INTRODUCTION
CHAPTER - I

INTRODUCTION

Irrigation basically involves artificial application of water for growing crops (Thimmaiah, 1994). According to Carruthers and Clark (1983) "Irrigation may be defined as the application of water by human agency to assist the growth of crops or grass." Water is indispensable to agricultural production. In areas where rainfall is plentiful and well distributed over the year, there is no problem of moisture for growing crops. In certain regions, rainfall may be abundant but it may be concentrated in a short period of the year, and the rest of the year will be dry. As a result, cultivation of crops may not be possible for the whole year. In these regions, provision of irrigation will facilitate growing of at least one crop in the year.

Not long ago, irrigation was referred as "artificial application of water." This historical illusion emphasizes the fact that irrigation is human effort to substitute for any deficiency in natural rainfall with the objective of a steady expansion in crop output (Dhawan, 1988a). The need for irrigation may be identified as follows:

1) Irrigation is essential for removal of adverse effects of drought or famine.
2) To assure timely and adequate irrigation for intensive agriculture.
3) For maximization of production of food, and all other commercial and horticultural crops.
4) It is a basic input influencing the cropping pattern.

An irrigation scheme confers a number of benefits, both direct and indirect (Gadgil, 1948). By direct benefits we mean an increase in the farm production as a result of provision of irrigation facility. The direct benefits of the irrigated area, by and large, calculable in quantitative terms. But it is not easy to do so in case of indirect benefits, as development of trading and industrial activities in the area might
have simultaneously been influenced partially by other economic factors. However, the indirect benefits of irrigation may be identified as follows.

a) It provides more investment opportunities to people.
b) It generates more and more employment and income.
c) It assists growth of output processing and input servicing industries.
d) It gives scope for development of other allied agricultural activities.
e) It improves the standard of living of the people of the region.
f) Lastly, it promotes all-round economic prosperity of the country.

While discussing direct and indirect benefits of irrigation, many researchers also refer to sectoral linkages. Backward linkages through demand for more fertilizers, tractors and other modern agricultural implements, fuel and the like, trigger more investment in secondary sector. Forward linkages in the form of increased production leading to higher marketable surplus and necessitate additional storage and processing facilities, and make additional investments more profitable (Hirschmen, 1959). Mellor (1970) underlines the importance of these linkages for economic growth in developing countries. He visualizes a definite increase in agricultural incomes after irrigation.

Among all the benefits, the greatest benefit of irrigation, however, is the sense of security engendered in the minds of the peasants and stability of agricultural business, which an irrigation system confers on the irrigated area.

Agriculture is the world’s largest water user in terms of volume, and it is also a relatively low value, low efficiency and highly subsidized water user. In the past, investment on irrigation dominated agricultural budgets in the countries throughout the world. Since 1940, 80 per cent of public expenditure in agriculture in Mexico was for irrigation projects, while China, Indonesia and Pakistan spent more than half of their agricultural investments on irrigation. In India irrigation accounted for about 30 per cent of all public investment.
India is mainly an agriculture country. Agriculture forms backbone of the economy, since it is the occupation of about 60 per cent of the people and it contributes about 24 per cent of the national income. India has abundant land and other resources. As regards cultivation and production of food and fiber, it has got natural gifts of land and water. But by cultivating the land and using other resources, the agriculture production in the country is not able to achieve the goal, which is expected from it. This is because agricultural production is a function of innumerable factors such as soil characteristics, weather conditions, seeds, fertilizers, pesticides water etc., (Pant, 1984). Since Indian Agriculture continues to be a gamble of the monsoon, vast area of cultivating land in the country continues to be at the mercy of untimely monsoons. It has been observed that India has a cycle of five years in which one year is good, other one is bad and remaining three are indifferent. The variability of rainfall largely determines the productive efficiency of Indian agriculture.

It is rightly said that nothing moves in the Indian economy unless agriculture moves and it is unless water moves into agriculture. The problem of Indian agriculture is mainly a problem of water supply. Land will not yield good crops unless it is given a plentiful supply of water. This is especially true in India because soil in India is comparatively dry.

Myrdal (1968) in his Asian Drama states that, “The annual rainfall of all India amounts to more than 3,000 million acre-feet of water. Out of this 1,000 million-acre feet are lost immediately due to evaporation and roughly 650 million-acre feet seep into soil, leaving 1350 million-acre feet to flow into the rivers system. One-third of the river flow i.e., about 450 million acre-feet is considered utilizable for irrigation, but in 1950 only 76 million acre feet were utilized.”

