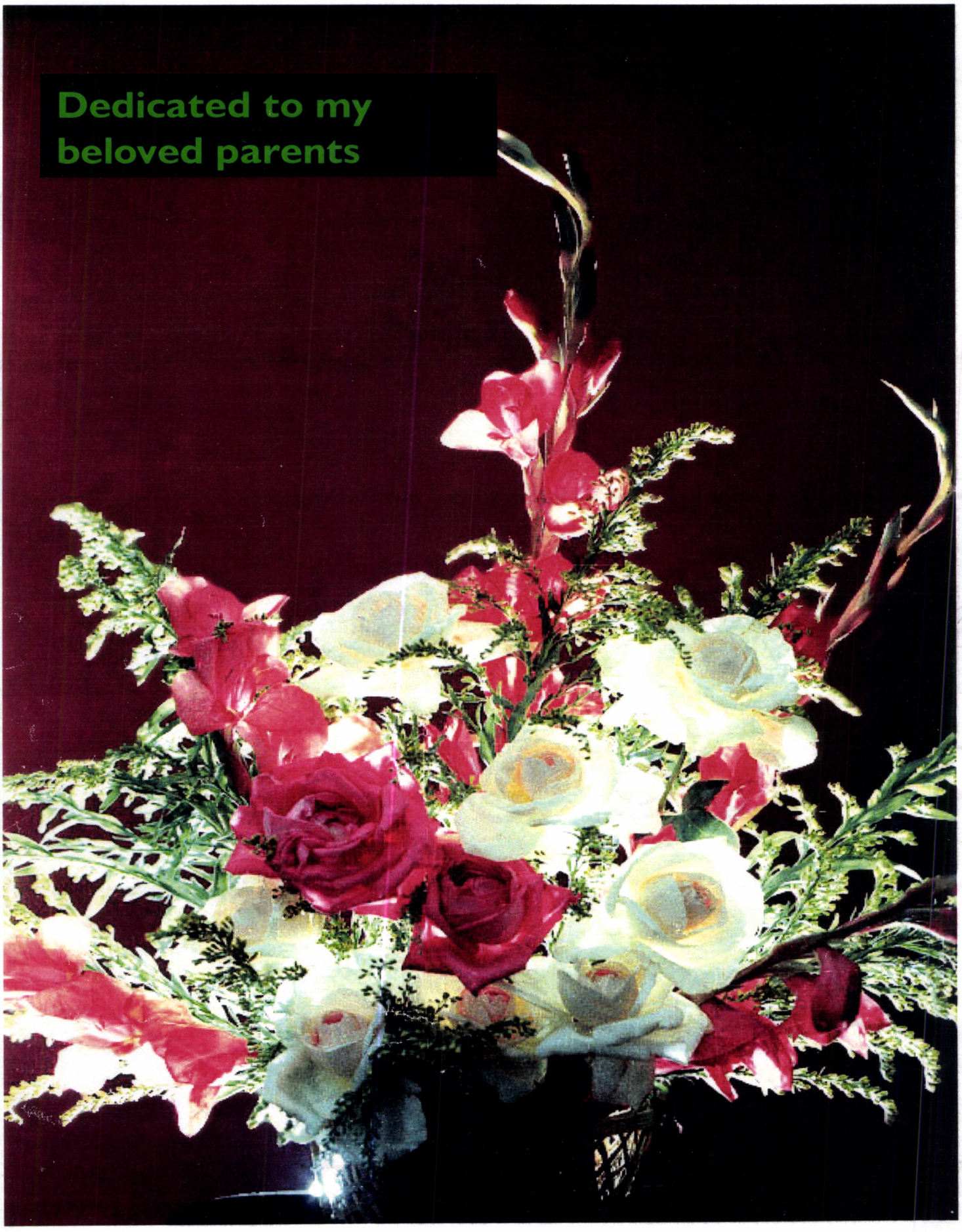
Dedicated to my
beloved parents

GROWTH AND DEVELOPMENT OF IRRIGATION IN MAHARASHTRA: A REGIONWISE ANALYSIS

By

SANGITA VISHNU WARADE
Reg. No. 20027

A thesis submitted to the

(731

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI, DIST. AHMEDNAGAR. 413722.
MAHARASHTRA STATE,
(INDIA)**

in partial fulfilment of the requirements for the degree

of

DOCTOR OF PHILOSOPHY (AGRICULTURE)

in

AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS

**POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI- 413 722, DIST.- AHMEDNAGAR
MAHARASHTRA (INDIA)**

2004

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MAHARASHTRA (INDIA)

2004

CANDIDATE'S DECLARATION

I hereby declare that, this thesis or part thereof has not been submitted by me or any other person to any other University or Institute for a Degree or Diploma.

Place : M.P.K.V., Rahuri

Dated: 10 / 12/ 2004.

(Sangita Warade)

Dr. D.V. Kasar
Head,
Department of Agricultural Economics,
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Rahuri-413 722, Dist. Ahmednagar,
Maharashtra (India)

CERTIFICATE

This is to certify that, the thesis entitled **"GROWTH AND DEVELOPMENT OF IRRIGATION IN MAHARASHTRA: A REGIONWISE ANALYSIS,"** submitted to the faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra State) in partial fulfilment of the requirements for the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in **AGRICULTURAL ECONOMICS**, embodies the results of a piece of *bonafide* research work carried out by **Miss SANGITA VISHNU WARADE,** under my guidance and supervision and that no part of the thesis has been submitted to any other university for degree or diploma. The assistance and help received during the course of this investigation have been duly acknowledged.

Place : M.P.K.V., Rahuri

Dated: 10 /12 /2004.

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Associate Dean,
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Maharashtra State, India.

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Place : M.P.K.V., RAHURI

Dated: 10/12/2004.

(D.M. Sawant)
Associate Dean

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Place: MPKV, Rahuri
Date : 10 / 12 /2004

(Sangita Warade)

T-6012

ABSTRACT

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By

SANGITA VISHNU WARADE

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DOCTOR OF PHILOSOPHY (AGRICULTURE)

In

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MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI- 413 722, DIST.- AHMEDNAGAR, MAHARASHTRA (INDIA)

2004

Research Guide	:	**Dr. D.V. Kasar**
Department	:	**Agricultural Economics**

An attempt has been made in this study to know temporal and spatial growth in irrigation, shift in allocation of irrigated area amongst irrigated crops, irrigation potential and utilization, factors responsible for growth in irrigation in different regions of the Maharashtra State. The districtwise data pertaining to net irrigated area, gross irrigated area, net sown area, gross sown area, sourcewise irrigated area, cropwise irrigated area, irrigation potential created and utilization of irrigation were collected. Time-series data for forty years i.e. from 1960-61 to 1999-2000 were collected in respect of all the four regions of the Maharashtra State which are Konkan, Vidarbha, Marathwada and Western Maharashtra from

Season and Crop Reports, Epitome of Agriculture, Economic Survey of Maharashtra and Statistical Abstract.

