important not only in agriculture dominated regions but throughout the world because of its relationship with different human phenomena. In Modern land use studies, the pioneering work was carried out by Thaer (1811) It was one of the first to apply a systematic method in land use analysis even today. It provides some interesting perspectives of land use study in china. Buck (1937) and his colleagues worked on a study of 16,786 farms in 68 localities in the eastern
agricultural region of China and covered not only land use but also size of holdings, farm labour, marketing and price, rural standards of living, nutrition and health, but this study fails to, to record the use of land on maps which is an important in the land use study.

Stamp (1951, 1962) pioneered in the land use studies in Britain, in 1930s he conducted survey to record the use of every parcel of land in Britain. For this purpose, intensive field work was conducted and different land use maps were prepared. Buck (1957) survey of China, the stamp survey and the U.S. survey either at the regional or at the state levels. The objective of these surveys and the methods followed are quite different from one another as they have been conducted under varying conditions. Later on, a voluminous book titled Land of Britain: Its use and Misuse (Stamp, 1960) incorporated the the findings of the survey and was published. A second land use survey of England and Wales was undertaken under the direction of Coleman and Maggs (1961) and numerous map sheets and reports were also published. The main motivating factor was how to support a huge population with a small amount of cultivated land: as such it is not surprising that the land use survey has been given the highest priority (Stamp1964). In Poland, under the direction of Kostrawiekai (1968), Department of Geography, the Polish academy of sciences developed a new pattern of land utilization based on agricultural typology, agricultural regionalization and planning or programming agricultural development.

In the post-war period, the study of land utilization has been undertaken by many universities and research organizations. In some countries, aerial photographs have been used for preparing the land use inventories. The mapping technique has improved and new dimensions have been added in the study (Sharan, 1969). Baker (1973), who published an article, entitled Land utilization in the United States: geographical aspect of the problem, this paper portrayed the trends in land utilization and emphasized the need for land surveys and classification. King, Murray (2001) severe drought in the recent summer of 2000/01 highlighted the significant impact that water plays in the productive land based industries of the Tasman district. Rationing of irrigation water reached an unprecedented level. This, coupled with the Tasman District Councils proposed resource management plan for water, questioned the efficient and equitable allocation of water for irrigation. The aims of this report are to gain an understanding of the resource and associated issues, to determine future
land uses changes, and to identify barriers to change. David Brauer and Dennis Gitz (2012) the objective of this study was to assess the effects of changes in irrigation allotments and land use to the Arch Hurley Conservancy district on stream flow out of Revuel to Creek. The results suggest that managers of Lake Meredith need to take into account water availability upstream of Ute Dam when devising plans for Lake Meredith.

Suria DarmaTarigan and Rudolf Kristian Tukayo (2013) studies made an observation that the Citarum River plays very important role in West Java economic activities In Indonesia; paddy irrigation covers an area of 7,230,183 ha. Ten percent (10%) of those area or 797,971 ha were supplied by reservoirs. Therefore, Citarum watershed is one of the most important watersheds in Indonesia. The study aimed to evaluate the influence of land use change on irrigation water supply in Citarum watershed.