The per capita availability of water has also been shrinking with the growth of population in the country. The per capita availability of water which was over 6400 cum. in 1951 has come down to about 1967 cum. at present against the global average 9231 cum. (Planning Commission, 1997). The per capita availability of
water in our country is not very high as compared to other countries and is less than half of that for U.S.A. and Japan.

The temporal and spatial variations in the occurrence of rainfall further result in drought-flood syndrome subjecting about one-third of the country to droughts and about one-eighth part to floods. Both floods and droughts cause extensive damage almost every year and thus affect adversely the national economy and living standard of the people at large. Hence, irrigation development is considered to be indispensable for removal of drought-flood-syndrome in the country.

Irrigation is crucial for the development of agriculture in India (Rath et al., 1989). It is necessary in order to ensure stability in crop production and fuller exploitation of cultivable land in all seasons. It is also necessary in order to derive and sustain benefits from biological improvements in crops, and technological improvements in cropping.

Irrigation appears to be one of the most viable sources of investment as it helps in increasing agricultural output, and at the same time, in generating rural employment by allowing agricultural activities throughout the year. It gives scope for growing the commercial crops instead of food crops. The fear of drought is removed from the minds of the farmers when irrigation facility is made available. An assured source of water supply spells prosperity, creates employment potential, leads to enhanced income and increases capital formation.

Irrigation is a key component of the technical package, which is needed to achieve productivity gains and therefore its contribution to food security in developing countries is widely recognized. For example, 66 per cent of the agricultural output in India is from the irrigated area. It is noted that average farm incomes have increased from 80 to 100 per cent as a result of irrigation, while yields have doubled compared with those achieved under the rainfed conditions. Also incremental labour days used per hectare have increased from 50 to 100 per cent.
Since the inception of the planning in our country, irrigation has been given top priority. Therefore irrigation was one of the major planks of the Five Year Plans. Hence, Public exchequer has invested huge amount for expansion of irrigation. The consideration behind this is that the nation would benefit a lot from expansion of irrigation.

In spite of fast pace of irrigation development, it has not yet been able to provide irrigation to all potentially irrigable land. Out of total geographical area of 329 million hectare, 185 million hectare is cultivable land of which 140 million hectare is net cropped area. And the ultimate irrigation potential with utilizable water is estimated as 139.9 million hectare of which only 90 million hectares has been created so far up to the end 1996-97 (Baijal et al., 2000).

The geographical area of Karnataka is 1,90,498-sq. km. accounting for 5.81 per cent of the total area of a country (Anonymous, 1996). The population of the State is 52.73 million (2001), of which 26.85 million are males and 25.88 million are females. The population density in the state is 275 per sq. km. (Anonymous, 2001). The State is situated in southern part of India. The agriculture has been the main occupation in the state. Two-thirds of the State receives less than 700-mm. annual rainfall, and therefore major portion of the state is always under the threat of drought or famine. In this context, the irrigation has become most important input to the agricultural development of the State. Therefore, the Government of Karnataka has been taking the development of irrigation projects in the state on a large scale. The investment, which was just Rs.4142 million in First Five Year Plan (1951-56), has increased to 85.16 billion at the end of March 1998. Correspondingly, the irrigation potential created, has also expanded from meager 0.78 million hectares at the end of First Five Year Plan to 3.49 million hectares. Comprising 1.66 million hectares under major and medium irrigation, 0.93 million hectares under minor irrigation (surface) and 0.90 million hectares under minor irrigation (ground water) at the end of March 1998. The ultimate irrigation potential of the State (all sources) has been estimated 5.5 million hectares (Anonymous, 1996).
The region of Bagalkot district in the State of Karnataka, experiences famine or drought as frequent as, being experienced by the rest of the country (It is one in every three years). The history of the scarcities and famines in Bagalkot district (formerly part of Bijapur district) date backs to 14th century AD (Meti, 1966). It is also true that the district witnessed many famines lasting for more than a year and in certain cases about or above a decade. A major irrigation project viz., the Ghataprabha project was therefore taken up in the year 1949 and completed during the year 1976-1977, in order to save the crops from the hazards of drought in the region. The present research work intends to have an analysis of differential impact of Ghataprabha irrigation project on different category of farmers and locations with particular emphasis on cropping pattern, uses of inputs, output and income.