The study revealed that the percentage share of gross irrigated area in gross cropped area has been highest in Western Maharashtra region (21.12) during forty years of the study. In Konkan region, percent of irrigated area has been lowest as compared to other regions as compared to surface irrigation. The compound growth rate of irrigation has been highest in Marathwada(4.76). It is observed that the compound growth of well irrigation has been higher in the State during the forty years of the study period. Among the regions, the growth of well irrigation has been highest in Vidarbha region as compared to other regions, whereas the growth of surface irrigation has been highest in Marathwada region. The proportionate share of well irrigation in gross irrigated area has been highest(75.45 per cent)in Marathwada region.

Sugarcane has been observed as highly water consuming crop. It contributed highest share in gross irrigated area in Western Maharashtra and Marathwada region. Irrigated area under paddy has shifted to groundnut in Konkan and Vidarbha region. Irrigated area of jowar and chilli has been shifted to gram and sugarcane in Western Maharashtra and Marathwada region. Sunflower has been introduced as a newly irrigated crop since the last decade in the State. The share of non-food crops in gross irrigated area showed an increase from 9.63 to 12.66 per cent in the State from 1960-63 to 1995-98.

Growth of irrigated area under major and medium irrigation projects has been higher than minor irrigation projects in the State during the period of forty years of the study. Whereas growth in utilization of major and medium irrigation projects has been less as compared to minor irrigation projects. Gap between potential created and utilization of irrigation has increased during forty years.

In the State, drip irrigation has shown positive and significant correlation with gross irrigated area. Increase in irrigated area of vegetable crops, gross irrigated area has increased significantly during the period of forty years.

The above findings led to policy implications that there is need to increase use of micro irrigation specially for sugarcane in Western Maharashtra and Marathwada region and also need to increase use of modern water saving technology for paddy in Konkan and Vidarbha regions. Efforts are needed to reduce gap between potential created and utilization of irrigation.

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INTRODUCTION

1. INTRODUCTION

1.1 Importance of Irrigation

In underdeveloped economy, where large percentage of population derive their livelihood from agriculture, the development of agriculture plays an important role in initiating and stabilizing the overall process of growth in economy. The development of agriculture in its own term is development of various factors contributing in the development of the growth of agriculture. The increase in level of agricultural production could be achieved through the process of extensive and intensive cultivation. There is a scope for increasing the level of agricultural production through the improvement in productivity of agriculture. The increase in productivity of agriculture becomes the function of proper use of the various inputs like water, fertilizer, improved seeds, pesticides etc. Of these inputs, water becomes obviously the most important one. This is because, the use of fertilizer, improved seeds etc. is greatly dependent upon adequate and timely supply of water input. The dependence on irrigation facilities for providing the water becomes, therefore, important for raising the agriculture productivity. Irrigation ensures a secure harvest, acts as insurance against inadequate and inconsistent monsoon. It increases the net area cultivated and more importantly, the "gross cropped area" by enhancing the crop intensity through double or multiple cropping. It diversifies and transforms the cropping pattern with such beneficial effects as the substitution of inferior and low value crops by superior and high value ones, that proves more remunerative to the farmers. Since the marginal productivity of irrigated land is higher than

T-6012

that of un-irrigated land, it is economically more profitable to cultivate an irrigated rather than an un-irrigated hectares of land. Because of this positive correlation that exists between provision of irrigation and increased agricultural production, extensive development of irrigation is, in fact, a basic and necessary pre-condition for an accelerated agricultural development.

Its positive impact on creation of additional rural employment for agricultural labourers and self-employed family workers of the cultivating household is well recognized. Irrigation itself needs labour, it generate on-farm employment through increased cropping intensity and adoption of improved and labour intensive cultural practices like transplantation, line sowing, application of complementary inputs like manure, fertilizers and pesticides. Voluminous transaction of agricultural goods and their processing may also increase the off-farm employment opportunities. Thus in an abundantly labour surplus rural economy, irrigation reduces the rigours of unemployment, under-employment and seasonal under-employment.

Other than this, the irrigation also has many benefits such as changes in cropping pattern, absorption of modern inputs i.e. HYV seeds, chemical fertilizers, pesticides, implements etc. It raises gross income of farmers and promotes consumption and investment expenditure of farmers. The irrigation assists the growth of output-processing and input servicing industries. It activates trade and transport, encourages rural electrification programmes and enables primary sector to achieve self-sufficiency in foodgrains and raw materials. Indirectly, the irrigation increases social benefits such as education level, knowledge, changes in the attitude of the farmers etc. It helps to give push to the growth of tertiary sector.

1.2 Irrigation in India

During the 50 years since independence, the Central Government had spent about Rs. 2,31,400 crores (at 1996-97 prices) on major, medium and minor irrigation works. As a result, the country's irrigation potential has increased from 22.6 million hectares in the pre-plan period (i.e. 1950-51) to 95.12 million hectares at the end of 2001-02. With this, India has the largest irrigated area among all the countries in the world. This has greatly contributed to the increase in foodgrains production of the country from 50.82 million tones in 1950-51 to 203 million tonnes in 2001-02.

1.2.1 Irrigation potential and utilization in the five-year plans

All the Five Year Plans have given considerable importance to the additional irrigation potential. The First Plan devoted as much as 25 per cent of the total Plan outlay on irrigation and added 3 million hectares of irrigation potential. Generally, however, between 10 to 12 per cent of the total plan outlay has been on the creation of irrigation potential ranging from 5 to 10 million hectares. Table 1.1 summarizes the plan outlays and irrigation potential created since 1950-51.

According to the review of expenditure incurred on irrigation during eight plans, which has been summarized in the Ninth Plan, a total investment of Rs. 2,31,380 crores (at 1996-97 prices) was made in irrigation, Command Area Development (CAD) and flood control. The details of investment under various heads are presented in table 1.1. The pattern of investment reveals a remarkable uniformity during the entire 46 years period. It is seen that the major and medium irrigation projects account for 57 per cent of total investment, minor irrigation

31-32 per cent, command area development between 5 to 7 per cent and flood control account for 5 per cent of total investment. This pattern could be observed during the first six plans and the same pattern is continued in the Seventh Plan and the Eighth Plan.

As a consequence of this investment, the potential created in terms of irrigated area was of the order of 95 million hectares; about 35 million hectares as a result of major and medium irrigation and 60 million hectares as a result of minor irrigation (Table 1.2). The potential utilized in major and medium irrigation was 86 per cent and in minor irrigation, it was 91 per cent.