Land use studies among Indian geographers are mainly by the inspiration from stamp, from the day he attended the 25th session of the Indian Science Congress at Calcutta, in the year 1938. The land utilization survey of the parganas and Howra district was conducted by Chatterjee (1945:1952). Rao (1947) has suggested land use classification on the lines of soil survey technique. He applied his idea to the land use analysis of the Godavari region. Ahmed (1954) has analyzed land use types in relation to physical elements, he is of opinion that slope of the land should be considered in preparing the development scheme for an Indian village. The land classification studies conducted by several scholars are noteworthy. Chatterjee (1952) conducted the land utilization survey of parganas and Howra district. Sen (1957) has made a study of the contemporary land use patterns in MatpalsBirbhum district of west Bengal. He has recommended a Five-point programme for the improvement of agriculture, based on manual trials in relation to soil, distribution of crops and social and economic conditions. A micro-regional approach to land use planning provides us some basic ideas on various types of land uses in India. One such attempt is that of Arunchalam (1959), of a micro level analysis of vanamadevi village; it provides us with a valuable rural land use classification of India. The report of Arunachalam (1959) aims at replanning land use by classifying land by considering its inherent capability and grouping of individual plots by taking their inherent quality. A micro-regional approach to land use planning of Deshpande (1959) provides a vigorous deal
on morphological ascendancy on land uses. The land utilization survey in the eastern Uttar Pradesh was conducted by Shafi (1961), he emphasized that the land use survey should be carried out in conjunction with the survey of land capability as this would help in determining the best uses of land. Mishra (1964) has studied land use in Khader and ravines of lower middle Gomati Valley. Under the guidance of Dayal and Sharan, the National Atlas Organization also prepared land use maps on a scale of 1:1,000,000. Sinha (1965) of Patna University intensively studied the land uses of canal irrigated areas of patna district. Tewari’s (1965) work on land utilization of Jaunsar Bawar, a micro regional approach to case village provides a systematic land use classification. Shafi (1966) in his paper on Techniques of rural land use planning with reference to India was of the opinion that land use survey of a vast country like India is easier to be conducted on the basis of sampling as it is very difficult to procure data for all the villages to be surveyed. Learmonth and Bhatt (1968) are of the opinion that sharp regional contrast in land use needs a spatial analysis. On the other hand, Sinha (1968) has taken weaver as well as Nelson techniques. Das (1969), Bhagalpur University, studied the population and land use of the Kosi Basin in North Bihar. Sharma (1972) has tested Bennett’s method of land capability classification. Similar studies have been made by the Government of Karnataka (Department of Planning, 1975) for the whole state and for Thana taluk by the state of Maharashtra.Setty (1984) has made an in-depth study of agricultural land use and location of service centres in Thungabhadra command area. He highlights the various problems entangled with the irrigated agriculture in Thungabhadra command area and concludes by giving some valuable suggestions for the improvement of agricultural land use and location of service centers he also emphasizes for an integrated area development plan for the Thungabhadra command area. Aruchamy (1986) has examined land uses and land utilization types in the Kambam valley of Madurai district in Tamil Nadu using remotely sensed data and ground sample based verification and has classified land capability using the land evaluation method developed by the food and agricultural organization of the United Nations for the developing countries. Pal and Mruthyunjaya (1990) studied silvipastoral system for development of wastelands of arid areas in Rajasthan using the time series data of 16 years from 1970-71 to 1986-87. The compound growth rate revealed that the area under forests, grazing land, cultivable wasteland, gross cropped area and area sown more than once registered a significant positive growth during the study period.
Ramanaiah et al. (1990) reported that the importance of forest land use in Andhra Pradesh was second only to agriculture. The increase in percentage of forest land in the state during the period from 1963-64 to 1978-79 was negligible. The non-cultivable land in the state showed an increase from 14.9 percentage of the total area in 1963-64 to 16.4 per cent in 1978-79, thus showing a net increase of 1.5 per cent. Between 1963-64 and 1978-79, the percentage of cultivable wasteland in the state had decreased by 1.8 per cent and the arable land in the state showed a marginal decrease of 0.1 per cent. Singh (1990) studied the land use pattern in the problematic areas of all the five agro-climatic regions of Uttar Pradesh, during the year 1988-89. The Study revealed that the hill region had the highest area under forest, permanent pastures, grazing land, tree crops and groves, non-cultivable wastelands and land under non-agricultural uses. The area sown more than once and the total cropped area, as well as the intensity of cropping had been found to be the highest in the eastern region and the lowest in the hill region. He concluded that the slopes of the hilly areas of UP could be successfully developed for the plantation of temperate fruits. Joshi and Prasad (1991) studied the optimal utilization of village community lands for sustainable development in Haryana. They reported that the state had large tracts of wastelands in the hands of village panchayats and the population was heavily dependent on its scarce forest and grazing land resources. They used linear programming to find an optimal land use pattern. The analysis revealed that the community lands have considerable potential for generating income, as they were suitable for the production of crops as well as being a source of fodder and fuel wood. Ratnareddy (1991) studied the trends of underutilization of land in the districts of Andhra Pradesh of a period of 33 years from 1955-56 to 1987-88. The study showed that the underutilized lands included current fallows, other fallows, and cultivable waste and grazing and pasture lands. The analysis suggested that underutilization of land was associated with irrigation, tractors, commercialization and such other factors. Such underutilization was attributed to the inability of the farmers to adjust to higher demand for resources. He concluded that land utilization largely depended on the availability of resources. Shrivastava et al (1991) studied the dynamics of land use and cropping system in the Tawacommand area of Hoshangabad district of Madhya Pradesh. They assessed the impact of the Tawa irrigation project on cropping pattern and land use in the area during the pre-project on cropping pattern and land use in the area during the pre-project period (1971-73 to 1974-75) and the post project period
(1975-76 to 1979-80). They observed a decline in the forestland as a result of illegal felling of trees for domestic purposes. They also reported that fallow land had increased since the introduction of the Tawa irrigation project. Singh and Karur (1991) studied the changing pattern of land utilization in Punjab since the inception of new farm technology in the mid-sixties i.e. from 1966-67 to 1987-88. The study revealed that the reported area for land utilization remained constant while the area under forests, area not available for cultivation and net area sown increased during the period. Due to intensification of agriculture, gross cropped area and cropping intensity increased. He concluded that Punjab agriculture had recorded drastic structural changes since the beginning of the green revolution. Vaidy and Sikka (1991) studied the land utilization pattern in Himachal Pradesh using secondary data for the period from 1966-67 to 1986-87. They observed that there had been no uniform trend in the changes in the land use classes. The area under forest showed an increasing trend while that on other categories had shown a declining trend. They have projected the land use pattern for the 2000 on the basis of compound growth rate calculated using the collected data. The projection revealed that the area under all categories except current fallows would show an increase. Mishra (1994) studied the changing profile of agriculture in Orissa and reported the change in cropping pattern for the period from 1950-51 to 1990-91. He observed that there was a gradual increase in the proportion of the net area sown at the cost of land under categories such as area not available for cultivation, other uncultivated land excluding fallow and fallow land. Nagabhushan (1994) studied the dynamics of land use in Dharwad district of Karnataka for a period of 21 years from 1970 to 1991. He employed cluster analysis and compound growth rate for the study and the study revealed that the growth rates of area under forests, land put to non-agricultural uses, current fallow, net area sown, total cropped area and area sown more than once were significant and positive. He opined that the improvement in the management practices was the main reason for the increase in area sown more than once. The growth rates of remaining land use categories were significant and negative. Negi (1994) studied the agricultural growth in Himachal Pradesh during the period 1972-73 to 1980-81. The study showed that the net area sown remained almost static during the period, while the area under forests went up from 21 percent to 27 percent during the period. Padmanaban and Chinnadurai (1994) studied the land use pattern in Tamil Nadu for the period 1960-61 to 1988-89. They reported that the total cropped area in Tamil
Nadu has declined from 7.32 mha in to 6.44 mha during the period and the area sown more than once declined from 1.32 mha to 0.90 mha during the same period. Over the years, the total cropped area has been consistently declining, at the same time the area under current fallow, other fallows and lands under non-agricultural use increasing year by year. Mangoli (1997) studied the land use dimensions in Bijapur district for a period of 21 years from 1971-72 to 1992-93. The study revealed that there was no change in the forest cover in almost all the taluks of Bijapur district. The growth rate for area sown more than once and land put to non-agricultural uses were positive and significant in almost all the taluks studied. The growth rates of area under crops like jowar, bajra and maize were positive and significant. Rajesth and Ramasamy (1998) studied the trends in underutilization of land in Tamil Nadu and identified the determinants for the same. The results indicated that there is a greater scope for further extension of area of land under cultivation, as the existence of vast area of land under current fallow, other fallow and cultivable wastes which can be brought under cultivation in Tamil Nadu. Prashantkumar (2003) studied the land use pattern in three dry zones of northern Karnataka and the results showed that there was a decline in the area under non-agricultural uses, cultivable waste, current fallow and other fallow land in the case of zone-I and in the area under nonagricultural uses, cultivable waste and net area sown in zon-II. There was a positive growth in barren and uncultivable land, current fallow and other fallow lands in zone-III. The share of area under cereals increased in the case of zone-II and zone-III. Goswami and Challa (2004) studied the land use pattern of India for the period 1950-51 to 1997-98. The results indicated that forest area had increased from 40.08 million ha in 1950-51 to 68.65 million hectare in 1997-98. There was significant increase in area under non-agricultural uses from 9.36 million hectare in 1950-51 to 12.3 million ha in 1997-98. It also revealed that the net area sown increased during the period 1951-1971. However, after 1971 the area is found to have remained same till 1997-98. Sreeja (2004) studied the change in land use pattern in Kollam district of Kerala. The results indicated that there was a substantial growth in the current fallow, which reflects the consequence of year to year rainfall variations showing inverse relationship between rainfall and current fallow. Barren and uncultivated land, permanent pastures, land under miscellaneous tree crops and groves and cultivable waste recorded a significant negative growth. D.H.Pawar & V. S. Pawar-Patil et al. (2013) in their studies on Impact of Irrigation Project on Agriculture Land Holding observed that the Dams are the
vital source to cater basic needs of water in the region. Dams are therefore, remain sole source of water. The present paper attempt to reveal the comparative assessment of the impact of irrigation development that has taken place after the construction of dam on river Tulshi Dam of Kolhapur-Maharashtra -on land holding. Investigation is based on intensive fieldwork of three sample villages in which the significant aspects like distribution of agriculture land, cultivated land, irrigated land and waste land are methodically analyzed. The analytical figures prevail that there is significant increment in irrigated and cultivated land in lieu of waste land.