1.1 SIGNIFICANCE OF THE STUDY

Several scholars and researchers have tackled the issues on irrigation on four broad issues, namely, technical, managerial, economic and sociological or socio-anthropological (Reddy, 1998). An individual researcher may not be in position to tackle all these problems at a time, due to lack of funds, manpower and time. Therefore here an attempt has been made to study only economic impact of Ghataprabha irrigation Project on the farmer community in the northern part of Karnataka.

The impact of irrigation in the Ghataprabha project area can be well brought out micro level, by studying six irrigated and two unirrigated representative villages as most of the characteristics; namely, physical, biological, environmental, human, cultural and economic conditions are unbiasedly represented by the chosen sample villages. However, generalization can not be extended too far.

The best way of studying and understanding the impact of irrigation is to examine the cropping pattern, cropping intensity, input uses, farm business income, net income and man-days of employment of sample farmers and compare them with the pre-project bench mark study data. But this is time consuming and can not
be done by individual researcher. Hence, the next best alternative approach is the evaluation of the different aspects of the relative benefits of irrigated farming over that of unirrigated farming through comparison between farmers with and those without irrigation. For this purpose two unirrigated villages are chosen which are similar in all respects or homogenous agro-climatic conditions except irrigation facilities.

Canal irrigation is, of course, only one of influence on production decisions. Relative price changes, climatic variation, revenue policies, and communications developments would all impinge upon decision-making to an extent, which would confuse the role of canal in production adjustments made through time. Only broad trends can be gleaned from comparisons of production before and after the canal's introduction. A cross-sectional study clearly has the effect of freezing such influences (Stone, 1984).

Irrigation would lead changes in cropping pattern, cropping intensities, productivity, judicious use of water and other essential inputs, which would in turn result in maximum productivity (yield) and give rise to increased income and enhance the employment opportunities in the command area. In order to estimate this net contribution of irrigation, a production function analysis using the data from the micro study has to be carried out. Through this production function approach, the direct effects of irrigation can be isolated from the effects of other inputs which are combined with irrigation (Mears, 1969).

According to Carruthers et al. (1977) Project evaluation studies are undertaken for two purposes namely,

(1) To provide feedback to the project itself. This enables an assessment of project performance – has it been success or not? The criteria for this judgment are the comparison between initial objectives, predicted performance and actual achievement of objectives and performance.
(2) To provide feedback to the planning process. This comes from the lessons gained from project experience and comparison of project achievements and the goals of current policy.

The main object of the present study is to evaluate the impact of irrigation on cropping pattern, income, employment, etc. and also issues and problems associated with irrigation potential created and environmental aspect.

1.2 LIMITATIONS

The study is based only one agricultural year data (1998-99).

(1) The primary data for the full agricultural year 1998-99 was collected, during 2000, on the memory bias of chosen sample farmers.

(2) The present research study is not a longitudinal but cross-sectional in nature due to lack of time and paucity of funds. Wherever possible some Base Period Data or figures from Command Area Development Authority (CADA) reports and Bench Mark Study are also referred too.

(3) General tendency of the farmers is to overestimate the expenditure on inputs and underestimate the production and returns.

1.3 OBJECTIVES OF THE STUDY

The study is conducted with the following objectives:

1) To study the impact of irrigation on cropping pattern,

2) To examine the impact of irrigation on production and productivity of land.

3) To study the cost of production and assess the impact of the irrigation and income.

4) To measure the income inequality among the farmers in the Command area of the Ghataprabha project.

5) To assess the impact of irrigation on employment, and

6) To study the environmental problems in the command area of the project.
1.4 HYPOTHESES OF THE STUDY

Keeping the above objectives in view, the following five hypotheses are drawn to test their validity:

1) Assured irrigation has lead to desirable change in the cropping pattern.
2) Irrigation has led to increase the demand for family labor and wage labor.
3) Irrigation has led to substantial increase in the levels of income of farming community.
4) Irrigation has led to increase the production and productivity.
5) Irrigation has reduced the income inequality in the farming community.

1.5 APPROACHES USED IN THE STUDY

According to Taylor (1980) the studies on irrigation impact are mainly two types, namely longitudinal and cross-sectional. They are as follows:

1) **Longitudinal Approach:** A comparison of actual after-project performance with before-project situation is longitudinal approach.