Table 1.1. Outlay on irrigation and flood control in the various Plans

(Rs. Crores at 1996-97 prices)

Period	Major and medium irrigation (1)	Minor irrigation (2)	Sub-total (3)	CAD (4)	Flood control (5)	Total (6)
First Six Plans (1951 to 1985)	72,000 (57)	39,780 (32)	1,11,780 (89)	6,540 (5)	7,240 (6)	1,25,560 (100)
Seventh Plan (1985-90)	21,210 (57)	11,800 (31)	33,010 (88)	2,760 (7)	1,800 (5)	37,570 (100)
Annual Plan (1990-92)	8,120 (57)	4,510 (32)	12,630 (89)	920 (6)	690 (5)	14,240 (100)
Eighth Plan (1992-97)	31,060 (57)	17,300 (32)	48,360 (89)	3,160 (6)	2,490 (5)	54,010 (100)
Total (1951-97)	1,32,390 (57)	73,390 (32)	2,05,780 (89)	13,380 (6)	12,220 (5)	2,31,380 (100)

(Note: Figures in brackets indicate percentages with the totals)
Source: Compiled and computed from Planning Commission, Ninth Five Year Plan (1997-2002), Vol. II, pp. 478.Planning Commission, Govt. of India

Table 1.2. Irrigation potential created and utilized upto the end of 1999-2000

(million hectares)

Source	Potential created	Potential utilized	Percent utilization
Major and Medium irrigation	35.3	30.5	86
Minor Irrigation	59.4	54.2	91
Total Irrigation	**94.7**	**84.7**	**89**

Source: 1. Ninth Five-Year Plan (1997-2002), Vol. II. Planning Commission
2. Economic Survey, 2001-2002. Planning Commission, Govt. of India

1.2.2 Irrigation potential and actual utilization

Unfortunately, the irrigation potential created over the years (in major and medium works) has not been fully utilized. For instance, at the end of the Seventh Plan (1989-90), the irrigation potential created and the actual irrigation utilized were 77 million hectares and 69 million hectares, respectively i.e. thegap of 8 million hectares. By 1999-00, this gap between potential and actual irrigation has widened still further. As against the irrigation potential of 95 million hectares created, the actual utilization was only 85 million hectares, with the gap of 10 million hectares. The non-utilization of the created irrigation potential occurred mainly due to delay in the construction of field channels and drains and in land leveling/shaping. Lack of involvement of farmers is also an important constraint in achieving full utilization of the created potential.

With a view in narrowing the gap between the potential created through the major and medium irrigation works and its ground level full utilization, the Central Government has

started the Command Area Development (CAD) programme. The basic objective of CAD Programme is to maximize productivity in the irrigation command areas through an integrated approach covering farm development works including construction of field channels and field drains, land shaping wherever necessary and the introduction of rotational supply of water to ensure equitable and assured distribution to individual farm holdings. CAD programme has not been particularly successful even though the Eighth Plan expected greater participation of the farmers (through their cooperatives) in the various activities of CAD programme.

The cost of creating irrigation potential through major and medium irrigation projects is Rs. 40,170/- per hectare (at 1996-97 prices) and that from minor irrigation projects is Rs. 12,970/- per hectare. This implies that the cost of irrigation for major and medium projects is more than three times per hectare as compared with that of minor irrigation projects (Datt and Sundaram, 2003).

1.2.3 Ground Water Resources

The Central Ground Water Board, set up in January 1997 at Faridabad (Haryana), has assessed the total availability of replenishable ground water resource of 43.39 million hectare metres (or about 433.86 billion cubic metres) per year through hydro geological surveys, exploration, evaluation and monitoring of ground water regime. It is estimated that, of this 7.13 million hectare metres is used for domestic and industrial purposes and 36.26 million hectare metres per year is available for irrigation. The available groundwater resource, however, is estimated at 37.24 per cent only (Datt and Sundaram, 2003).

1.2.4 Growth in Irrigated Area

Overall percentage of net irrigated area to net sown area in the country has increased from 17.56 per cent in 1950-51 to 40.00 per cent in 2000-01, whereas the percentage of gross irrigated area to gross sown area has also been increased from 17.10 to 39.22 per cent during the above said period. The decadal growth in irrigated area in country has been indicated in Table 1.3. Consequently, the food production has quadrupled from 50.82 million tones in 1950-51 to 209 million tonnes in 2001-02.

Table 1.3 Periodwise percentage of irrigated area to sown area in India.

Sr. No.	Particulars	Years					
		1950-51	1960-61	1970-71	1980-81	1990-91	2000-01
1.	Percentage of net irrigated area to net sown area	17.56	18.51	22.17	27.65	33.41	40.00
2.	Percentage of gross irrigated area to gross sown area	17.10	18.31	23.04	28.83	33.63	39.22

(Source: Agricultural Statistics at a Glance, 2002, Govt. of India)

1.2.5 Drip Irrigation

According to some experts, there is a potential to install drip irrigation system in 10 million hectares of agricultural land in India mostly in the water scarced states of Madhya Pradesh, Gujarat, Rajasthan, Maharashtra, Andhra Pradesh and Tamil Nadu. The system is highly suitable for horticultural crops. The area under drip irrigation in the country has increased from a meagre of 1500 hectares in 1985 to about 70,000 hectares in 1992 and an estimated 1,00,000 hectares in 1998(Anonymous, 2003a). In the country, Maharashtra state ranks first in area under drip irrigation.

1.2.6 National Water Policy:

The draft of a new policy prepared by the Working Group of the National Water Resources Council was considered for adoption after removing/changing some provisions in it. On April 1, 2002, the draft was finalized and adopted. The National Water Policy 2002 stresses on the maintenance of irrigation projects; calls for setting up of river basin organizations by the states; calls for dam safety legislation to ensure proper inspection, maintenance and surveillance; stresses the need for maintaining ecological balance in water allocation mandating minimum flows in perennial streams; calls for participatory approach in water management between user associations and the use of modern information system by private sector; and stresses on the need of using non-conventional methods of water conservation like rainwater harvesting, artificial recharge of ground water, inter-basin transfers, desalination of brackish and sea water, etc.

1.2.7 Accelerated Irrigation Benefits Programme

The Accelerated Irrigation Benefits Programme (AIBP) was launched by the Central government in 1996-97 to harness the Ultimate Irrigation Potential (UIP) through early completion of the hitherto uncompleted irrigation projects. Substantial progress has been made in the completion of 149 projects of which 20 are reported to have been completed.

1.2.8 Command Area Development Programme

In 1974-75, the Union Government had started a Command Area Development Programme (CADP) to bridge the gap between the created potential and utilizable potential which is still being continued. In 1974, in the beginning of this programme 60 major

and medium irrigation projects with a culturable command area of 15 million hectares were included under this programme. As on March 31, 2001 there were 236 projects covered under this programme with a culturable command area of 22.72 million hectares spread over 28 states and 2 Union Territories.

1.2.9 Watershed Development

Watershed development involves levelling of land, preserving canal irrigation water for crop use by preventing losses, improving water distribution systems, conserving scarce land resources, etc. In the last decade more than 10,000 watershed development projects were launched in the country. The different Watershed Development programmes are National Watershed Development Project (Rainfed Areas), Watershed Development Fund, Watershed Development in Drought Prone Areas, Watershed Development Project in North Eastern States, World Bank Aided Watershed Development Projects, DANIDA Aided Projects, A German Kreditanstant for Widderaufbau (KFW) assisted Integrated Watershed Management and Doon Valley Integrated Watershed Development Project. The Swiss Development Corporation has also aided two watershed development projects.