2.4 Impact of irrigation on cropping pattern and crop productivity

The influence of physical environment on distribution of crops has been brought out by Ramakrishnan (1930) in Coimbatore district, Rajamanikkam (1933) in Tiruchinapalli district, Ayyer (1937) in Coimbatore district and Rajagopal (1942) in Tanjahor district. Gupta (1963) measured the change in cropping patterns in all states by taking the average percentage over the previous year. The study stressed the importance of irrigation and fertilizer, which induced desirable changes in cropping patterns. The study covered a period of ten years from 1949-50 to 1958-59. The analysis indicated that the relative importance of the area devoted to the cereals has declined, whereas that of cash crops had increased. Vasantha Devi (1964) has accounted for the physical factors influencing the crop distribution and crop association in South India. Analytical studies have also been attempted on factors affecting agricultural land use, its related aspects and cropping pattern. Bhatia (1965) has analyzed the pattern of crop concentration diversification in India, Sharma (1965) has attempted quantitative delimitation or agricultural regions in India. Savale (1966) has analyzed the role of irrigation and cropping pattern in agricultural development. Ayyar (1968) has given a statistical approach to the study of crop combination regions, suggesting the maximum distance method to group important crops into an association. Tripathy and Agarwal (1968) and Garg (1968) have applied weaver and Doh method to the study of crop combination, ranking and the changing pattern. Mandal (1969) has elaborated weaver’s method in analyzing crop regions with special reference to North Bihar. Indian council of agricultural research (1969) has brought out the papers presented at the seminar on various aspects of cropping patterns in India and the various states including Karnataka and Tamilnadu. The report of the irrigation commission (1972) also gives the distribution of crops in
Tamilnadu, Karnataka and Kerala and also in the Cauvery basin. University of agricultural sciences (1973) has suggested a cropping pattern in different rainfall patterns and agro-climatic regions of the Mysore state (Karnataka). Government of Tamilnadu (1974) has brought out district-wise statistics and description on various aspects of agriculture including irrigation. Descriptive studies on the distribution of individual crops have been attempted in the earlier geographical studies. Sharma and continho (1974) have analyzed the change in area, production and productivity of jowar in Karnataka. Singh (1974) has made a comprehensive study of the factors affecting Indian agriculture including irrigation, cropping pattern and other aspects of agriculture in India. Biradar (1975) noted that major portion of the area under Ghataprabha irrigation project received irrigation water for four months either in kharif or in rabi season. In a smaller portion of the area water was available for 8-12 months. Based on factors like soil characteristics, climatic conditions, water requirement of crops etc. the crops suggested for the area were hybrid Jowar, hybrid Maize, Chilli and Wheat on clay soils. Sugarcane, Cotton and Wheat were suggested for the command area as such.

The National commission of agriculture (1976) has brought out a report on a comprehensive study of the rainfall and cropping patterns of the country and individual states using the taluk as a unit of area and divided the whole country and individual states into suitable agro-climatic regions it also suggested a cropping pattern for the future. Water resources development organization (PWD), Government of Karnataka suggested a cropping pattern for futures for the entire Cauvery basin area, taking into the consideration of availability of moisture that is rainfall and irrigation. Kuriyan and james (1977) have analyzed the changes in the cropping pattern in Tamilnadu from 1960-61 to 1970-71 using taluk as a unit of study.

