INTRODUCTION

Agriculture has been the subject matter of the geographic study since long. It is not only because most of the people depend for food and several raw materials on it, but also because largest fraction of land under human occupancy is used for agricultural purposes. Agriculture is main occupation of working population and major source of income in developing countries. Though significance of agriculture in term of employment and generation of national income is gradually declining, the development of agriculture is an essential for rural development in India as well as in Madhya Pradesh. As Schultz remarks that agriculture sector is not capable of contributing to economic growth as much as other sectors of the economy, nevertheless, its development will strengthen the rate of industrial development by increasing food production capacity, by capital formation, by providing market for industrial output of consumer's goods, and by utilizing agricultural inputs originated in industrial sector (T. U. Schultz, 1964, pp 3-6)*. In this perspective agricultural planning and evaluation of agricultural development assume top position in overall development planning in India.

* References are arranged alphabetically at the end of the thesis.
It has been accepted that among the inputs essential, irrigation is indispensable for agricultural development. Its use is conditioned by several variables. While low rainfall and its vagaries necessitate the development of artificial means of water supply, it is also essential to take maximum benefits out of the chemical fertilizers, and to some extent, high yielding variety of seeds. On the other hand, irrigation is conditioned by the nature of terrain, availability of water resources, and above all socio-politico-economic situations.

In traditional agriculture, one hectare of land with irrigation was supposed to have an additional yield of 0.2 tonnes. The utility of irrigation in high yielding crops is far more, if combined with optimal doses of other inputs and package of practice. There is no significant scope for increasing the net area under cultivation in this state. The only way to increase area under cultivation is to grow more than one crop on the same agricultural land with the help of irrigation which indeed is the main plank of our agricultural strategy in all the five year plans. Though the need of irrigation has been felt since long in different parts of the state, systematic assessment of water resources estimated recently by the State Govt. Irrigation Department. There are two main sources of water—underground and surface water. The surface
water is feasible through rivers, streams, tanks and reservoirs, while feasibility and supply of ground water is determined by the rainfall regimes, structure, terrain and soils.

Realizing the importance of underground water preliminary geohydrological surveys have been conducted in the State. Based on the available information about annual rainfall and number of wells used for irrigation total ground water potential has been estimated at 5,865,304 hect. m. and present utilization is 599,987 hect.m. (Ground Water Survey, 1980). Very little potential of underground water has been utilized. There are 21 districts where level of utilization is lower than the state average (10.23%). It indicates that there is ample scope for the development of irrigation through wells and tube-wells in the state. The potential which can be exploited is estimated to be 24 million acre feet. According to this estimate 30 lakh wells and 30,000 tube wells can be commissioned (Madhya Pradesh Ke Jal Sansadhan Avam Sinchai Ka Vikas, 1990).

Total surface water has been estimated at 125,777 crore cubic metre available in rivers and big nullah of the state. Out of this 7880.5 million cubic metre are confined in rivers of the Ganga drainage system, 2550.4 million m$^3$ in Narmada river system, 1659.2 million m$^3$ in
rivers of Mahanadi system and only 487.6 million $M^3$ in Godavari system. Utilizing these water potentials, some 120 lakh hectares net area can be provided with irrigation. Only 20.5 lakh hectares area has been irrigated at present. It means more than four-fifth of water resource is going waste.

The position of this state in respect of the use of inputs are far behind the national average. For example, only 9.8 per cent of the total cropped area is irrigated in this period against the country’s average is 26.6 per cent in 1977–78. Gross irrigated area is 15.5 per cent of the total cropped area in 1986–87. Similarly, in adoption of other developmental measures for agriculture, the position of the state is not satisfactory. Among the developmental measures the basic necessary for the transformation of the face of agriculture in this state is irrigation and others are very closely associated with it.

No doubt, provision of ensured timely water supply raises the productivity of land, but the real benefit comes only when improved seeds and fertilizers are used along with the irrigation. The correlation coefficient of value of crops per unit with the use of high yielding variety of seeds is very high ($r = +0.87$). It is also high with the extent of irrigated area ($r = +0.77$), and fertilizers ($r = +0.64$). This indicates that these three
inputs in a basket is most effective to raise productivity.

The immediate effect of the creation of irrigation facilities may be manifested in the expansion of net area sown by annexing cultivable waste lands into it, and by intensifying the cropping pattern. The irrigation has played a vital role in enhancing the yield rates of the crops rather than in colonization in the state. At the same time, it has also influenced the adoptability of certain yield raising inputs such as high yielding variety of seeds and fertilizers. It is proposed to analyse the use of these inputs co-varies temporally and spatially with the extent of irrigated area.