2) **Cross-sectional approach:** 'With and without' project comparison is cross-sectional study.

Longitudinal studies are possible where pre-irrigation socio-economic benchmark data are available. Since suitable socio-economic benchmark data often are not available and the length of effective recall for most respondents, especially for detailed quantitative data, is limited this approach is considered erroneous. Therefore this approach may not be feasible. The major limitation to the ‘with and without’ approach is possible difficulty in finding a with project situation that of irrigation, to the without-project situation. These similarities concern most directly the physical and biological environment, the infrastructural and institutional environment and the human and cultural environment (Taylor, 1980). Thus in practice large number of the researchers used this cross-sectional approach in their research work.
The present study has employed a cross-sectional approach to examine the impact of irrigation. For this study, the status of irrigation benefits in 1998-99 is compared with that of unirrigated situation for the same year.

Under cross-sectional approach, as Regan and Weitwell (1947) have shown, two situations, such as, the development of the economy with the project and the development that would accrue without it is compared. Eckstein (1958) conducted similar type of study. He has also used "with and without" approach to evaluate irrigation impact in terms of the difference it makes, that is in terms of the effects which it specially causes.

The present study, uses a production function approach to quantify the response of crop production to irrigation. The relative importance of each factor of production, including irrigation, to total output is estimated in value or in income terms, and the rates of substitution between two inputs can be identified. The economic impact of irrigation can then be analyzed by comparing the per hectare marginal value product at price (Asnawi et al., 1985).

Irrigation impact has several dimensions. First is the extent of expansion of irrigation facilities, which has occurred as a result of investments during the last five decades. The second concerns the effects of irrigation on productivity of land and its growth. Then there is the question whether irrigation development accentuates disparities in the agrarian economy. Finally, an important is the environmental impact of irrigation (Vaidynathan, 1987).

Irrigation impact possesses significant, 'area-effect', 'crop pattern effect' and 'yield effect'. It increases the 'net area cultivated', and more importantly, the 'gross cropped area', by enhancing the crop intensity through double or multiple cropping. Since the marginal productivity of irrigated land is higher than that of unirrigated land, it is economically more profitable to cultivate an irrigated rather than an unirrigated hectare or acre of land. Therefore, taking the contributory role of irrigation in providing for the cultivation of high value crops and the use of HYV seed
fertilizer technology, the credit is given to irrigation for the rise in output in the wake of switch over from dry to irrigated farming.

In this study, researcher has attempted a detailed production function analysis. But most of the analysis is based on percentages and averages which are used to analyze the impact of irrigation on cropping pattern, input use, income, and other related problems and issues.

Ghataprabha project, one of the major irrigation projects in Karnataka State, is selected, for present research study. It is selected purposively for the following reasons:

(a) The study region lies in the rainfall shadow area and it covers droughts are in the semi-arid zone of the state.

(b) Researcher is familiarity with the area since 1988.

1.6 RESEARCH METHODOLOGY

The methodology including brief description of the study area, sampling frame work, collection and sources of data, concepts used and analytical tools followed in carrying out of the present study are presented in this part under the following main heads:

1) Study area and location.

2) The sample.

3) Nature and sources of data.

4) Definitions and concepts of terms used.

5) Analytical techniques.

1.6.1 Study Area and Location

The Ghataprabha Left Bank Canal of Ghataprabha project (Here after called as GLBC), a large surface river valley project of Belgaum district in Karnataka State
(Figure 1.1). The project consists of components of Ghataprabha Right Bank Canal (GRBC), Ghataprabha Left Bank Canal (GLBC) and Chikkodi Branch Canal. The Ghataprabha Left Bank Canal is selected for present research study. It is selected purposively for the study region lies in the rainfall shadow area it covers a drought area in the semi-arid zone of the State.

From the Dhupadal Weir small extent was being irrigated, since 1900. Extension of irrigation was started since about the beginning of the Second Five Year Plan. The important features of GLBC are outlined as below:

The GLBC taking off from Dhupadal weir situated at Gokaka taluk, Belgaum district of northern part of Karnataka, with latitude of North 16° 12' and longitude of East 74°47'. GLBC consists of two branches at 71st km. i.e. South branch and Bilagi branch canal. The length of GLBC is 109 km. and traverses in three talukas of Bagalkot and four talukas of Belgaum district. The GLBC carries 2850 Cusecs of water to irrigate 1,61,872 hectares. In the year 2001, Ghataprabha project irrigates 1,54,120 hectares (3,81,000 acres) of land.