There are some studies on the impact of irrigation on crop patterns. Nadkarnietal (1980) have studied various aspects of irrigation in Karnataka and its impact. Pingle (1980) examined the growth rates of area, production and productivity of selected crops of Andhra Pradesh. The study covered the period 1955-56 to 1976-77 and was divided into two sub-periods, namely, pre-green revolution (1955-56 to 1965-66) and green revolution period (1966-67 to 1976-77). During the pre-green revolution period the results indicated a shift of area towards rice from other crops.
The growth rate of area for rice was positive while they were negative for sorghum and bajra. It was observed that the shift in area towards rice was further intensified during the green revolution period. Regarding the growth rates of yield, all crops except rice, registered a negative growth rate before the green revolution. Rao (1981) has pointed out how the provision of irrigation facilities under command areas of Malaprabha and Ghataprabha projects resulted in the change of cropping pattern and increase in area under double cropping. Rao and Kalavary (1983) have analyzed the changes in the cropping pattern of Madurai district with the availability of water supply. Subramanyam and Vidyanath (1983) have studied the cropping pattern in Andhra Pradesh in relation to moisture adequacy. Jayamani (1984) has grouped various taluk of Tamilnadu into 4 regions of agricultural specialization based on cropping pattern. Ranga Rao and Ray (1985) used the exponential function of the form $y = ab^t$ to estimate the compound growth rates of pulses during the period 1967-68 to 1983-84. In Karnataka, pulse production had grown by 3.00 per cent per annum. While productivity had grown by 1.20 per cent, the compound growth rate of area was 1.95%. During the same period, the growth rates for area, production and productivity for the whole of India were 0.37, 0.17 and -0.24 per cent, respectively. Low and unstable yields rather than prices was found to be the main reason for stagnant growth rates. Acharya and Lodha (1986) studied the cropping pattern of head; mid and tail reach groups of farmers of Guda irrigation project of Rajasthan State. A decreasing trend was found in the proportion of area under maize, wheat and sugarcane when moved from head to mid and tail-end farmers. A reverse trend was observed in the case of proportion of area under pulses like blackgram, greengram and pea. Rajakishor (1986) studied the use of water and its impact on cropping pattern at different locations of a canal irrigation system in Bamnal minor canal in Orissa. The study revealed that due to the availability of adequate water at the head reach and the mid reach, the farmers had devoted a considerable proportion of area to labour and capital intensive crops like high yielding rice and potato. In contrast, because of inadequacy and uncertainty of water at the tail reach, the farmers had cultivated low duty crops like pulses and groundnut on a larger scale than their counterparts in the other two locations of the canal. Patil (1987) analyzed the cropping patterns under different sources of irrigation in Mudhol taluk of Karnataka state. It was found out that kharif was main cropping season for the canal irrigated farms in which maize occupied 46.05 per cent of the total cropped area and sorghum and wheat were grown
during rabi season to a smaller extent. On well irrigated farms rabi was the main cropping season with wheat and chickpea accounting for 59.05 and 15.85 per cent of the total cropped area, respectively. On canal plus well irrigation farms sugarcane, banana and cotton occupied 47.5 per cent of the total cropped area. Sirohi and Pal (1988) analyzed the growth and instability of the production of commercial crops in India by taking two time periods viz., 1950-51 to 1964-65 and 1967-68 to 1983-84. The study indicated that substantial decline in the rate of growth of area caused the deceleration in the production of cotton, groundnut and sugarcane. The compound annual growth rates of production of cotton (2.47%), groundnut (4.01%) and sugarcane (3.27%) during the first period declined to 0.06, 0.12 and 1.81 per cent, respectively during the latter period. The study concluded that the growth and instability in the production of these crops were complementary rather than competitive processes in intensively irrigated regions. Benakatti (1989) studied the growth and instability in foodgrain production in Karnataka for the period 1955-56 to 1984-85. The study revealed that crops which had shown lower increase in productivity like rice, ragi and pulses showed higher increases in area. Sorghum which had shown high growth in productivity lost area to other crops while bajra did not experience any change. The exception was wheat which despite showing very high increase in productivity had also gained in area. The increase in area under rice was mostly attributable to the increase in area irrigated. Kaligoud (1989) studied the cropping pattern in Ghataprabha command area and observed the cropping patterns on the lands with conjunctive use of water. All size groups of farms were practically identical with the highest proportion of area under annual and perennial crops and rabi crop was dominant on the lands without conjunctive use of water. The study also showed that there was an inverse relationship between the farm size and cropping intensity. Oppen et al. (1989) analyzed the impact of Tawa irrigation project on cropping pattern and agricultural production in Hosangabad district of Madhya Pradesh. It was reported that the Tawa irrigation project had affected cropping patterns and increased cropping intensity in the project area. The area under wheat increased by 25.00 per cent, chickpea by 48.00 per cent, pigeonpea by 10.00 per cent, and area under sesamum and linseed decreased by 45.00 per cent and 33.00 per cent in that order during 1977-78 and 1986-87. Krishna et al. (1991) studied the growth and instability of agriculture in Kerala and observed a shift in the cropping pattern, the cropping pattern shifted in favour of plantation and commercial crops. They
concluded that though this shift in cropping pattern is a welcome shift in terms of the theories of economic development, it is at the cost of making the state deficient in rice, the staple crop of the state. The shift in the cropping pattern can also be attributed to the exorbitant wage levels. DES (1992) analyzed the trends in area, yield and production of principal crops of Karnataka state during 1960-90. The study indicated that area under cereals had increased by 6.00 per cent during 1989-90 over 1980-81 while area under bajra and wheat crops decreased during the given period. Among the major cereals growing districts only Belgaum, Bijapur and Raichur registered positive growth rates of yield whereas Dharwad, Bellary, chitradurga, Gulbargha and Mysore districts experienced negative growth rate of yield. Krishnakumar and Swaminathan (1992) examined the changes in cropping pattern, crop combination, crop area and diversification of crop enterprises in Tamil Nadu. The results revealed that the changes were mainly due to change in agricultural inputs-high yielding varieties, fertilizers, pesticides, irrigation intensity and tractor use. The analysis indicated that in the western and north western regions modernization was low because of low rainfall, poor soils and poor irrigation facilities. Rao (1992) studied the effects of canal irrigation on the level of use of modern inputs and its contribution to productivity growth in Nalgonda district of Andhra Pradesh. The effects of canal irrigation were studied through the changes in output level and output over time 1960-83. From the comparison of productivity and output series between command area and non-command area over time, it could be inferred that irrigation led to productive absorption of technologies. Canal irrigation contributed to the growth of factor productivity (by 25.0%) and agricultural output significantly. Sisodia (1992) evaluated the performance of “warabandi” (fixation of turns) system of irrigation management in Chambal command area of Madhya Pradesh. As a result of the introduction of warabandi programme, irrigation ratio has increased from 40.19 per cent in 1981-1982 (before warabandi) to 87.39 per cent in 1986-87. A steady increase in the irrigated area was observed during the implementation period of six years. The judicious use of water by the cultivators has thus resulted in the coastal delta of Cuttack, Puri and Balasore for every 100 hectares that were under irrigation, eight hectares have gone out of cultivation due to water logging. The resource use in the problem area is seriously affected. The policy measures suggested to tackle the problem include conjunctive use of water I command area, drainage and supply of rotational irrigation water, changing the
cropping pattern and introduction of more light duty crops. Singh and Mohammed (1992) studied the dynamics of cropping pattern in northern India. The study reveals that the total cropped area and area under cereals and vegetables had increased while it has decreased in the case of millets and cash crops. As far as the special organization of land use is concerned and despite the subsistence economy prevalent in the area, the predictions of van-thunen’s theory would appear to be supported by the facts. Srivastava and Gupta (1992) studied the equity in benefits from irrigation in Gondak command area of North Bihar between different size groups in the upper and lower reaches. Irrigation ration had increased with farm size with some exception. Most of the farmers under each size-group complained about inequitable distribution of water due to non-existence of operational water user’s co-operatives, lack of proper and timely regulation of water and poor repair and maintenance of irrigation channels from the outlets which aggravated over a period of time. Koppad (1993) studied the economics of cropping systems in Malaprabha command area (Karnataka state) by collecting data for the agriculture year 1991-92. The results of the study revealed that cotton as a sole crop and maize-wheat system were the most important cropping systems followed by maximum number of farmers in all the three locations (head, mid and tail reaches) of the command area and also by small and large farmers. It was found that larger proportion of the farmers, 87.0 to 95.0 per cent, had grown cotton as a sole crop in all the three locations. The introduction of canal water had given a stimulus to the production of cotton and maize-wheat system had been witnessed in the later years as a second important cropping system. The study also noted that cropping intensity in the head reach was less than the cropping intensities in the mid and tail reaches as the higher proportion of the area was occupied by cotton and rabi sorghum and rabi wheat grown as a single crop in the head reach.