The mechanical innovation is also a major constraint in the adoption of high yielding varieties. These varieties, could be grown with great success in the areas of extensive and adequate irrigation, especially in the tube-wells tracts. The multiple cropping and raising of two or more crops in a year is possible only through mechanization of the agricultural operations. Machines and equipments like thrashers, tractors, tillers and engines, pumping sets etc. are, therefore, required for the timely and efficient operation of the high yielding short duration growing varieties. The mechanization of agriculture helps in the proper utilization of inputs like water, fertilizers, pesticides and insecticides. It is well
established that with the use of modern equipments, the utilization efficiency of these inputs is substantially increased. For example, a farmer having a tractor and a blade terracer, manages to grade his land to a much better level in the course of time as compared to the farmer not having similar sources of power and equipment at his disposal. The proper grading of fields helps in reducing water losses and labour required during irrigation. Among many useful aids which increase the efficiency of the farmer are seed-cum-fertilizer drill, well designed plant protection equipments, dunlop-carts and thrashers. Moreover, a prerequisite for mechanization is the availability of sufficient power which is the nucleus of all technological developments. As a matter of fact, electric power has a vital role in the development and extension of high yielding varieties. It supplies the mechanical power to the tube-wells, pumping sets, thrashers, crushers and chaff-cutters. Madhya Pradesh is one of the backward state of the country. The agriculture, which provides more than half of the value of the net domestic products, is still characterised by low productivity in spite of the formulation and implementation of several programmes during the plan periods. The average yield of foodgrains in the state is only two-thirds of the country’s average.
OBJECTIVES

The objective of the present study are:

(i) To analyse the growth, distribution and pattern of factors responsible for irrigation and the contrasts in irrigation development in the different parts of the state.

(ii) To observe the changes in irrigation and farm mechanization facilities since 1969 (from fourth five year plan) to 1987.

(iii) Evaluation of the relationship of use of important yield raising input with the agricultural output and on the other hand, with the socio-economic conditions of the study area.

(iv) To analyse spatial variation in levels of agricultural development in the context of physio-socio-economic environment.

(v) To work out the relationship between temporal and spatial aspects of irrigation and other developmental measures.

(vi) To find out the correlation between irrigation and farm mechanization, with crop output in the selected areas of Madhya Pradesh.
STUDY AREA

For the present investigation Madhya Pradesh state has been selected. Situated in the heart of the country, the state extends from 17° 48' to 26° 52' north latitudes and from 74° 02' to 84° 25' east longitudes and covers 443.4 thousand Sq. km. (14.5 per cent of country's) area and thus stands first among the states. For the present study, out of the 45 districts 27 districts have been selected on the bases of highly irrigated and highly farm mechanized area above the state average. For the present study data are calculated for three references years (1969-70, 1976-77 and 1986-87). There were only 43 districts in the state in 1969-70, therefore to make comparable the 45 districts of 1976-77 and 1986-87 are annexed to their parent districts. It is proposed to analyse that how crop output is related with the irrigation and farm mechanization. There are 52,138.5 thousand people (1981) living in this state who constitute 7.6% of total population of the country and thus state ranks 6th in the size of population. About four-fifths of its people are living in the villages and more than three-fourths of the workers are engaged in agricultural occupation. From the point of view of proportion of workers in cultivation this state stands second just after Bihar among states of the
country. Such a heavy dependence of people and economy of farming necessitates special consideration of agriculture in the development planning.

From the point of view of performance of agriculture, the state is far behind than the national average. Yields of crops are low, dragging down the productivity.

Further, the state presents diversity in physical and cultural environment. Consequently, the state cannot be recognized as a single geographical unit. This results in spatial variation in agricultural bases as well as in levels of development. Thus this state can be taken as a test case for the analysis of the relationship of environment and agricultural conditions. At the same time, this is a state of two crops of different nature, i.e. rice and wheat, which are supposed to react differently towards the yield-raising inputs.