1.6.2 Sampling Design

The present study is carried out in the GLBC of Ghataprabha project of Belgaum in Karnataka State. The present research does not pertain to either individual canal or farmers, but it aims at study of over all GLBC system. Hence, to obtain representative picture of the whole command area of the GLBC in terms of crops, costs and returns etc, a representative sample talukas, villages and farmers were chosen from the whole command area of GLBC system.

A three stage random sampling procedure was used for selection of farmers. Under GLBC command area all seven talukas get the benefit of irrigation - three talukas from Bagalkot and four talukas from the Belgaum district.

In the first stage Bilagi, Jamkhandi, and Mudhol talukas from Bagalkot district and Gokak and Raibag talukas from Belgaum district were selected for the study.
The second stage is to select the villages for study to examine the impact of irrigation. Six villages were selected randomly, one each village from Jamkhandi, Mudhol, Gokak and Raibag talukas and two villages from Bilagi taluka were selected (For details see Table 1.1). Incidentally these six villages represent Head\(^1\), Middle and Tail-end of the GLBC.

**Table 1.1 : Sample Design in Ghataprabha Command Area**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>District</th>
<th>Taluka</th>
<th>Village</th>
<th>Irrigated/Unirrigated</th>
<th>Reach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BELGAUM</td>
<td>1) GOKAK</td>
<td>1)Arabhavi</td>
<td>Irrigated</td>
<td>Head</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2)Kaithnal</td>
<td>Unirrigated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) RAIBAG</td>
<td>3) Harogeri</td>
<td>Irrigated</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>BAGALKOT</td>
<td>3) JAMKHANDI</td>
<td>4) Hunnur</td>
<td>Irrigated</td>
<td>Middle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4)MUDHOL</td>
<td>5)Shirol</td>
<td>Middle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6)Mallapur PJ</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5)BILAGI</td>
<td>7)Khatarki</td>
<td>Tail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8) Kundargi</td>
<td>Tail</td>
</tr>
</tbody>
</table>

For comparison purpose, two more villages, were selected one each from Mudhol (Bagalkot district) and Gokak (Belgaum district) to represent unirrigated situation. These selected villages are Mallapur PJ and Kaithanal\(^2\). These villages have same characteristics in terms of environment, rainfall, soil structure, socio-economic conditions, farm practices etc. The only difference between irrigated and unirrigated villages is irrigation from the Ghataprabha Left Bank Canal.

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\(^1\) For the present study, the Head portion was identified between the first and 50\(^{th}\) kms. of the Main canal, the Middle portion between 51\(^{st}\) and 70\(^{th}\) kms. and Tail-end between 71\(^{st}\) and 109 kms.

\(^2\) For the present study both unirrigated villages were selected from the Benchmark survey.
Table 1.2: Land Holding Pattern and Selection of Samples in the Command Area

<table>
<thead>
<tr>
<th>Size Groups</th>
<th>Farm size (ha)</th>
<th>Category of Farmers</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Category</td>
<td>In Proportion</td>
</tr>
<tr>
<td>I</td>
<td>Less than 1</td>
<td>Marginal</td>
<td>29*</td>
</tr>
<tr>
<td>II</td>
<td>1 to 2</td>
<td>Small</td>
<td>24</td>
</tr>
<tr>
<td>III</td>
<td>2 to 4</td>
<td>Semi-medium</td>
<td>15</td>
</tr>
<tr>
<td>IV</td>
<td>4 to 10</td>
<td>Medium</td>
<td>03</td>
</tr>
<tr>
<td>V</td>
<td>Above 10</td>
<td>Large</td>
<td>03</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Note: * Indicates percentage.

Thus this research is based on cross-sectional data using “with and without” approach. In the third stage, after identifying the villages the pattern of farm size in the command area of both the districts was collected, which is as shown in Table 1.2.