Kaushik (1993) analyzed the growth and instability of production of oilseeds and other crops in India for the period 1968-69 to 1991-92. The study revealed that during period I (1968-69 to 1979-80) the growth rate of productivity in the case of groundnut was 1.65 per cent per annum, whereas the growth rate in area was 0.009 per cent. In period II (1980-81 to 1991-92), the area under groundnut registered a growth rate of 3.85 per cent per annum. Pulses which registered a negative rate of growth of production and productivity in period I have shown considerable improvement in period II. The study noted that the increase in production of oilseeds owes much on the favorable prices, the introduction of minimum support prices and the market
intervention scheme. Nachappa (1993) studied the growth and instability in cereal production in Karnataka for the period 1970-90. The results of the study show that the area under cereals which had decreased at a rate of 0.30 per cent per annum during the seventies, increased at the rate of 0.20 per cent per annum in the eighties. During the same period, the growth rates for area under bajra, ragi and maize decreased. The productivity of cereals for the state as a whole declined from 3.00 per cent during the seventies to 0.29 per cent per annum during the eighties mainly due to the negative growth rates in rice and sorghum yields. Nagaraj (1993) studied the cropping systems in Tungabhadra command area in Karnataka state. The findings of the study indicated that cotton as a sole crop followed by rice as a sole crop was the most important cropping systems. Highest per hectares profitability of cotton motivated farmers to grow cotton. Maximum number of farmers grew rice in head reach and this decreased as one moved from head to middle and middle to tail reaches of the canal command, as the quantity of irrigation water decreased in the same order. The study also showed that as many as 17.5 per cent of the tail reach farmers kept their fields fallow during rabi season because of unassured water supply the tail reach. Deviations were also found from the recommended cropping system. Behura and Naik (1994) studied the change in the cropping pattern for the period from 1966-67 to 1990-91 in Orissa. The results revealed that the area under rice, which is the most important crop of the district, declined. They observed that the reduction in area under rice was mainly due to substitution of paddy-by other crops. Vivekananda and Satyapriya(1994) in their attempt to study the karnataka’s changing cropping pattern reported that the share of area under all cereal crops declined from 55 per cent to 47 per cent between 1956-1957 and 1989-90; the decline is much sharper during the eighties. The decline is under jowar, bajra and wheat with an increase in the share of area under rice and ragi among the cereal crops, Maize, a new entrant in the cropping pattern of the state, however, registered an increase in its hare from a mere 0.10 per cent to 2.10 per cent. The increase has been quite considerable in the case of oil seeds (12.23 per cent to 19.77 per cent) and sugarcane ( 0.52 per cent to 2.16 per cent).Gajja et al. (1994) analyzed the productivity variation and land irrigability class in kakrapar canal command area in Gujarat State. The results showed that the farmers in the command area allocated large acreage to high water requirement crops like sugarcane and rice as compared to low water requirement crops like sorghum, bajra, cotton and wheat because they had high profitability and low yield uncertainty than
the latter ones.. Phuke et al. (1994) studied the investment pattern on Marathwada farms in prabhani district of Maharashtra. The average intensity of cropping was found to be 164.19 per cent in command area irrigated and the double cropped and gross cropped area was higher on the same than outside the command area. The overall picture of the command area cropping pattern indicated that nearly 40.0 per cent of the total cropped area was under kharif crops, 25.0 per cent under rabi crops, 21.0 per cent under perennial crops and the remaining 14.0 per cent area was under summer crops. Damayanthi (1995) studied the cropping pattern changes in pookod village in Trichur district of Kerala and reported that most of the households surveyed had either sold their paddy fields or the fields were lying idle for years together. In many cases, the paddy fields were converted to or were under conversion to garden lands. Some of them undertook cultivation only once in a year instead of twice a year as they used to be in the past because of high cost of cultivation. The tendency of paddy land conversion along with increased demand for house sites were attributed as the causative factors for the declining availability of land for agricultural purposes and thus reducing the share of agriculture in providing employment of rural population. Parmer et al. (1995) examined the degree of change in cropping pattern in the four districts of south Gujarat during the period 1960-61 to 1989-90. The total span was divided into three sub periods viz. 1960-61 to 1989-90. The total span was divided into three sub periods viz, 1960-61 to 1969-70, 1970-71 to 1979-80 and 1980-81 to 1989-90. The changes in cropping pattern were measured by rank correlation coefficient. Fluctuations in cropping pattern was found severe in Bharuch district, moderate in Surat and Valsad and least in Danya, in the Bharuch district the acreage under tur increased tremendously while that of other crops decreased. Arora and Srivastava (1996) examined the nature and pace of diversification of cropping pattern and food grain mix in India during the period from 1950-51 to 1994-95. It is revealed from the findings that though food grains have preponderance in gross cropped area as compared to non-food grains, their relative share has been consistently declining since the early 1960s. The share of rice in gross cropped area has been showing a declining trend during the 1990s whereas the share of wheat was consistently rising at the cost of coarse cereals and pulses. The cereal based cropping system, extensively adopted and extended even on marginal land, has endangered the soil health and water resource availability in the country. Maheshwari (1996) analyzed the growth pattern in agriculture of Karnataka state by dividing the period into three,
pre-green revolution from 1955-56 to 1966-67 (period I), the early green revolution from 1967-68 to 1974-80 (period-II) and later phase of the green revolution from 1980-81 to 1989-90 (period – III). The crops selected were rice sorghum, ragi, tur and groundnut. It was observed that there was growth in period—I, which continued in period-II. In period-I the gross irrigated area rose by 3.1 per cent per annum, while in period-II. It increased at the rate of 1.7 per cent per annum. Thus, in period-I irrigation was responsible for growth, while in period-II it was due to the high yielding variety seeds and chemical fertilizers. Patil (1996) studied the cropping patterns in Karnataka during the post-green revolution period confined to the years from 1970-71 to 1993—94. The analysis revealed that the cropping pattern changes have been very significant as compared to the country as a whole. The growth rate of productivity of food grains in the second period (1983-84 to 1993-94) has increased marginally. The major foodgrains Viz., sorghum, ragi, bajra and chickpea have shown. Radhakrishna (1996) in the analysis of food trends and food security concerns of India found that annual growth rate of area of larger coverage of the irrigated area. Farmers in the head and middle reaches have shown stronger inclination to grow double crop than the tail-enders. The study further indicated that after the introduction of warabandi the cropping pattern has tilted towards non-food grains which were remunerative to the farmers. Gauraha (1996) in his study of the impact of irrigation on cropping pattern at two points of time viz., 1985-86 and 1995-96 in Raipur district of Madhya Pradesh revealed that the cropped area in the kharif season on the whole has declined, while the area under rabi and summer crops has increased as a result of the development of some assured irrigation and higher yield and income from rabi and summer crops. There has been a shift from low income crops to high income crops. Atibudhi (1997) investigated the effects of major irrigation projects in creating water logging problems in coastal districts of Orissa. Dhindsaa and Sharma (1997) studied the impact of irrigation in Punjab for the period 1966-67 to 1991-92. The increase in gross irrigated area in various regions of the State has resulted in a heavy fall in the area under chickpea and other pulses. The adverse impact of irrigation in the case of chickpea has been felt in the state with short-run acreage irrigation elasticities. They opined that irrigation has a backlash effect affecting the cultivation of pulse crops in the state. Kushwaha et al. (1997) examined the impact of prudent canal water use on land utilization pattern and productivity in Ghazipur district of Uttar Pradesh at three points of time, i.e. 1984-85, 1990-91 and 1995-96. With the use of canal water, the
water table has gone up. During 1984-85 there was no waterlogged area but after use of canal water during 1990-91 the waterlogged area reached 1.81 hectares. But prudent use of canal water later has increased the production and productivity of field crops to a considerable extent. Better remedial measures such as improved water management, better drainage facilities and adequate and regular supply of water would go a long way in raising the productivity of crops in the study area. Singh et al. (1997) studied the cropping pattern during pre (1959-60 to 1968-69) and post (1969-70 to 1990-91) green revolution period in the three agro-climatic zones of the plateau region of Bihar. Rice was the most important crop of all the zones contributing to more than 70 per cent of the total cropped area and its share remained unchanged in the all the zones of the region. There had been a marginal change in the share of maize in total cropped area in pre-green revolution period whereas wheat and maize showed marked changes during the post-green revolution period. Kumar and Singh (1998) made an attempt to analyze the cropping pattern in north Bihar during post-green revolution period (1970-71 to 1993-94). The study revealed that the cropping pattern of north Bihar is still predominated by cereal crops. Among the cereals, wheat has emerged as major cereal crop. They concluded that the predominance of cereal crops in the cropping pattern was attributed to the food grain scarcity in the project area and bio-chemical and genetic innovations in principal cereal crops during post green revolution period. Prasher and Bahl (1998) studied the growth and instability in Himachal Pradesh agriculture by employing time series date from 1980-81 to 1989-90. The study indicated that the annual growth rate in area under maize was significant in the state. Ranjan and Singh (1998) studied the cropping pattern in North Bihar during post-green revolution period. According to the findings there was no marked increase in rice area but wheat area showed an increasing trend, and oilseeds also gained in area. The coefficient of concordance test revealed that there was a significant change in cropping pattern in the project area over three specified points of time of 1974-1984 and 1994. Shiyan and pandya (1998) analyzed the levels of crop diversification in different agro-climatic zones of Gujarat for the period from 1960-61 to 1995-96. It was found that there existed wide spatio temporal disparity in the acreage allocation for different crops. In general, the farmers have shifted their cropping pattern from the subsistence crops to the commercial crops. Subhashini (2001) assessed the shift in cropping pattern in Tamil Nadu state and south arcot district with special reference to oilseed crops. An analysis of three year average of
area under major crops in four categories viz., (1) paddy, (2) oilseeds, (3) other food crops arid (4) non-food crops before and after removing open general license were carried out. The results indicated that in Tamil Nadu except paddy, the other three categories experienced a reduction in area. Hazra (2001) studied the changes in cropping pattern at the all India level by considering the area share of crops and crop groups at four time points, capturing, respectively the Triennium ending average of areas at 1966-67, 1976-77, 1986-87 and 1996-97. The study revealed that there was a shift from traditionally grown less remunerative crops to more remunerative crops. This crop shift took place due to government policies and thrust on some crops in a given time. Market infrastructure development and certain other price related support also induced the changes in cropping pattern. Virenderkumar et al. (2002) in their work to examine the changing cropping pattern in Himachal Pradesh reported that total cropped area increased by about 21 thousand hectares from 16.69 per cent to 17.06 per cent of the total geographical area during the period 1972-96. The area under wheat, as per cent of total cropped area, increased from 34.27 per cent to 37.66 per cent that of maize went up from 28.11 per cent to 32.58 per cent. The magnitude of decline in percentage share in area in ragi and other millets was much higher than that of barley. Goswani et al. (2003) in their attempt to study the changes of cropping pattern in Mizoram stated that during the period under study maximum growth rate in area achieved in pulses (13.82 per cent) followed by tapioca (9.46 per cent), oil seed (7.06 per cent) and maize (3.25 per cent). Area under sugarcane and cotton was showing a significant negative growth rate of 2.56 per cent. Goswami and Challa (2004) studied the changes in cropping pattern for the period 1951 to 1998. The results showed that there was gradual shift in area from food crops to non-food crops indicating more diversification in recent times. The proportion of area under total cereals to total cropped area reduced from 61.1 per cent in 1950-51 to 53.08 per cent in 1997-98. Reverse scenario was noticed in case of total oil seeds where there was almost three fold increase in area during the period under study.