SOURCES OF DATA

The important source of agricultural statistics is the Commissioner of Land Records and Settlements Office, Madhya Pradesh Government, Gwalior. Several publications are brought out by this office, such as Season and Crop Reports, Basic Agricultural Statistics of Madhya Pradesh, Agricultural Census of Madhya Pradesh.
etc. These publications contain statistical information about area, production (output) and yield of crops, irrigation, landuse, livestock, agricultural implements, agricultural wage rates, and farm harvest prices. These information are available on district level. Some recent data have been collected from the Gwalior and Bhopal (unpublished records). Directorate of Agriculture, Madhya Pradesh, Bhopal also publishes agricultural data, among them annual publication of Agricultural Statistics contains valuable information about area, production and yield of crops, irrigation, use of fertilizers and other inputs and other developmental measures. Publications of the Directorate of Economics and Statistics, Madhya Pradesh, Bhopal have provided many useful data through its publications, particular mention be made of Statistical Abstracts of Madhya Pradesh. Agriculture and Livestock Statistics and Pocket Compendium of Madhya Pradesh for various year. These have been main sources of data for the back years. Sources of information pertaining to the development of irrigation during plans and irrigation potentials have been the occasional publications and records of the office of the Chief Engineer, Irrigation, Govt. of Madhya Pradesh, Bhopal. Data about climatic elements have been extracted from the publications of the Meteorological Department, Poona. Publications of National
Council of Applied Economic Research, New Delhi, such as Techno Economic Survey of Madhya Pradesh and Cropping pattern of Madhya Pradesh have also been frequently consulted for past data. Census publications are major sources of population statistics. Information about fertilizers have been obtained from Fertilizer Statistics 1986-87, The Fertilizer Association of India, New Delhi. Basic maps are extracted from plates and atlases published by the National Atlas and Thematic Mapping Organization, Calcutta and Survey of India.

METHODS AND TECHNIQUES

Data are transformed into rates and ratios. Analyses have been taken with both absolute and percentage values. The methods applied include use of correlation, regression, variance, combination and grouping techniques. Regions have been on the principle of dispersion from a central value, i.e. mean. The essential matter so derived is presented in maps, diagrams, graphs and tables, synthesizing a large body of data into present study.

Most of the maps are choropleth maps on which the areal differences in the importance of particular elements are shown by the difference in the density of shading. In most of these maps, other information relevant to that particular element have been presented.
Diagramatically. These diagrams help in comprehension of the discussion. Cartographic techniques have been extensively employed to present a visually appealing spatial view of agriculture and irrigation growth, in the region in consonance with the essentially geographic presentation.

THE PROBLEM

Madhya Pradesh state has the top position in terms of net area sown but not in terms of gross area. Mainly due to inadequate irrigation facilities. The traditional agricultural system with poor development and low proportion of cash crops coupled with low yield leads to low agricultural output of land leading to low per capita income of the state. While, agriculture is the main economic activity for the people of this state with 80 per cent of the population residing in rural areas. More than 76 per cent of the total working population is directly engaged in agricultural activities. Agriculture plays such a predominant role that even the most urbanized urban centres are not free from agricultural activity. In most of the medium and small urban centres of the state more than one-third of their working population is engaged in agricultural activity.
Irrigation and farm mechanization are necessary for prosperous and stable agriculture. Madhya Pradesh has great potential for irrigation. The area under irrigation is only 11.5% of the total cropped area which is very much lower than the country's average of 27.5%. Much progress have been made in agriculture through Five Year Plans. Even than this state has far behind the national average.

The benefits of agricultural development have not been equitably distributed socially and spatially. In India, those regions ecologically suited to the technology offered for agricultural development have prospered, while those with less suitable endowment of natural resources, such as most part of Madhya Pradesh, have lagged behind. As Lipton (1978) says, breeding cereals for high nutrient response does little for regions suffering both from poor soils and from lack of water. Agricultural development envisaged through improved seeds has, therefore, remained a localised phenomenon concentrated in favourable regions. Similarly, new agricultural technology has been suited to the needs of only rich farmers (B. H. Farmer, 1977). Thus, while some areas have been able to adopt new yield-raising technology, regions of poor, small and marginal farmers are lagging far behind.
PLAN OF WORK

The study has been divided into seven chapters in all. In chapter 1, elements of physical environment and population characteristics affecting irrigation, farm mechanization and agricultural development. Chapter 2, deals land use pattern. Since irrigation is most basic need for agricultural development, it has been discussed in chapter 3. Farm mechanization has been made the subject matter of chapter 4. Therefore, crop output have been discussed in chapter 5. It also includes discussion on cropping pattern and agricultural productivity. Impact of irrigation and farm mechanization on crop output in selected areas of Madhya Pradesh have been discussed in chapter 6. The study has been summarized and concluded in chapter 7.