1.2.10 Water Requirements in 2050

According to the Planning Commission and National Commission for Integrated Water Resources Development (NCIWRD), the water requirement for irrigation alone would be 1191 billion cubic metres and a total of 1681 million cubic metres including that for other purposes by 2050(Anonymous, 2003a).

1.3 Irrigation in Maharashtra State

In Maharashtra, the net area irrigated in 2000-01 was 29.59 lakh hectares, out of which the area irrigated under wells was 14 lakh hectares. The gross irrigated area was 36.47 lakh hectares. The proportion of gross irrigated area to gross cropped area was 16.39 per cent (Anonymous, 2002).

1.3.1 Water Resource of the State

The geographical area of the state is 308 lakh hectares and cultivable area is 225 lakh hectares. Out of this, 40 per cent of the area is drought prone and about 7 per cent area is flood prone. The highly variable rainfall in Maharashtra ranging from 400 to 6000 mm occurs in a 4 months' period between June and September with the number of rainy days varying between 40 and 100. The estimated average annual availability of water resources consists of 164 km^3 of subsurface resources. Of the 5 river basin systems, only 58 per cent of this average annual availability is found in the four major river basins (Krishna, Godavari, Tapi and Narmada) from east of the Western Ghats. These four river basins comprise 92 per cent of the cultivable land and 75 per cent of the people living in rural settlements and fast growing towns and industrial area. An estimated 49 per cent of the area of these river basins containing 43 per cent of the population is already considered deficit or highly deficit in regard to water availability; and these river deficit areas are expected to increase steadily as both the population increase and the economic growth takes place. Moreover, Maharashtra shares all these four river basins with neighboring states and various inter-state river water tribunal awards/agreements and decisions on water sharing have reduced estimated available surface water resources in these river

basins for the state of Maharashtra to about 125 km^3 (Government of Maharashtra, 2003)

1.3.2 Irrigation Potential

The first Maharashtra Irrigation Commission popularly known as Barve Commission in its report 1962 estimated surface irrigation potential of 52.61 lakh hectares and 9 lakh hectares as ground water potential. The ultimate potential in state as per evaluation by the World Bank in the year 1979 was estimated at 61.93 lakh hectares. In 1984, the state government had appointed a Fact Finding Committee on regional imbalances in Maharashtra under the Chairmanship of Late V.M. Dandekar to identify backlog portion pertained to irrigation in three regions of the state. The committee had found that the major backlog portion pertained to irrigation and accordingly estimated that Rs. 1386 crore would be required to remove the backlog. It was estimated that three-fourth of ultimate irrigation potential is likely to be realized through surface water resources.

Different studies have revealed that out of the total cultivated area of 200 lakh hectares in the state, about 84 lakh hectares (42 per cent) can be brought under irrigation from all resources. It is estimated that about three fourth of ultimate potential i.e. 63.05 lakh hectares would be through surface water resources. Second Maharashtra Irrigation Commission (Chitale Commission) report submitted in 1999 estimated that 126 lakh hectares (55.75 per cent) area can be brought under irrigation. Potential created through major and medium irrigation projects is 60 lakh hectares and utilization is around 37 lakh hectares.

1.3.3 Growth in Irrigated Area

The decadal growth in relation to percentage of net irrigated area to net sown area and also gross irrigated area to gross sown area is presented in Table 1.4. it is noted that in Maharashtra, the proportion of net irrigated area to net sown area has increased from 6.00 per cent in 1960-61 to 16.78 per cent in 2001-02 and the proportion of gross irrigated area to gross sown area has increased from 6.48 per cent in 1960-61 to 16.39 per cent in 2001-02 showing a significant growth in irrigated area in the state of Maharashtra.

Table 1.4 Periodwise percentage of irrigated area to sown area in Maharashtra State

Sr. No.	Particulars	Years				
		1960-61	1970-71	1980-81	1990-91	2001-02
1.	Percentage of net irrigated area to net sown area	6.00	7.62	10.19	14.39	16.78
2.	Percentage of gross irrigated area to gross sown area	6.48	8.38	12.30	15.18	16.39

(Source: Economic survey of Maharashtra, 2002-03)

1.3.4 Irrigation Development Corporations

In order to accelerate the completion of irrigation projects in Maharashtra State, the Government has established five Irrigation Development Corporations in the State. These are as follows:

1. Maharashtra Krishna Valley Development Corporation (MKVDC)
2. Godavari Marathwada Irrigation Development Corporation (GMIDC)

3. Vidarbha Irrigation Development Corporation (VIDC)
4. Tapi Irrigation Development Corporation (TIDC)
5. Konkan Irrigation Development Corporation (KIDC)

1.3.5 Irrigation Projects

Maharashtra had set a target to cover 73 lakh hectares of land with irrigation projects but until now it has realized a potential of only 36 lakh hectares after spending Rs. 25,000 crores on 1,940 major, medium and minor irrigation projects (Anonymous, 2003a). It is still working on 1,160 such projects involving an investment of Rs. 27,000 crores and may take more than ten years to complete the same. The irrigation potential in the state by the end of June 2000, through all the types of irrigation projects taken together was 46.876 lakh hectares (Anonymous, 2003a). The share of major, medium and minor (both state and local sector) irrigation projects in total irrigation potential was 47.2, 12.80 and 40 per cent, respectively.

1.3.6 Project Investment

According to the 11th Quarterly Survey of Projects Investment conducted by Projects Today, as of 30th June 2003, the state had 1,046 projects worth a whopping Rs. 1,94,972 crores in various stages of planning and implementation (Government of Maharashtra, 2003). Over 10 per cent of the overall projects investment in India is in Maharashtra. Furthermore, the state enjoys a robust implementation ratio of 50.2 per cent, very much higher than the national average of 37.60.

1.3.7 Maharashtra State Water Policy

Maharashtra Government have declared State Water Policy with objectives to ensure the sustainable development and

optimal use and management of the state's water resources to provide the greatest economic and social benefit for the people of the state of Maharashtra in a manner that maintains important ecological values within rivers and adjoining lands.

1.3.8 Drip Irrigation

In Maharashtra, farmers growing wide-spaced and perennial crops such as grapes, bananas, mango, pomegranate, citrus and vegetables have primarily taken to drip irrigation. On farm, irrigation efficiency of properly designed and managed drip irrigation systems is about 90 per cent whereas it is about 70 per cent for sprinkler and just 45 per cent for surface irrigation methods (Narayanamurthy, 2003). The micro-irrigation systems need high investment and cost of installation. The slow growth of drip irrigation is not due to economic reasons but due to the lack of awareness among the farmers about the real economic and resource-related advantages of the new irrigation technology.