2.5 Impact of irrigation on agriculture: The regional accounts if irrigation with one or all modes and its effects have been studied by different scholars such as Ayyar (1931) Gadgil’s (1948) work in “Economic effects of irrigation- a report of the survey of the direct and indirect benefits of Godavari and pravara canals throws light on many dire ct and indirect benefits of irrigation in dry areas. It concludes that
provision of the irrigation facility to the people of Godavari and pravara canal commend area has enabled them to have a superior cropping pattern, higher per acre productivity and higher gross farm income. Gadgil(1948), in an outstanding research of his, evaluates economic effects of irrigation with reference to the Godavari and the Pravara canals. His study throws light on many direct and indirect benefits of irrigation. Further he presents the beneficial impact of irrigation in dry areas.

The planning Commission of the Government of India In 1958 constituted a group under the chairmanship of D.R. Gadgil to study and to measure the and to the extent possible the indirect benefits arising from the selected schemes like the sarola canal (Uttar Pradesh), Tribenei Canal (Bihar), Damodar canal (west Bengal), Cauvery Mettur Project (Tamil Nadu), Nijamsagar Project (Andhra Pradesh) and Ganga canal (Rajasthan). Studies so commissioned were the ex-post assessment of benefits of irrigation provided by different projects with the help of the primary data. The studies have concluded that irrigation leads to the intensive use of land, to shifts from food to commercial crops, increase in cropping intensity, promotion of the use of modern and traditional inputs and increase in gross production and income.

