CHAPTER - II

RESEARCH METHODOLOGY

II.1 INTRODUCTION

Water is an important pre-requisite for agricultural development. An assured water supply spells, prosperity, creates employment potential, increases income and enhances capital formation. The need for regulated supplies of water and manure at regular intervals and in requisite doses was long realised for the increase in the productivity of land. In fact, the production of a crop requires soil, water, seed, labour, implements, proper planning and management.

As pointed out by Sir Charles Trevelyan, Irrigation is every thing in India; water is more valuable than land, because when water is applied to land, it increases its productiveness at least six fold\(^5\) To over- come the scarcity

of water conjunctive use of water from all sources is essential.

II.2 PROFILE OF THE STUDY AREA

Haryana, since, its inception as the sixteenth state of India on November 1, 1966, has never looked back, Haryana occupies second position among all the states in case of overall development and particular in case of agricultural development. Sprawling over an area of about 44,056 sq.kms. it is situated between 27°40' and 29°42' north latitude and 74°54' and 77°40' east longitude. In shape, it is an irregular oval with its long axis lying from the north west to south east (Fig 1).

The region in the north is bounded by Siwalik hills in the east by River Yamuna, in the south and south west it grades into the Thar and the low broken Aravalli ridge and River Ghaggar forms some part of its boundary with Punjab in the west.

The terrain is simply the usual alluvial monotony. The Siwaliks in this area are formed for the most part of barely coherent sandrock, with occasional clays, gravels and conglomerates, an ideal lithology for gullying. The Siwaliks are newly formed hills. In contrast to these hills of the north and north-east the outliers of the Aravallis are there
in the south and south east. These are old mountain systems also with bared rocks. In the east Yamuna forms summit level of the plain. In the southern part of the plains a band of minimum elevation runs roughly east-west the alluvium meets from the Aravallis that of the Himalyas. This band is slightly above 213 metres in Rohtak district and eastern Hisar. The western most part is characterized by shifting sand hills interrupted in places by firmer and in parts loamy bottoms. This is the bagar tract(Fig 2).

Rivers: The region is not rich in perennial rivers, the only perennial river forming its eastern boundary is Yamuna. It has the origin in snowy regions of Himalayas. The other river of Importance is Ghaggar, which though perennial in its upper course, becomes dry after flowing for a short distance from the hills. The Ghaggar contains a lot more water during the rainy season and at that time it normally flows up to Hanumangarh in Rajasthan. There is no perennial stream flowing through the state but seasonal main streams which enter from south are Dohan, Krishnawati, Sahibi, Landaha, Kasauti and Indori.

In general the water table in the plain rises from the west towards the east and north east. The water table, generally, follows the topography of the ground surface. The depth of water table is high in Mahendragarh, Bhiwani,
Hisar, Sirsa districts and low in the districts of Karnal, Jind, Sonepat, Rohtak and Gurgaon.

**Climate:** This region has semi-arid monsoon type of climate. Owing to a long distance from the seas, the region fails to get the full benefit from monsoon. There is lack of sufficient rainfall; there is high summer temperature and severe cold waves in winter season. This state has its southern and western boundaries with Rajasthan. So there are strong dust in the summer.

**Rainfall:**

In Haryana rainfall is the only dominant single weather parameter and climatic hazard in farming because of its meagreness, concentration, intensity, variability and unreliability. Rainfall varies from about 100 cms. in the foot hills of Siwaliks in the north to about 20 cms. in arid areas of south and south west. Generally, between 70 to 80 per cent of the rainfall is concentrated during the three months of the monsoon season and the rest takes place during winter season due to western cyclonic disturbances.

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On the basis of above physical features Haryana can be studied under three distinct physiographic regions:

(i) The Hilly Area and the Piedmont plain:

Nearly 1.48 per cent of the area comes under the hilly region in the state and the piedmont plain comprises of 1.67 percent of the area, some areas of Ambala, Gurgaon, Bhiwani and Mahendragarh districts comprise this region.

(ii) The Flood Plain (Khaddar of Bet and Naili and Alluvial plain):

Out of the total area of the state, about 68.21 percent lying under 300 mts. in height is a levelled plain and can be designated as the Ghagger - Yamuna plain. It comprises of the Ambala (partly), Kurukshetra, Hisar, Sirsa, Jind, Karnal, Sonepat and Rohtak districts.