1.3.9 Water Users Association

Government of Maharashtra encourages the formation of Water Users' Association (WUAs) on the irrigation projects in the state. Directorate of Irrigation Research and Development (DIRD), Pune monitors the activities of formation of WUAs in the state. The State Government has taken policy decision in July, 2001 for formation of Co-operative Water Users Association(s) [WUAs] and handing over to them the irrigation management within a span of three years on all irrigation projects. The policy seeks to reduce the gap between irrigation potential created and actual area irrigated, to increase water use efficiency of irrigation management, to restrict the maintenance

expenditure and to recover government water charges effectively. By the end of September 2002, in all, there were 283 WUAs in operation covering the area of about 88 thousand hectares.

1.3.10 Regional Variation

Variation in irrigation development was found amongst the regions of the state. Western Maharashtra region occupied largest share (50 per cent) in gross irrigated area of the state (Chitale, 1999). Inspite of highest rainfall in the Konkan region, irrigated area is lowest amongst the four regions of the state. In Konkan region, slope and percolating lateriteic soil reduce water-storing capacity. Irrigated area in Marathwada and Vidarbha regions was 9.03 and 8.00 lakh hectares respectively during 2000-01. Highest growth in irrigated area was found in Marathwada region (Shete 1995). The reason behind the highest irrigated area of Western Maharashtra was diversion of rivers from Sahyadri to east of it in Western Maharashtra.

1.4 The Problem

Agriculture is the main occupation of 61 per cent population in the Country. In Maharashtra, dry land agriculture occupies about 85 per cent of the cultivated area. The rainfall is an uncertain factor, which brings changes in all agricultural activities from production to marketing and many times, it gives negative impact on agriculture sector. Irrigation is only the compensating factor for dry land agriculture and can stabilize dynamic activities in agriculture. However, according to first Irrigation Commission under the Chairmanship of S.G. Barve, the potential for irrigation is about 52 lakh hectares and according to World Bank, it is 61 lakh hectares and as per Second Maharashtra Irrigation Commission, it is 55.57 per cent. The

Maharashtra State is having great scope for increasing irrigation for agriculture. The area under irrigation may be increased by increasing availability of irrigation water as well as by developing irrigation technology. After the introduction of Green Revolution, there were vast changes in the cropping pattern of the state agriculture. Besides this, the high yielding varieties of different crops are introduced. Use of fertilizers and pesticides has been also increased efficiently.

In view of this, it is necessary to examine all these changes in the agriculture of Maharashtra state over a period of time in general and irrigation development in particular. The growth and development of irrigation has not been smooth over entire State and there exists disparities in growth and development of irrigation between different regions of Maharashtra. Irrigated area under different crops in different regions is also varying over a period of time. However, a very few studies were undertaken to assess the problem regarding regionwise growth and development of irrigation in the state. Looking to the importance and nature of the regionwise disparities in irrigation, it is essential to study this problem in depth and hence the research topic "Growth and Development of Irrigation in Maharashtra: A Regionwise Analysis" is undertaken for the study with the following objectives.

1.5 Objectives of the Study

The study was undertaken with the following specific objectives.

1. To study the temporal and spatial growth in irrigation in different regions of Maharashtra,

2. To study the shift in allocation of irrigated area amongst the crops over a period of time in different regions,
3. To study development of irrigation potential and its utilization,
4. To identify the factors responsible for growth and development of irrigation in different regions and
5. To suggest strategies for growth and development of irrigation.

1.6 Hypotheses of the study

In light of foregoing theoretical propositions and review of literature presented in next chapter, the following hypotheses are proposed to be tested for fulfilling requirements of the objectives of the study;

1. Growth rates of irrigation in all regions have been positive and varying over decades,
2. In Marathwada region, growth rate of irrigation has been highest in comparison with other regions of the state,
3. Irrigated area under non-foodgrains crops has been increasing and therefore the share of area under foodgrains in total irrigated area is declining and
4. Gap in potential and utilization of irrigation over a period of time is showing a decline in the state.

1.7 Scope and Utility of the Study:

Irrigation is an important input in cultivation and subsistence of all plant life. A highly efficient and irrigated cropping system alone can sustain agriculture for India's expanding population. Maharashtra is one of the leading states

in agriculture in India. The state is having tremendous potential of irrigation water, which can be used efficiently for growing variety of crops. The surface water resources of the state are mainly in the form of water resources from river. There are three major river basins and two major river sub basins in the state. The Godavari, Krishna, Tapi and Narmada are the important river basins in Maharashtra. The irrigation growth will take place through the development of these river basins. This study will help to such development by providing empirical evidences. The results of the present study will be helpful in formulating suitable irrigation policies to the State Government. The study would focus on allocation of irrigation water to different crops, changes in cropping pattern, allocation of inputs and technology etc. The study of temporal and spatial changes in irrigation growth over a period of time in different regions of Maharashtra will help in understanding structural development of irrigation in the different regions of the state. Study will also be helpful in reducing variations in irrigation growth and development across the regions in the state and in making decisions for each region in the state. With the help of findings, allocation of water as well as funds diversion amongst the regions can be managed. It will be helpful to formulate schemes pertaining to the specific region. It will be useful in identifying cropping pattern through the allocation of irrigated area amongst different crops in different regions of the state. Results will identify specific crops in the different regions for which modern water saving technologies can be used and overuse of water can be reduced. It will be helpful to find out specific crops where water diversion is possible. Findings will be helpful to emphasize on the regionwise development of well and surface irrigation and to get direction

for establishing irrigation projects with respect to unutilized potential and rainfall. The findings of the study will be useful for preparing policies regarding construction of watersheds, installation of drip and sprinkler irrigation systems, construction of canals and tanks and harvesting of water as per need of the particular region. It will also be useful for allocating water between irrigation and non-irrigation purpose with respect to their needs and also in allocating water between rural and urban areas.

REVIEW OF LITERATURE

2.REVIEW OF LITERATURE

The review of past literature becomes a guideline for any systematic research work. Knowledge of previous research work helps to plan the research work more systematically and effectively. This needs that research worker should review research findings of past studies closely related to the area of his research work. Such knowledge provides insight in respect of a manner in which given research problem could be tackled to accomplish the objectives under study.

The main objective of the present study is to analyze scientifically the growth in irrigation over a period of time in different regions, allocation of irrigated area to different crops and the variables influencing irrigation growth in Maharashtra. This chapter is therefore devoted to explain the reviews drawn from previous studies on irrigation in order to have a sound methodological framework for the present study. The reviews drawn on earlier similar studies have been divided into 5 groups keeping in view the objectives as indicated below.

1. Growth of Irrigation: Temporal and Spatial
2. Shift in allocation of irrigated area
3. Potential and Utilization of Irrigation
4. Factors influencing irrigation growth
5. Strategies for growth and development of irrigation.

2.1 Growth of Irrigation: Temporal and Spatial

In this section, the studies on growth in irrigation both spatial and temporal in different parts of the country have been briefly abstracted as below.