Just after the inception of Indian planning, Epstein (1961) conducted a study during 1954-55 in Mandya district of Karnataka. She made a comparative study of a wet and a dry village and concluded that irrigation has considerably raised the productivity of the land, growth of commercial crops, prices of land. Singh and Singh (1962) have examined the effects of bhakra dam on the socio-economic aspects of the neighboring areas, by selecting 8 already irrigated villages, 15 villages irrigated through the dam and 7 dry villages. The study has concluded that the pattern and cropping intensity have changed in the villages under the dam with higher stable production conditions and with greater returns. As a consequence, the standard of living of the farmers has gone up. The study made by Basu and Mukerjee(1963) and ARDC(1980) analyzed the income aspect of canals and tube well respectively. The latter pointed out that the net income for the project areas formed Rs.1, 056 in Bhojpur district, Bihar which was higher than non-project are. However, these studies have not dealt with aspects such as impact of irrigation on cropping intensity, employment, generation, wages, livestock income etc. Randhwa (1964) has described various aspects of agriculture in Tamilnadu, Karnataka and Kerala. The direct and indirect impacts of irrigation have been analyzed by Jha (1967) taking the tribeni
canal in Chaparam district of Bihar. It is a comparison between the project area and a control area. The study has concluded that irrigation has definitely brought prosperity to the cultivators of the project area, as compared with the cultivators of the control area. Mukherjee, Singh, and Mukherjee.1967 in their historical analysis of the changes in agricultural landscape in Varanasi district during 1911-1963 suggests that one of the main factors for change is the spread of modern irrigational facilities, especially, canals and tube wells, since independence. The study has shown a sharp fall in the area of dry crops and an increase in paddy and double cropping. It is further suggested that the early paddy is more important in the tube well irrigated areas while late paddy is important in the canal-irrigated areas. Bjaradwaj (1974) studied the farm management date from different states and studies the effect of irrigation. She uses the log-linear relationship through OLS technique and concludes that, general tendency for intensity of cropping to increase with the percentage area irrigated, irrigation influencing the relation between inputs and output to an acre and the size of the holding but not very systematic relation between percentage area irrigated and earners per acre. She compares the results from irrigated and unirrigated holdings in Punjab and partially irrigated and dry holdings in Bombay. Rao(1974) in a paper titled 'New challenges before Indian Agriculture’ shows that the double cropped area under irrigation has grown faster than under rainfed conditions because irrigation accompanied by water control and scientific water management practices. Gadgil (1978), in an outstanding research of his, evaluates economic effects of irrigation with reference to the Godavari and the Pravara canals. The study concludes that the provision of irrigation facility to the people of the Godavari and Pravara canal command area has enabled them to have a superior cropping pattern, higher productivity and gross farm income. The indirect benefits have also accrued to the people in the processing and transporting of enhanced agricultural production in the command area. The study of Rao and Thamarajakshi (1978) on some aspects of growth of Indian agriculture suggests that irrigation is a crucial variable in the growth process considering its positive impact on crop yield and cropping intensity. They have computed that the relative difference between irrigated and unirrigated field in India works out to 50 to 100 per cent in the case of rice, wheat and other cereals while zero order correlation of gross irrigated area with the net sown area under all crops and area sown more than once is estimated at around 0.90. A study on the impact of canal irrigation in Bellary district, based on a survey of the Thungabhadra command
area Mishra and Vivekananda, (1979), has observed that the pattern of crop cultivation has undergone some basic changes after canal irrigation in the villages. Further, canal irrigation has induced the use of modern inputs and practices in farming and positively affected the employment of labour to a given unit of area. The study has conclusively proved that the productivity and the net income to an acre are higher in irrigated areas than in the dry areas while the cost of farming has also gone up correspondingly in these areas. Fujiwara (1982), studying the development of irrigation under the Thungabhadra project, observes that the land on either side of the river, covered for most part with thorny bushes, has transformed itself into very fertile land and concludes that the command area which was once backward both economically and socially has now become the granary rich in foodgrains. A more recent study on Indira Gandhi canal system of Rajasthan is by Gurjar (1987) who considers irrigation as a vital infrastructure for modernization of agriculture. It is obvious from his study that there are many visible impacts of Indira Gandhi canal on the agricultural system of Rajasthan, more especially the arid parts of the state. He correlates irrigation positively with various agricultural aspects in this region and reveals through his findings that there is significant contribution from irrigation to agricultural modernization, productivity, crop land use patterns and agricultural products. Pandey’s (1979) work is about a typical situation in a command area of Bihar whose economy is agricultural. He is of opinion that irrigation is a key input to agricultural development. Controversy however arises over its role across regions. A study by Alexander (1982) is in a comparative framework of both the irrigated and non-irrigated parts of Ganga Nagar district in Rajasthan. This study has concluded that irrigation has facilitated intensification of agricultural activity through increased use of labour, fertilizers, insecticides and other inputs and enabled farmers to use improved tools and machines. Besides, irrigation has also paved the way for modernization of occupational values and specialization. Dhawan (1984) concludes that a programme of extensive irrigation in areas which experience low or medium rainfall would greatly assist in the goals of maximizing agricultural growth, achieving stability in output and ensuring an equitable sharing of the gains of growth. Palanisami (1984), in a study of irrigation water management, details the system-dependent and farmer—dependent determinants of canal water distribution in India. He has taken the lower Bhavani project in Tamil Nadu as a case in point. The effect of water availability on input use and crop yield is presented by using a three-stage
simultaneous equation system. Farmers cropping pattern and agricultural benefits are discussed with respect to farm location (distance), farm size and soil type. Raghukumar (1984) has attempted a study on various aspects of development of agriculture in Mysore district. A different but impact study is that of Satpathy (1984) has made a critical and in-depth review of important issues such as impact of irrigation on farm economy, lacunae in irrigation planning and policy both at the micro and macro levels and pricing policy for the sale of public irrigation water. In terms of policy variables, the study pleads strongly for minor irrigation, improvement of irrigation systems both at the project and field levels, reduction of inter-district disparity in the distribution of irrigation benefits and rationalization of water rate structure. Pal (1985), through a case study of some states of the Indian union, confirms the contribution of irrigation in this regard. His important contribution is the conceptual framework for measuring the contribution of irrigation Of the several studies on socio-economic transformation, Rao and Govindaraju (1986) similar to the of study Rao and Simhadri (1989) of the several studies on socio-economic transformation), the study of Rao and simhadri (1989) on Sriram Nagar irrigation project since 1971 has been a deep analysis of vibrant changes observed in the land use, cropping pattern, demography, agricultural systems, patterns of distribution of settlements and levels of development. A significant contribution is in the method of collection of data on the various facts during the time periods. Pawar (1989), describes the spation-temporal development of irrigation in relation to socio-physical environment that has shaped the agrarian economy of the region of the Upper Krishna Basin, Maharashtra. He also examines the impact of irrigation on the use of mechanical and biochemical inputs, land use in general and cropping pattern in particular. Varghese, Solanki and Singh, (1989), has substantially proved how water can bring prosperity and development to the dry regions. Socio-economic changes brought about by the canal systems in Ganga Nagar hold no comparison. Verma (1990), examines the effects of irrigation on agricultural structures and productivity. The study uses regression analysis and reaches the conclusion that there is positive association between the level of irrigation and the variables of agricultural structure and productivity in different regions. Sharma (1990) attempted to study interstate disparities in growth of agriculturein India from 1966-67 to 1987-88. It was observed that four states viz, punjab, Haryana, Uttar Pradesh and Maharashtra experienced growth rate in food grains lower than the national average. He suggested that
interstate disparities in growth performance of agriculture in India can be minimized by bringing the farmer in the ambit of efficient extension education and training activities, sound government policies and efficient supply network of various inputs. Singh et al. (1993) attempted a district-wise analysis to identify the factors effecting area and production of gram in Bihar. Annual rainfall was found to have a significant effect on reproduction only in two districts. The regression co-efficient for irrigated area was negative in most districts implying that as area under irrigation increased, gram was pushed to more and more marginal lands and substituted by superior crops. Shivakumar (1994) reported that in Karnataka, there was statewide shift from food based agriculture to horticulture, sericulture, dry land crops forestry and the like. Thampan(1994). The trend analysis of different crops over sixth and seventh-five year plan periods covering the eighties revealed that growth in production during the VII plan period was much less for all the cereals and pulses compared to that during the VI plan period. In the case of rice, the annual growth rate of production declined from 7.8 to 5.4 percent between the plan periods and for wheat the decline was more glaring, from 6.9 to 2.8 per cent. The reasons attributed for the deceleration of output growth were indiscriminate use of chemical inputs and neglect of soil health. Sawant and Achuthan (1995) analyzed the India’s agricultural growth across crops and regions for the 1967-68 to 1992-93. They found that the food grains output in the 1980s expanded at the low rate of 1.32 per cent in Andhra Pradesh and remained stagnant with non-significant growth in Karnataka. Shift in area from food grains to non-food grains was pronounced and the performance of non-food grains production was better in 1980’s which was mainly attributed by area expansion. In Karnataka the yield per hectare of cotton increased at the rate of 9.63 per cent during 1980s. While groundnut output growth was non-significant. Jayakumar and Velayudhan (2002) studied the agricultural stagnation in Kerala and reported that agriculture, though stagnant for the last many years, is still a major sector of Kerala economy. They observed that the area and production of food crops have been declining over the years, while the area of cultivation; production and productivity of cash crops have increased. They concluded that the prevalence of obsolete technology in the state and the relative profitability, which influence the farmer’s decision allocate his land under different crops, resulted in agricultural stagnation. Dr. S. S. Motebennur (2013) made an observation that the problem of low agricultural productivity can be tackled by improving farm facility irrigational facilities. Differences in the provisions of
irrigation facilities account for a substantial amount of variation in agricultural output between regions. If constant supply of water is ensured transformation and expansion of agriculture can take place. Without irrigation very little can be expected from extensive cultivation. Besides, irrigation helps greatly in raising the yield of land. In the foregoing analysis an evaluation of the aspects of irrigation in Dharwad district, has been made in detail in order to understand the role and impact of irrigation in the development of agriculture and its efficiency. Sanjay Patil (2013) this research paper has been undertaken to make comprehensive study of impact of physical features and irrigation on agriculture land use changes and identification of determinants in Pune district by evaluating the objectives. The main objective is to examine physical background and the feasibility of agricultural land use affecting by the irrigation facilities and to suggest best practices and better use of agricultural determinants for better agriculture planning and development. The used many techniques to analyze the data such as Doi’s method for crop combinations, Karl Person’s correlation coefficient method for correlating various variables and for multiple regression analysis for prediction.