(iii) The Sandy Undulating Plain:

About 25.55 per cent of the area below 300 mts. in height and lying in the districts Bhiwani, Mahendragarh, and north western extreme of Gurgaon is undulating or rolling in
Haryana is primarily an agricultural state. The economic viability and the prosperity of its people largely depends on the agricultural wealth produced in the fields by its hard working and sturdy farmers. Near about 80% of the population subsists directly or indirectly on agriculture. In other words, agriculture is the backbone of its economy. In agrarian sector, the state has registered an annual growth rate of 4.5 percent. It could be possible only with the available irrigational facilities. For a flourishing agriculture, provision of timely and adequate supply of water is absolutely essential.

11.2 A General Survey of The Resources in Haryana:

Water is one of the important resources essential for farming. There are three mediums through which water is available in the state. They are rainfall, surface water and ground water.

Rainfall as a source of water:

Geographically, the location of the state does not favour heavy rainfall. The major part of the precipitation
is received during the rainy months of July, August and September and remaining part of the rainfall is received during the winter season i.e. in December and January months due to cyclonic disturbance, which is highly beneficial for rabi crops especially wheat. The rainfall in Haryana varies from 20 cms. to 100 cms. per annum. The maximum rainfall is in the north-eastern part of Haryana and minimum in the western part (Fig.3). There are considerable variations in the rainfall from year to year and its distribution is also irregular in both time and space, the water deficiency, therefore, is a problem everywhere. The Monsoon rainfall decreases from east to west and north-east to south-west, cyclonic rainfall faces from north to south. The intensity of monsoon rainfall varies between 15 mm. and 30 mm. per day. The intensity of cyclonic rainfall varies between 8 mm. to 14 mm. per day.

Surface Water :-

Considering the scanty rainfall in Haryana, surface water has played a vital role in the development of agriculture. The perennial rivers contributing the surface water in Haryana are Yamuna, Sutlej and Ravi - Beas. Rivers Sutlej and Yamuna pour maximum part of the surface water in the canals of Haryana. Beside these, there is one seasonal river Ghaggar which has a lot more water during the rainy
season but after that it sometimes goes dry. The seasonal main streams flowing in Haryana are Dohan, Krishnawati, Sahibi, Landaha, Kasauti and Indori.

Ground Water:-

When rainfall occurs some water enters into the pores of the soil and accumulates. It is ground water. It flows inside with the slope, the speed of water is very slow. At a certain depth the pore space in the soil is completely filled with water and the level at which it occurs is known as water table, generally, flows along with the topography of ground surface.

In the south and south-western part of Haryana, the underground water is found at greater depth in comparison to other parts. The possible reason for this, as advanced by many investigators is that there is a suspected buried ridge or high density alluvium which acts as an obstacle to the flow of subterranean water from Siwalik area towards the south-west dry region of Haryana state.

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the ground water potential has now been assessed as 8 million acre feet and this has already been exploited to the extent of 6 million acre feet ...........

Ground water is also an important contributor in the water resources.

Soils :-

Soil is another vital resource after water for agricultural development. The configuration and soil characteristics show the richness of the land of Haryana. The whole region is a vast plain area and its general slope is towards western and south western side. The hilly area is more rugged or undulating compared to other areas. The higher part is more irregular and deforestation of slope has caused considerable damage to the surface and soil of the region. The southern arid and semi-arid tract has sand dunes accumulation projecting out at places but increasing human intervention has mostly repressed them and have converted this tract into a cultivable area irrigated by canals.

2Irrigation in Haryana - Perspective *written by S.G. Sundarm, IAS, Commissioner and Secretary to Govt. of Haryana, Irrigation & Power Department p.3
The soils of Haryana are coarse and sandy and can be classified into 6 categories as given by Jasbir Singh in his book, "An agricultural Geography of Haryana" (Fig 4).

Category 1: The very Light Soil:

(Sandy and Loamy Sand) The chief characteristics of these soils are that they are very deep, light, highly permeable and well drained. These soils spread over the districts of Bhiwani (western part i.e. Bagar), western Mahendergarh and Hisar, (Bagar). Here, the Thar Desert touches the plains of Haryana. This is the arid region, with maximum permeability causing excessive drainage which means a tendency to dry up rapidly and a low water-holding capacity. This leads to periods of drought. The water available in this area is of brackish type because of the high content of salt present in water and underground water is mostly unsuited for irrigation purposes.