Gadre (1983) studied economic assessment of technological change in agriculture in Vidarbha region. He found that irrigation sources during 1956-57 were scarce and as such the irrigated area was insignificant in both the districts of Akola and Amravati. He observed slight improvement in irrigation of these two districts in 1983. In fact, if expressed in terms of percentage to net cropped area, the irrigated area was 6.3 per cent in Akola and 0.77 per cent in Amravati, the actual irrigated area being 2368 and 4774 hectares, respectively. During the course of time, this situation of irrigation had been slightly improved, in 1983 to the extent of 2.88 and 1.51 per cent of the gross cropped area in Akola and Amravati districts, respectively. Well irrigation was the most common source accounting nearly 70 per cent and 90 per cent of the total irrigated area in Akola and Amravati districts respectively. Irrigation was mostly given to the crops of *rabi* season.

Suresh Kumar (1983) found that in Maharashtra, only 13 per cent of cropped area was under irrigation. In the state, 32 per cent area was drought prone and 55 per cent of area received comparatively less precipitation. Irrigated area had increased from 10.52 lakh hectares in 1956-57 to 26.96 lakh hectares in 1981-82. Wells, canals and tanks contributed 60 per cent, 23 per cent and 13 per cent irrigation, respectively.

Dogra (1986) estimated that the area under irrigation in India was 51 million hectares before sixth plan and 60 million hectares at the end of sixth plan. Actual increase in sixth plan period was 18 per cent.

Dutt (1987) studied role of groundwater in development of agriculture in India. The study revealed that the number of dug wells, private shallow wells and public deep wells had increased surprisely from 3860, 3 and 2.4 thousands in pre-plan period to 9990, 4778 and 71.20 thousands in seventh plan.

Mahendradev (1987) found in his study on growth and instability in foodgrains production an inter-state analysis found that the percentage of net irrigated area to net sown area at the all India level increased by 60 per cent during the period from 1960-61 to 1983-84. In spite of this acceleration, around 70 per cent of the area was cultivated under rainfed conditions. At the state level, the extent of irrigation varied from around 11 per cent in Maharashtra to around 86 per cent in Punjab in 1983-84.

In Haryana and UP, the proportion of net irrigated area to net sown area was around 60 per cent. In states of Gujarat, Karnataka, MP, Maharashtra and Rajasthan the percentage increase was more than 50 per cent during the period 1960-61 to 1983-84 but the proportion was less than 25 per cent in these states even in 1983-84. The percentage of net irrigated area under tube wells was also higher in three states namely Punjab, Harayana and Uttar Pradesh.

Sale (1987) reported that net irrigated area in Maharashtra was 10,72,200 hectares in 1960-61, which had increased to 19,08,500 hectares i.e. by 77.99 per cent during 1982-83. The proportion of the net area irrigated to net sown area had increased from 5.99 per cent in 1960-61 to 10.42 per cent in 1982-83. The gross irrigated area also showed the similar trend. This means that the irrigated area in the state

had increased significantly. The area irrigated by wells as well as canals showed an increasing trend.

According to Joshi (1988), the area under irrigation was 3.30 per cent in Akola district of Vidarbha region in Maharashtra. He compared this with the Vidarbha region and Maharashtra state, which was 9.3 and 12.2 per cent, respectively. Percentage of irrigated area had been increased from 1.22 in 1968-69 to 3.30 in 1979-80, in Akola district. The study showed a wide variation in irrigation growth from district to district and region to region in the state.

Lohar (1989) revealed that the net irrigated area in Maharashtra in 1951-52 was 8.51 lakh hectares, which had reached to 20.25 lakh hectares in 1981-82. The number of wells had increased from 405 in 1951-52 to 1138 in 1980-81, whereas number of canals and tanks had increased from 446 to 841 over the same period in Maharashtra.

Kurian (1990) observed that out of total geographical area of India of 328.73 million hectares, about 141 million hectares (46 per cent) were net sown area. Gross cropped area was around 177 million hectares by 1985-86, implying a cropping intensity at around 126 per cent. Net irrigated area had increased to about 42 million hectares in the year 1985-86, which accounted for about 30 per cent of the net sown area. The corresponding gross irrigated area was about 54 million hectares, which also constituted roughly 30 per cent of the gross cropped area. The share of Maharashtra state in India was 12.8 per cent for net sown area, 4.5 per cent for net irrigated area, cropping intensity was 112.09 per cent, ultimate

irrigation potential was 6.6 per cent and potential utilized was 36.8 per cent in 1983-84.

Dhanagare (1992) found that in the state of Maharashtra, 10.5 per cent of its total cultivated area was under irrigation in 1978-79, whereas this percentage was 26.60 for the rest of India. However, throughout the three decades (1960-90) since the formation of Maharashtra state, this proportion of irrigated land had been rising slowly but steadily from 6 per cent in 1960 to 13 per cent in 1990. Compared to the other states, this proportion of irrigated area was much lower in Maharashtra in 1992. However, there was more than 100 per cent increase in land under irrigation.

Sidhu and Sidhu (1992) studied irrigation infrastructure of Punjab. The percentage of irrigated area to total net area sown had increased from 20.5 per cent in 1950-51 to 54 per cent in 1960-61 and 59 per cent in 1965-66. Well irrigation was a dominant source of irrigation during 1950-51 but it lost its significance to canal irrigation during seventies. Since then, private tube-wells replaced the wells and became relatively an important source of irrigation. This shift was caused firstly by the necessity of timely and controlled irrigation being required for success of High Yielding Varieties of various crops. The number of tube-wells had increased from merely 1973 in 1950-51 to 7,42,000 in 1988-89. Irrigated area in Punjab, which increased from 59 per cent in 1965-66 to more than 90 per cent in 1988-89. Punjab had hardly any significant area irrigated by tube-wells in 1950. The share of tube wells in irrigation had increased from 4.36 per

cent in 1960-61 to 61.62 per cent in 1985-86 and stagnated at almost this level since then.

According to Joshi (1993), major area of Marathwada region is located in central Maharashtra plateau zone having surface and subsurface sources of irrigation. The irrigation efficiency worked out to 32 to 40 per cent. The major irrigation projects in the region were Jayakwadi, Purna, Manar, Manjara, Upper Painganga and Majalgaon. There were medium and minor irrigation projects in the region. Major sources of irrigation were the wells (78 per cent), followed by Government canals (17 per cent). The area irrigated by other sources was 5 per cent. The percentage of gross irrigated area to gross cropped area was 6 per cent as against 10 per cent at the state level.

Mishra (1993) studied source-wise irrigated area in India. Canals constituted the single most important source of irrigation, which provided irrigation to nearly one-third (32 per cent) of total area under irrigation. The next in source was tube-wells, which also irrigated nearly one-third (30 percent) of holdings. Wells and tube-wells taken together irrigated nearly half (48 per cent) of holdings. Irrigated area by tanks was nearly one tenth (11 per cent) of gross irrigated area. Other sources taken together were nearly one tenth (9 per cent) of the irrigated area.

Chand (1994) studied role of water-rights in farmer-managed hill irrigation systems. He found that in the state of Haryana, percentage share of Kuhls (small gravity channels, constructed along mountain side) was 82 per cent, wells had 11

T-6012

per cent and channels had 7 per cent in total irrigation sources.