The total 60 farmers from different categories were selected in unirrigated segment was arrived as shown in Table 1.3

Table 1.3: Distribution of Farmers According to Farm Size (Unirrigated)

<table>
<thead>
<tr>
<th>Size Groups</th>
<th>Farm Size (ha)</th>
<th>Number of Sample Farmers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bagalkot</td>
<td>Belgaum</td>
</tr>
<tr>
<td>I</td>
<td>Less than 1</td>
<td>08</td>
<td>09</td>
</tr>
<tr>
<td>II</td>
<td>1 to 2</td>
<td>09</td>
<td>08</td>
</tr>
<tr>
<td>III</td>
<td>2 to 4</td>
<td>08</td>
<td>07</td>
</tr>
<tr>
<td>IV</td>
<td>4 to 10</td>
<td>04</td>
<td>05</td>
</tr>
<tr>
<td>V</td>
<td>Above 10</td>
<td>01</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

Sources: Adapted from table 1.2.
The selection 180 irrigated sample farmers was based on stratified random sampling, the strata being size of land holding, subsequently holdings were classified into five categories. From each size group, holdings were selected at proportionately. The 30 irrigated farmers were selected from the six each irrigated villages. And 60 irrigated farmers were selected from the each reach. The total number of different categories of farmers selected in each reach of the canal was arrived as shown in Table 1.4

Table 1.4 : Distribution of Farmers according to Farm Size and Reach Wise

<table>
<thead>
<tr>
<th>Size Groups</th>
<th>Farm Size (ha)</th>
<th>Number of Sample Farmers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Head</td>
<td>Middle</td>
</tr>
<tr>
<td>I</td>
<td>Less than 1</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>II</td>
<td>1 to 2</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>III</td>
<td>2 to 4</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>IV</td>
<td>4 to 10</td>
<td>09</td>
<td>09</td>
</tr>
<tr>
<td>V</td>
<td>Above 10</td>
<td>02</td>
<td>02</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Sources: Adapted from table 1.2

1.6.3 Nature and Sources of Data

1.6.3.1 Primary Data

The primary data for the present study on quantitative variables like cropping pattern, cost of cultivation and various other related information in the command area from the selected farmers was collected by survey method with the help of questionnaire specially designed for the purpose (Appendix I). The data pertain to the agricultural year 1998-1999.

Since large number of sample farmers do not keep the records; it was difficult task for the farmers to remember expenditure incurred on purchased agricultural inputs. By contacting soon after the harvesting season the margin of
mistakes in reporting was minimized. Head of the farm family or elder person in the family was contacted at his residence or in a village and was interviewed. This less costly method was employed to overcome the paucity of funds and time at the disposal of researcher.

To examine the impact of canal irrigation on cropping pattern, cropping intensity, productivity (yield), cost of cultivation and income etc. is analyzed.

1.6.3.2 Secondary Data

To evaluate the impact of canal irrigation system, data on cropping pattern (localized and actual), details of water users co-operative societies (WUCs), alkalinity, salinity and water-logging, technical features of the project and other related information were collected from the Irrigation Department, Command Area Development Authority, Department of Agriculture and District Statistical Office.

Further, data used in present study were collected from various periodicals, journals and reports published by individuals, institutions both national and international agencies.

1.6.4 Definitions and Concepts of Terms Used

1.6.4.1 Cropping Pattern

The term ‘cropping pattern’—refers to the proportion of area under various crops at a point of time.

1.6.4.2 Cropping Intensity

The cropping intensity index is the ratio of the gross cropped area to net cultivated area in percentage. The measure of cropping intensity was reckoned with duration of the crop where by area under annual crops (like sugarcane) has been counted three times and area under two-seasonal crops (like cotton and chilies) has been counted twice. For instance, if the area under sugarcane is one hectare, the gross cropped area is treated as equivalent to three hectares for the entire year.
calculating the cropping intensity. Similarly, two-seasonal crops like cotton, consumed water for two-seasons. Therefore the gross cropped area is considered as double of the net cotton area.

1.6.5 Cost Concepts

By and large, the tool of Farm Management Procedure for estimation of costs and returns, per hectare has been used in the study. They are as follows—

1.6.5.1 Cost A: Includes following items of costs—

i) Value of hired human labor (permanent and casual).

ii) Value of hired bullock labor or owned bullock labor.

iii) Value of both farms produced and purchased seed.

iv) Value of pesticides / insecticides.

v) Value of farm-yard manure (owned and purchased).

vi) Value of fertilizers.

vii) Hired machinery charges.

viii) Interest on working capital.

ix) Irrigation charges.

x) Land revenue

xi) Depreciation charges of machinery.