Category II: The Light Soils:

(Relatively Sandy Loam and Sandy Soft Loam). The main characteristics of these soils are that they are light, well drained, capable of retaining moisture. These are best for dry farming but with the help of modern practices. Having high proportion of sand than silt and clay, they have an
ideal degree of both permeability and water holding capacity. Their capacity can be further improved by using farm yard manures or adding silt to them by canal irrigation or by using green manures. These soils give higher yields if needed care is given. These soils spread over eastern part of Bhiwani, northern portion of Mahendragarh, south western Rohtak, South western Gurgaon and Sirsa districts.

Category III: The Medium Soils:

(Light Loam, Coarse Loam) These soils have chief characteristics like that of they are deep, well drained and fertile, capable of producing a variety of crops. These soils have content of silt and clay. These soils are compact and stiff because of the addition of silt over years by canal water. These soils have low water-holding capacity and moderate permeability because of compactness, pro-longed irrigation in this part of Haryana has led to the water logging problem in the neighbouring areas of canals. This area needs irrigation during rabi season, otherwise there is sufficient rainfall for higher yields. These soils spread over the area of eastern and northern Rohtak, eastern Gurgaon, Faridabad, whole of Jind and north eastern Hisar, Light Loam is found in western and Central Ambala and western Sonepat.
Category IV : The Moderately Heavy Soil :-

(Silty Loam). The chief characteristics of this soil is that this is inferior, poor, grey - coloured and stiff. Silty Loam has higher content of silt and clay than loam, so it is compact and reduces water holding capacity. When this soil is dry, it is difficult to work upon it and its tillage also needs more draught power per unit area. A variety of crops can be grown over it and their yields are also high. This category of soil is spread over the area of north Karnal, Sonepat, tehsils of Ballabgarh and Palwal. This soil is locally known as khaddar.

Category V : The Heavy Soil and Very Heavy Soil :-

(Clayey Silt, Silty Clay or Stiff Loam or Stiff Clay). The chief characteristics of these soils are that they are poor, permeable, lack drainage facility and power of holding moisture is also less. These soils are rich in organic matter and poor in salt content. These soils have 75 percent proportion of silt and clay and they appear like hard red clay. These soils give higher yields if sufficient quantity of water is supplied to them. The area of the tehsils of Gulha, Thanesar, west Jagadhari, extreme east of Ambala are covered by these category of soils.
Category VI : The Soils on Siwaliks. The Piedmont Plain and The Rocky Surface :-

Sandstones found in the hilly area of Siwaliks are formed by the accumulation of sand, clay, rock fragments of different shapes and sizes i.e. pebbles, boulders etc. This also exists in upper portion of piedmont plain. These types of areas are in the Kalka and Naraingarh tehsils.

The soil found in piedmont plain is of poor quality and sandy, lying on undulating plain where thorny bushes have grown and this plain at several places is criss-crossed by ravines. In Kalka and Naraingarh this area is known as Ghar and Kandli in Jagadhari tehsil.

The Rocky Surface are found in Tosham area in Bhiwani district and in Gurgaon and Mahendragarh districts. This is a residual and weathered material which is deep, coarse light inferior, infertile to raise crops. It is vanishing because it is being washed away by torrential summer rains and removed by wind blasts of hot-dry period.

Natural Vegetation and Forest Resources :-
HARYANA
Forests
1981

Forest Covered Area

Source: Census Atlas, HARYANA.

Fig. 5
Long human occupancy and extension of agriculture area have greatly influenced the natural vegetation in Haryana. In the past some part of north-eastern Haryana was covered by forests but with the increase in population, more and more land was brought under cultivation. There was deforestation and at present about 4 percent of the total geographic area of the state is under forests which is lowest among all the states of India. When in 1966, Haryana became the 16th state of India, only 3.12 percent of its area was under forest but the state of Haryana is conscious of loss of forests and some attempts are being made to gradually improve the forest cover by planting trees along the roads and canal-bank. The consequences of the efforts can be seen from the figures that from 3.12 percent in 1966-67, the forest covered area rose to 3.2 percent in 1975-76 and further to 3.8 percent in 1985-86 (Fig 5). It is evident that the forests have been over-utilized and a lot of improvement is needed to correct the situation.