Shinde *et al.* (1994) studied irrigation development in Western Maharashtra. The results revealed that there was a creation of massive irrigation potential and huge expenditure was made on irrigation since inception of planning area. The net irrigated area and gross irrigated area had increased considerably since 1960-61 to 1990-91 in all districts of Western Maharashtra. However, there was no significant increase in net sown area in Western Maharashtra. In Nasik district, maximum proportionate change in net irrigated area to net sown area was observed from 4.83 to 13.83 per cent during the period 1960-61 to 1990-91. The proportion of net irrigated area was highest (20.39 per cent) in Satara and lowest in Dhule (8.69 per cent) districts. The proportion of area irrigated by surface irrigation showed considerable increase in Sangli (18.11 per cent), Pune (8.98 per cent) and Jalgaon (5.29 per cent) districts, while in other districts of region, the well irrigation was the only major source of irrigation.

Radkar (1995) studied area irrigated by different sources in Satara district during 1985-86. He found that in Satara district, the percentage of net area irrigated to net sown area was 20.16 per cent. The sources of irrigation were the wells and surface irrigation (government canals). Out of the total irrigated area, 41.23 per cent was irrigated by surface irrigation and 58.77 per cent was dependent on well irrigation.

Shete (1995) estimated the growth rates of net sown area and gross cropped area during the period from 1956 to 1990

in Maharashtra and reported that Western Maharashtra and Konkan regions experienced marginal decrease in net sown area and gross cropped area as well. Though the decrease in the gross cropped area in these regions was marginal, the same could be due to the farmers preferences to reallocate cropped area in favour of commercially important annual and perennial crops. In Marathwada and Vidarbha regions, however, both net sown area as well as gross cropped area had expanded at the rate of 1.18 and 0.52 per cent and 0.25 and 0.47 per cent per annum during the study period, respectively. In Marathwada region, the expansion in net sown area occurred mostly during the early part of the post-technological (1967-78) change period; whereas the land use intensity increased during the period 1967-78 on introduction of irrigation water from Jayakwadi Irrigation Project. Most of the expansion in net sown area and gross cropped area in Vidarbha region took place during periods 1956-67 and 1978-89.

Mahendradev and Mangekar(1996) in their study on Maharashtra's agricultural development revealed that proportion of lifting of ground water was 30 per cent. In districts of Nasik, Jalgaon, Aurangabad, Ahmednagar, Pune, Satara, Sangli and Solapur, lifting of ground water had gone upto 40 to 50 per cent. However in Vidarbha, Konkan, as well as in Marathwada region except Aurangabad district, the water-lifting rate was low. Therefore, the area under irrigation could be increased by using groundwater in these regions. In Amaravati Division (four districts), total area under irrigation through surface and wells was not more than 4 to 5 per cent. If the productivity of Vidarbha area had to be increased, the programmes of digging wells could be implemented. Groundwater availability in these

three districts of Chandrapur, Bhandara, Gadchiroli was high but the rate of lifting of groundwater was very low at that time.

Bahekar and Bhole(1997) studied growth and utilization of irrigation water in Akola district of Vidarbha. The study revealed that irrigation had a crucial role in reducing uncertainty in agriculture and helped in stabilizing the production and income of the farmers. The results of the study indicated that well irrigation was a major source of irrigation in Akola district. The area had remained stagnant at around 3.50 per cent of gross cropped area. In surface irrigation, hardly one fourth of the potential created was utilized.

In 1997, Bhalla and Singh estimated percentage of gross irrigated area to gross cropped area in different states of India for the period of 35 years i.e. during 1960 to 1995. It was 6.90 per cent in 1962-65, 12.66 per cent in 1980-82 and 15.38 per cent in 1992-95 in Maharashtra. It was 19.00 per cent in 1962-65, 29.29 per cent in 1980-83 and 35.60 per cent in 1992-95 in India.

Dangat and Yadav(1997) studied the irrigation potential created and its utilization during the last 35 years in Maharashtra State. The results of the study revealed that the proportion of net irrigated area to net sown area increased from 6 per cent during the year 1960-61 to 15 per cent during the year 1994-95. The gross cropped area had also increased over the period under study. The area irrigated by well irrigation had increased by three folds over 1960-61. The increased irrigation facilities had favoured the increased share of the crops like sugarcane and wheat. Though proportion of irrigated area under

food grain crops to total cropped area had increased during the period under study, its share had declined from 63 per cent (1960-61) to 52 per cent (1994-95) in the State.

According to Dhawan (1997), in India net irrigated area by government canals had increased from 14.50 million hectares to 16.60 million hectares in 1992-93, whereas gross irrigated area by government canals had increased from 18.61 million hectares to 21.89 million hectares.

Kasar *et al.* (1997) studied region-wise variation in development of irrigation and its utilization in Maharashtra. The study revealed that both net and gross irrigated area had significantly increased by the linear growth rate of 4.50 and 6.56 per cent per annum, respectively during the period from 1960-61 to 1996-97 in Maharashtra. The rate of growth in irrigation was significantly higher in Period-I (1960-61 to 1977-78) than the Period-II (1978-79 to 1995-96). The wells have appeared to be the major source of irrigation. The development of irrigation was quite conspicuous in Western Maharashtra followed by Marathwada and Vidarbha, while it was poor in Konkan region. Of the total irrigable area during the year 1995-96, the share of these regions was 51.27,26.05,21.08 and 1.50 per cent, respectively in the state.

Pawar *et al.* (1997) studied water utilization in Maharshtra. It was revealed that during the first plan period, potential in the state was 0.274 million hectares and by the end of 1997, it had reached to 3.29 million hectares. The well irrigation was the major source of irrigation (54.60 per cent),

followed by canals (22.75 per cent) and reservoirs (15.58 per cent).

Mohanty (1999) in his study on agricultural modernization and social inequality in Satara district reported that percentage of net irrigated area to net sown area had increased significantly from 13.43 per cent in 1970-71 to 22.52 per cent in 1990-91. The percentage of net irrigated area to net sown area was more in case of the small and marginal farmers holding which was one of the reasons of higher cropping intensity.

Nagaraj *et al.* (1999) in their study on groundwater utilization of US and India. In the study he had taken Karnataka State as a representative sample of India. In this study he estimated some parameters of Karnataka. The number of wells in the Karnataka State had increased from 1.35 lakhs in 1960 to around 5.1 lakhs by 1984-85 and to around 9 lakhs by 1993, registering a compound growth rate of 6 per cent. The net area irrigated from wells had increased from 4.6 lakh hectares in 1970 to 7.2 lakhs hectares by 1993, registering a compound growth rate of 2 per cent.

According to Shende (2000), Vidarbha region, especially Western Vidarbha predominantly known as dry land agriculture, ~~which~~ has less than 10 per cent of the gross cropped area covered under irrigation. The percentage of gross irrigated area to gross cropped area was lowest in the districts of Western Vidarbha zone. It had increased from West to East and therefore, the highest irrigated area was seen in Eastern Vidarbha zone. The highest percentage of irrigated area was noted in Buldhana district (50 per cent) followed by Gadchiroli (28.21 per cent),

Chandrapur (19.21 per cent) and Nagpur (13.90 per cent). Agriculture conditions of Eastern Vidarbha were favorable with paddy as the major crop of this region.