1.6.5.2 Cost B: Includes Cost A, plus rental value of own land and interest on fixed Capital.3

1.6.5.3 Cost C: Cost A plus the imputed value of family labor except rental value of owned land.

The costs of hired labor have been evaluated at the prevailing wage rate in different seasons for agricultural year 1999-2000. The cost of family labor has been

3 Cost B is not considered in present study, because the rental value of own land and interest on fixed capital would exaggerated current investment (input). In situation where yield is low, this would turn even in a few cases of positive into negative which is an artifact. However even in the lower landholding size farmers record positive returns may be due to relatively higher outputs or low cost of inputs (per hectare).
evaluated at the wage rate for casually hired labor. Difficulties involved in correctly ascertaining the maintenance cost of own bullocks by interview method.

The working cost of owned bullock labor has been evaluated at the rate of Rs.225/- per pair per day, the prevalent rate of hiring a pair of bullock, was considered in view of difficulties involved in correctly ascertaining the maintenance cost of own bullocks by interview method.

While assessing the value of seeds and cane ratoons prevalent in the village at the time of sowing have been taken in to consideration. The value of chemical fertilizers and pesticides/ insecticides has been taken according to their market prices. Farm produced manure was evaluated at rates prevailing in the villages. Irrigation charges and land revenues have been calculated on the basis of actual payments made in different sample villages. Wherever the machinery or implements have been hired, actual hire charges have been added. Interest on working capital (crop loans) has been worked out for six months at an interest of 10 per cent per annum. The kind of payments are evaluated at prices prevalent in the sample villages at the time of payments are made.

Output includes the value of both main and by-products of crops evaluated at the village, market or factory prices prevailing.

1.7 INCOME CONCEPTS

Farm Business Income (FBI)=Gross Value of Agricultural Output (GVAO)—Cost A

Net Income or Net Return (NT OR NR) = Gross Value of Agricultural output—Cost C.

1.8 ANALYTICAL TECHNIQUES

Tabular analysis with simple statistical parameters likes averages, percentages, coefficients was employed for estimation of productivity or yield, cropping intensity index, etc. The aggregate and ratio measures, such as farm business income, net income, and input-output ratio have been worked out to compare the efficiency of the farms with and without irrigation.
1.8.1 Functional Analysis

The production function approach has been used to examine the input-output relationship separately for two types of farms, viz., irrigated and unirrigated. Cobb-Douglas production function has been fitted to the data to study the relationship between variable resources, such as seeds, chemicals, farm yard manure, fertilizers, human labor, bullock labor, irrigation charges and land revenue and output (Gross Value of Agricultural Output) per hectare for irrigated farms. For unirrigated farms, the irrigation charges has not been take in to account for studying relationship between resources and output.

For studying resource productivity on two sets of farms. Viz., irrigated and unirrigated, marginal value of productivity has been calculated.

The production function used in the study was specified as follows-

\[ Y = a \cdot X_1^{b_1} \cdot X_2^{b_2} \cdot X_3^{b_3} \cdots X_g^{b_g} \cdot e^{\mu} \]

After taking log on both sides, the equation becomes log linear and is specified as below-

\[ \log Y = \log a + b_1 \cdot \log X_1 + b_2 \cdot \log X_2 + \cdots + b_g \cdot \log X_g + \mu \]

Where,

- \( Y \) = Gross return in rupees per hectare. (Rs./ha.).
- \( X_1 \) = Value of hired labour human labour (Rs./ha.).
- \( X_2 \) = Value of bullock labour (Rs./ha.).
- \( X_3 \) = Value of seeds (Rs./ha.).
- \( X_4 \) = Value of farmyard manure (Rs./ha.).
- \( X_5 \) = Value of chemicals fertilizers (Rs./ha.).
- \( X_6 \) = Irrigation charges\(^4\) (Rs./ha.).
- \( X_7 \) = Value of insecticides/pesticides (Rs./ha.)