**ECONOMY OF THE STATE**

Agro-economically, the green revolution as described by economist Sheila Bhalla, has etched Haryana predominantly into three regions and two other small sub-regions. The richest tract consists of the Karnal district and its adjacent area. Its gross irrigated area is nearly 70 per
cent of the total cropped area and is mainly irrigated by tube-wells. This is the region to which the green revolution came first and was consolidated. It has 26 per cent of the total cropped area under high yielding variety (HYV) seeds. The second most prosperous area runs in a broad west to east belt across the middle of Haryana covering most of Hisar and parts of Rohtak district. Although 62 percent of its total cropped area is irrigated from the agricultural point of view this irrigation is not available to the farmers in the quantity and at the time it is wanted, with the result that only 14 percent of the total cropped area is under HYV crops. The third ranking region in terms of agricultural richness and prosperity is the rain desert region in which the returns from cultivation are meagre. This arid region borders Rajasthan, its gross irrigated area is only 12 per cent of the total cropped area and less than 6 per cent of it is under HYV seeds. This region continues to be poor and technologically backward. For all practical purposes, the green revolution has simply bypassed it. The other two small agro-economically identifiable regions are widely separated from the rest of Haryana, of them one is the second poorest regions of Haryana in terms of cultivators income. It lies in the north constituting the high rainfall, hill and ‘cho’ area covering much of the Ambala district, the high rainfall, being ruinous to its crops. Now both HYV wheat and
same rice are grown in this region more usually on the strength of rainfall rather than irrigation and labour intensive methods of production are used. A part of the poorest of all regions lies in the south east of the state. It is an area defined by a large area adjacent to the west of Delhi, including parts of Rohtak and a large part of Gurgaon. Now HYV wheat grows but on an extremely limited scale and low cash value crops like bajra, jowar and maize are the main crops.

Haryana State has made tremendous progress in the field of Agriculture since its formation. The net area sown and total cropped area in the State has risen from 3423 thousand ha. and 4599 thousand ha. in 1966-67 to 3593 thousand ha. and 5651 thousand ha. respectively during 1989-90. The double cropped area in the State has risen from 1176 thousand ha. to 2058 thousand hectares (by 75%) during the period 1966-67 to 1989-90. Following table gives information relating to the net area sown, area sown more than once and total cropped area for the different plan periods since 1966-67. The Agricultural land of Haryana is divided into different parts:

**Net Sown Area** :- It is the net area sown under crops, the area sown more than once during the year being counted only
once. There is marginal change in Net Sown Area since 1966-1967 to 1987-88.

**Total Cropped Area** :- It includes total area covered with crops during the year. In case, different crops are raised on the same land during the year, the same area is counted more than once. It is almost static since the inception of the state.

**Fallow land** :- It denotes cultivable land which after abandonment remains uncultivated over a long period called 'old fallows' and those kept uncultivated during the current year are called 'current fallows'. It has doubled in 20 years time since the inception of the state.

**Land Not Available For Cultivation** :- This includes absolutely barren and unculturable land like mountains, deserts etc. which cannot be brought under plough except exhorbitant cost, land covered by buildings, roads and railways and waterways or otherwise appropriated for non-agricultural use.

**Area Under Forest** :- This includes actually forested area on the land classed or administered as forest under any legal enactmant dealing with forests whether state or private. Besides, the forest area along roads, railways and canals have been included.
# TABLE -I
CLASSIFICATION OF AREA IN HARYANA STATE

(OOO' Hectares)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Area</th>
<th>Forests</th>
<th>Land put to non agricultural use</th>
<th>Barren uncultivable land</th>
<th>Cultivable waste land</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-67</td>
<td>4399</td>
<td>91</td>
<td>257</td>
<td>232</td>
<td>87</td>
</tr>
<tr>
<td>1975-76</td>
<td>4404</td>
<td>104</td>
<td>374</td>
<td>99</td>
<td>34</td>
</tr>
<tr>
<td>1985-86</td>
<td>4391</td>
<td>166</td>
<td>236</td>
<td>156</td>
<td>23</td>
</tr>
<tr>
<td>1987-88</td>
<td>4391</td>
<td>166</td>
<td>233</td>
<td>172</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Current Net Sown Area</th>
<th>Cultivable Area</th>
<th>Area Sown More Than Once</th>
<th>Total Cropped Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-67</td>
<td>259</td>
<td>3423</td>
<td>3819</td>
<td>1176</td>
</tr>
<tr>
<td>1975-76</td>
<td>125</td>
<td>3624</td>
<td>3827</td>
<td>1827</td>
</tr>
<tr>
<td>1985-86</td>
<td>168</td>
<td>3613</td>
<td>3833</td>
<td>1988</td>
</tr>
<tr>
<td>1986-87</td>
<td>528</td>
<td>3233</td>
<td>3821</td>
<td>1453</td>
</tr>
</tbody>
</table>


Other Uncultivated Land Excluding Fallow Lands. :-
This denotes land available for cultivation either not taken up for cultivation or abandoned later on for one reason or the other and includes culturable waste, permanent pastures and other grazing lands and lands under miscellaneous tree crops and groves.