2.6 Demography and impact of irrigation on socio-economic life

Much has been said and written about population and problem of its growth at the global, continental, national and sub-national levels. The census of India volumes gives the details of growth, composition and structure of the population of the country as well as the states. Kristian Tukayo (2013) studies made an observation that the Citarum River plays very important role in West Java Tremendous land use change occurred in the past ten years in Citarum watershed. Settlement areas increased more than a double during 2000 to 2009.

The earliest geographical studies on population are those published in the nineteen thirties by the Journal of Madras Geographer,s Association like those of krishnaswami(1930) on Coimbatore, Gopalan (1937) on Human geography of Tanjore district. Srinivasa Raghavan (1937) on Tanjore and Rao (1937) on influence of physical features on the human geography of trichinopoly district and Kuriyan (1938) has studied the various aspects of population of kerala.
Until the nineteen sixties, most of the geographical study on population was concerned with the pattern of distribution and composition, with the exception of the work by Geddes (1941, 1942) on regional population change and variability in India. At the national level there have been India and Pakistan, Geddes and Larmouth (1953) on variability in population change and regional variations there in 1921-40, Memoria (1957) on growth and migration in India. Sengupta’s (1970) study is on population and resource development in India. Spate (1972) gives various aspects of India’s population including its dynamics. State wise accounts of population are available in the census volumes though a great deal of importance is given to the urban aspect. The state gazetteers and district gazetteers also give an account of the distribution of population. Ananthapadmanabhan (1968) has described the distribution of population in Tamilnadu. M.Quadir and Ostar-(2003) - interpret that “Irrigation has long played a key role in feeding the expanding world population and is expected to play a still greater role in the agriculture future. Dhangadhi, kailali (2010) the proposal, being a rehabilitation of existing irrigation system, there would be minimal impact on land use in intake site and along the canal alignment after the construction work. It is likely that the area of land, which is now cultivated will be changed into settlements and some of them developed into market centers with growing economic activities due to increase in agricultural production. Impact on Environment, Impact on Human life, and Population Pressure The predicted environmental and social impacts will be both beneficial and adverse. Some of the negative effects caused by the construction of Rani-Jamara-Kulariya Irrigation Project will affect people in various negative ways. During construction stage, the major beneficial impacts are employment opportunity to local people, Impact on local economy due to increased economic activities, Enhancement in technical skill of local people. Once in operation, the RJK Irrigation Project is likely to result in a crop production and use of agro-chemical pesticides, chemical fertilizers, employment opportunity to local people, Increase in income and living standard from socio-economic benefits derived from increase in agricultural products due to assured year round irrigation facility, impact on agro-based local economy, impact on landless farmers and small landholders, appreciation of land value, enhancement of technical skill and other enhancement works, protection of existing canal and Protection of settlement. Suria Darma Tarigan and Rudolf Ranganadey (2015) studied the relationship between the irrigation system and development of agricultural land use of
Akna mouza, Hugli district a riverine flat alluvial tract of rain fed moribund river Saraswati. He made an observation that irrigation not only forms the habitat of growing crops but also supports human requirements for housing and infrastructural developments, which ultimately influence socio-economic aspects of the society.