\(^4\) For unirrigated farms, the variable \( X_6 \) is not considered.
$X_8 = \text{Value of family labour (Rs/ ha.)}$

$X_9 = \text{Land revenue (Rs./ha.), and depreciation charges.}$

$n = \text{Number of explanatory variables.}$

$b_i = \text{Regression Coefficients.}$

$\mu = \text{random error term}$

### 1.8.2 Marginal Value of Products

Marginal value products (MVPs) of the inputs were estimated from the fitted production function. Symbolically, it is expressed as follows.

$$
\text{MVPs} = \frac{\bar{y}}{\bar{x}_i} = b_i \times \frac{\bar{y}}{\bar{x}_i}
$$

Where,

- $\bar{y} = \text{Geometric mean of output, and}$
- $\bar{x}_i = \text{Geometric mean of resources.}$

The test of significance was conducted as under; where, $SE(MVP x_i)=SE (b_i)$ $x_i$, since the values of dependent and independent variables were expressed in monetary terms.

$$
\text{Cal}^{*} t^{*} = \frac{(MVP x_i - P x_i)}{SE(MVP x_i)}
$$

Where,

- $SE(MVP x_i)=SE(b_i)* \frac{\bar{y}}{\bar{x}_i}$, since the value of dependent and independent variables was expressed in monetary terms.

$MVP x_i = \text{Marginal value product of } x_i \text{ resource}$

$P x_i = \text{Acquisition unit price of } x_i \text{ resource}$

$SE(MVP x_i) = \text{Standard error of } MVP x_i$, and

$SE(b_i) = \text{Standard error of regression inefficient associated with } x_i \text{ resources.}$
1.9 GINI CONCENTRATION RATIO

This ratio was adopted to assess the concentration ratio of annual income among the farmers in the irrigated and unirrigated segment for the study area.

In order to analyze the degree of inequality in the distribution of income, Gini concentration ratios or Gini Indices of concentration were estimated, with using the following formula (Singh, 2000).

$$G = 1 + \frac{2}{n} \sum_{i=1}^{n} \frac{(n - Y_i)}{Z}$$

Where,

$G$ = Gini concentration ratio to the distribution of income of all households.

$n$ = Population size

$Z$ = Mean income

$Y_i$ = Income of the $i^{th}$ household.

The above equation is defined as the area between Lorenz curve and diagonal to the total area under the diagonal. It is an increasing function of inequality and equals to zero when distribution is perfectly equal.

Gini concentration ratio is more opaque since it measures the distance between the diagonal and Lorenz curve. Unlike Lorenz curve comparisons, the Gini concentration ratio comparisons are always conclusive since one real number must be greater than, equal to or less.
1.10 ORGANIZATION OF THE THESIS

The study is presented in to eight chapters.

Chapter I: Introduction

It deals with the introduction, meaning and role of irrigation in the economic development of the country. The significance of the present study is highlighted. The objectives and hypothesis are discussed, type of approaches used in the study, sampling design, nature and sources of data, definitions and concepts, and analytical tools used in the study are described.

Chapter II: Review of Select Literature

An extensive selected review of literature available on the related topics is carried out in this chapter.

Chapter III: Development of Irrigation

In this chapter, the development of irrigation in the World, India and Karnataka is discussed.

Chapter IV: The Profile of the Study Area

A detailed profile of the Ghataprabha Project are presented in chapter IV. A brief profile of Belgaum and Bagalkot districts and silent features of the project and command area are presented in the chapter. The cropping pattern and irrigation potential created and its utilization are also discussed.

Chapter V: Impact of Irrigation on Cropping Pattern and Productivity

The fifth chapter presents impact of irrigation on cropping pattern, cropping intensity and productivity.
Chapter VI: Impact of Irrigation on Income and Employment

The findings of the field study on the impact irrigation on gross value of agricultural output (GVAO), farm business income (FBI), net income or returns (NI) Input and output analysis and generation of employment are presented in chapter VI. A comparative analysis of income from irrigated and unirrigated segments in the command area and its variation in different reaches and in the different size-group of farms is made. Income inequality is analyzed with the help of Gini concentration ratios and coefficient of variation between the irrigated and unirrigated segment.

Chapter VII: Participatory Irrigation Management and Impact of Irrigation on Environment

An attempt is made to explain the participatory irrigation management and impact of irrigation on environment in the country and command area.

Chapter VIII: Summary and Policy Implications

A summary of the main findings emerging from the study is presented in concluding chapter. The main findings of the study are that a change in the cropping pattern in irrigated segment. Income and employment from irrigated farming are comparatively higher than that in the unirrigated farming.