**Infrastructure :-**

**Power :-** The state of Haryana is the first in the country to achieve 100 per cent electrification of all its 6,745 villages and 81 towns (according to 1981 census). Uchani (Karnal) is the last of Haryana's all villages electrified on 29th Nov., 1970. The installed capacity was 343 MW in 1966-67 it increased to 751 MW in 1978-79 and further to 1946 MW in 1984-85. The electricity generated in 1978-79 was 20312 lakh KMW and in 1984-85, it was 41678 KMW i.e almost doubled in a decade.

**Transport :-** Transport includes road transport, development of roads and the railways.

The railway system in India is divided into various zones which are further sub-divided into divisions. About 1220 Kms. of rail length comes under the share of Haryana.

The total strength of Haryana Roadways buses was 496 and it covered 372.23 lakh Kilometres during 1966-67. The passenger transport in the state was totally nationalised in 1972. Haryana Roadways has made tremendous progress since then. The total fleet strength and total Kilometerage covered
increased to 3498 and 3820.10 lakh respectively during 1989-90. Number of passengers carried daily by these buses had increased from 1,02,823 in 1966-67 to 15,49,181 in 1989-90.

**TABLE - II**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>METALLED</th>
<th>UNMETALLED</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-67</td>
<td>5,321</td>
<td>816</td>
<td>6,137</td>
</tr>
<tr>
<td>1975-76</td>
<td>15,280</td>
<td>1,059</td>
<td>16,339</td>
</tr>
<tr>
<td>1985-86</td>
<td>20,285</td>
<td>2,056</td>
<td>22,341</td>
</tr>
</tbody>
</table>


When the state of Haryana came into being the total kilometreage of roads was 6,137 but increased to 16,339 kms. in 1975-76 and further to 22,341 kms. in 1985-86. It means 4 times increase in 20 years.

**Irrigation**:- Water and power are the two essential elements for the development of agriculture. Therefore, great stress has been laid on the exploitation of underground water resources. The percentage of net area irrigated to net area sown in the State has increased from 37.8% in 1966-67 to 73.9% in 1989-90. In actual terms net area irrigated in the state has risen from 1293 thousand hectares in 1966-67 to 2657 thousand hectares in 1989-90. Out of it, net area irrigated by Wells, Tube-wells was 289 thousand
hectares and 1294 thousand hectares respectively. Similarly, the gross area irrigated in the State rose from 1736 thousand hectares in 1966-67 to 4253 thousand hectares in 1989-90. Percentage of gross area irrigated to total cropped area has risen from 37.8% in 1966-67 to 75.3% in 1989-90.

Following table depicts the data of net area and gross area irrigated in the State for the different plan periods:

TABLE - III

<table>
<thead>
<tr>
<th>Year</th>
<th>Net Area Irrigated</th>
<th>Gross Area Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-67</td>
<td>1293</td>
<td>1736</td>
</tr>
<tr>
<td>1978-79</td>
<td>1917</td>
<td>2979</td>
</tr>
<tr>
<td>1984-85</td>
<td>2189</td>
<td>3504</td>
</tr>
</tbody>
</table>

Source: Statistical Abstract of Haryana 1985-90

**Industries**: Haryana was industrially not very much developed at the time of formation of the State. There were only 1270 registered factories in the state during 1966. Out of these only 1168 were working. The number of registered and unregistered working factories rose to 550 and 4843 respectively in 1989-90. The number of workers employed in the registered working factories has risen from 71016 in
1966 in 1966 to 261548 in 1989. Following table gives the number of registered factories in the state and workers employed in them at end of different plan periods.

**TABLE - IV**

<table>
<thead>
<tr>
<th>INDUSTRIES</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>No of registered</td>
<td>No of Working registered factories</td>
<td>No of workers employed in the working registered factories</td>
</tr>
<tr>
<td>1966</td>
<td>1270</td>
<td>1168</td>
<td>71016</td>
</tr>
<tr>
<td>1978</td>
<td>2614</td>
<td>2183</td>
<td>138763</td>
</tr>
<tr>
<td>1984</td>
<td>4707</td>
<td>4335</td>
<td>220535</td>
</tr>
</tbody>
</table>

**Source:** Statistical Abstract of Haryana for different years 1967,1979,1985.

The number of registered small scale industrial units has risen in the state from 4755 in 1966-67 to 92000 in 1989-90. These 92000 units were employing 5.52 lakh persons.

Thus, the state of Haryana has made tremendous progress in almost all sectors of its economy, particularly the agriculture sector. But in the agriculture sector still there is vast scope to progress, provided the available water resources are utilized efficiently and economically.
II.3 Objectives of the Study:-

Water is crucial ever for sustainance of life and economic well being. It is a renewable but limited resource made available through a complex hydrological cycle comprising of a set of related ecological processes. It is available to an ecosystem through precipitation, surface run off, replenishing of ground water and is finally, returned to the atmosphere through evaporation and transpiration.

Haryana excelled in the performance of its agriculture in the whole country mainly because of the optimal utilization of its renewable resources in general and water in particular. The objectives of the present study are:-

(i) To evaluate the position of surface and ground water in the state of Haryana.

(ii) To analyse the availability of surface and ground water resources over time and space.

(iii) To examine whether there is proper utilization of water resources in the state of Haryana over time & space.

(iv) To analyse how the conjunctive use of surface and ground water has been responsible for the agricultural development in Haryana.

(v) To examine how the other determinants besides water have influenced the pace of agricultural development in the state of Haryana.

(vi) To suggest ways for the efficient management and optimal conjunctive use of water resources.
II.4 DATA BASE :-

The present study is based on the data collected from different sources as it has used the information related to the number of aspects of water availability and use as well as agricultural production.

Some of the aspects on which data has been collected from secondary sources are :-

(i) Net sown area and gross cropped area to find out intensity of cropping district wise since 1966 to 1989-90.
(ii) Area Covered by forest and total geographical area of the state, to find out its percentage of forest cover in the state since 1966 onwards.
(iii) Gross Cropped Area,
(iv) Harvest price of six crops since 1966 and production of these crops since 1966 to find out value productivity.
(v) The number of male agricultural workers.
(vi) Fertilizer consumption in the state.
(vii) Area of six crops (rice, wheat, bajra, maize, sugarcane, cotton) under HYV.
(viii) Net area irrigated by different sources.
(ix) Gross area irrigated,
Area irrigated under six crops.

Volume of canal water.

Volume of ground water.

Average annual rainfall district wise.

Yearly discharge of water from rivers and canals.

Length of Canals.

The data in regard to above parameters have been obtained from the Statistical Abstract of Haryana of different periods from 1966 to 1990-91. The data pertaining to canals were obtained from the Irrigation Department, Chandigarh (Haryana).

The data pertaining to ground water was taken from Haryana State Minor Irrigation Tube-well Corporation (HSMTIC), Chandigarh and Central Ground Water Board, North West Zone, Chandigarh.

II.5 METHODOLOGY

In order to answer various questions raised in this study statistical and cartographical methods have been employed. The statistical analysis has been attempted with the help of tables.

The data presented through different tables have been compared to draw the conclusions. In order to quantify the amount of water availability, productivity of crops and
intensity of cropping, simple formulae have been used. These are:

(a) To find out volume of rain water the formula used is as follows:

\[
\text{Volume of Rain Water in the district} = \frac{\text{Net Sown Area}}{\text{Annual rainfall for the respective district}} \times \text{Average}
\]

Rainfall is distributed all over the cultivable land; therefore, volume of rain water available in the district can be calculated with the help of above formula. Total volume of rain water available in the state has been obtained by adding volume of rain water for each district.

(b) Productivity is an important indicator of agricultural development and to find out productivity following formula has been used:

\[
\text{Productivity of a crop} = \frac{\text{Production of a particular crop}}{\text{Area under that crop}}
\]
Forming this formula productivity of a single crop would emerge and by adding productivity of major crops in the region in a year, the overall productivity of the state could be known.

(c) For calculating intensity of cropping following formula is used:

\[ \text{Intensity of cropping} = \frac{\text{Net sown Area}}{\text{Total cropped Area}} \times 100 \]

In the course of this study various cartographic methods have also been used. Choropleth methods have been used to show soil types, forest covered area, rainfall and quality of ground water. Simple graphs have been used to show the number of tractors, number of tubewell, fertilizer consumption and simple bar diagrams have been used to show the productivity and number of male agricultural workers in the state.

The present study is an attempt to understand the effect of water and related inputs over a period of two decades from 1966-67 to 1988-89. This has obviously created a problem of changing administrative divisions within the study area as there were only 7 districts in 1966-67, which increased to 11 districts in 1977-78 and further to 12 districts in
1987-88. The analysis as it is based on the district level data has been carried on with respect to this limitation.