From the above said reviews on irrigation growth and sourcewise irrigation, it is observed that there has been wide variation in the percentage of irrigated area from state to state in the country. Percentage of irrigated area in the Maharashtra state was low as compared to other states of the country. Even in the state, it had been varying from district to district and over regions. Lowest percent of irrigation was in Konkan region and highest in Western Maharashtra. Growth rates of the irrigated area in the state were ranging from 4 to 6 per cent. Percentage of irrigated area had increased from 6 to 15 in the state during the period from 1960 to 2000. Share of well irrigation was the highest as compared to surface irrigation in the state. Growth rates of irrigation in different regions were also varying.

2.2 Shift in Allocation of Irrigated Area

In this section, the studies concerning to allocation of irrigated area to different crops over a period of time are reviewed in order to know the shifts in allocation of irrigated area in different regions of the country and state of Maharashtra. It would help to figure out extent of diversification in the cropping system over a period of time in different regions.

Suresh Kumar (1983) studied on agriculture in Maharashtra. He found that irrigated area under rice was 2.51 thousand hectares in 1956-57 which increased to 4.08 thousand

hectares in 1981-82. The irrigated area of wheat was 1.12 thousand hectares which increased to 6.12 thousand hectares during the same period of the study.

Gupta and Tiwari (1985) analyzed the factors affecting crop diversification in three tracts of Allahabad district in Uttar Pradesh for the year 1981-82.They observed that farm size had a significant negative effect on diversification i.e. large farms were relatively less diversified. The distance from market, land rented, farm net worth variables had a significant negative effect while price risk, yield risk and irrigation intensity had a significant positive effect on diversification.

Ashturkar (1986) in his study on progress of water management in Maharashtra pointed out that *jowar, bajara,* paddy and cotton based cropping system with irrigation were found equally profitable as compared to sugarcane. The duration of these crop sequences was three to four months less than that of sugarcane. *Jowar, bajara,* paddy and cotton required protective irrigation in the *kharif* season, while wheat, gram, sunflower and safflower made the best use of available irrigation water in the *rabi* season. The groundnut used good deal of available water in the summer season. The water requirement of these crops was two to three times less than that of sugarcane. If the area under sugarcane had restricted, large area could be brought under irrigation, which ultimately would have been increased and stabilize the production and productivity of major cereals, pulses and oilseeds crops in the state. It could help in increasing employment and income of the rural masses and could bring about growth and equity in irrigation water use in the state.

Mitra (1987) studied irrigation in drought prone areas of Maharashtra. He estimated average area irrigated (i.e. from 1976-77 to 1980-81) under Mula project of Maharashtra, which was 13,713 hectares, 19,497 hectares, 9,623 hectares and 42,833 hectares during *kharif*, *rabi*, hot weather and annual, respectively. Utilization of irrigation of Mula project was 49.29 per cent at average of five years (1976 to 1980).

Dhawan (1988a) in his study on Indian irrigation stated that Indian farmers had continued to show a note worthy preference for growing foodgrains under irrigated conditions. During 1983-84, farmers had allocated about 75 per cent of total irrigated area to cereals and pulses. Whereas out of total unirrigated area they had allocated 71 per cent area to cereals and pulses. The main revolutionary crops were wheat and rice under irrigated conditions.

Selvarajan and Subramaniam(1988) studied water resource budgeting in Amravathy river basin in Tamilnadu state. He found that paddy and Sugarcane alone accounted for 93.9 per cent of total irrigation water requirement of the command area-cropping pattern.

Rath and Mitra(1989) in their study on economics of irrigation in water scarce regions of Maharashtra State stated that if irrigation was provided to only a crop of *rabi jowar*, then the water ultimately available would have been sufficient to irrigate 64 per cent of the net sown area of the state of Maharashtra. Since *rabi jowar* required less irrigation water than other crops, this percentage figure highlighted great relative scarcity of irrigation water in the state in general

and in drought prone agricultural regions of Western Maharashtra, Marathwada and Vidarbha. Among the crops grown under canal irrigation, sugarcane was the most water-using crop. Though sugarcane had occupied less than 10 per cent of the total irrigated land under canals, it was consuming at least half of the total irrigation water. Even if an acre of irrigated land taken out from sugarcane is put under three successive seasonal crops in the three seasons of the year, the net irrigated area would increase by anywhere between 30 and 60 per cent or 50 to 100 per cent in case of *suru* sugarcane depending on the crop pattern followed.

The net income per unit of water was not much high for sugarcane as compared to *jowar* and some other crops. On the profitability of sugarcane, examination of economics of net returns per unit of water under irrigation showed that sugarcane generated the smallest net income per unit of water, indeed most of foodgrains like *jowar, bajara* and wheat gave two to four times as much net income as sugarcane, and groundnut in *kharif* season and onion, chillies in *rabi* gave almost 2 to 4.5 times as much.

They also stated that no more than 34 per cent of the cultivated land in the Maharashtra state was likely to be irrigated. A cropping pattern shift away from sugarcane to low intensive crops could increase this to 50 per cent of total cultivated area. Also, this would bring many more small and marginal farmers within the fold of irrigation. But it was difficult to implement this because many sugar factories were dependent on sugarcane for their production.

Bhatia and Tiwari (1990) studied the diversification, growth and stability of agricultural economy in Uttar Pradesh

for the period 1970-71, 1976-77 and 1980-81 separately. The Herfindahl Index and Entropy Index were used to measure diversification. They concluded that Uttar Pradesh economy was undergoing gradual diversification in favour of secondary and tertiary sectors, which was a healthy sign of economic development. The contribution of forestry and logging subsectors seemed to be almost falling. Availability of irrigation water all round the year in a district was expected to promote diversification.

In 1990, Mitra studied impact of irrigation on instability of production in Maharashtra. He found that at the state level, an average irrigated area under wheat, *bajara*, sugarcane, cotton and groundnut had increased by more than 100 per cent (wheat 285 per cent) in four years period ending 1979-80 over nine years period ending 1964-65. For *jowar*, the corresponding increase recorded was 75 per cent. Indeed percentage increase in an average irrigated area under most of the crops between the nine years period ending 1975-76 and four years period ending 1979-80 was quite impressive.

By and large, a similar picture was found in the four regions of Maharashtra State. In Bombay region, wheat, rice and sugarcane were the irrigated crops during the period 1956-57 to 1964-65. Even in eighties, these crops accounted for major irrigated area with substantial increase in average area irrigated. In Pune region, *jowar* and sugarcane were the major irrigated crops during the period 1956-57 to 1964-65, whereas in eighties the average irrigated area under sugarcane had increased very substantially. In Aurangabad region, *jowar* followed by wheat were the two major irrigated crops during 1956-57 to 1964-65, but by 1980s, an average irrigated area

under wheat had increased very substantially. In Nagpur region, rice was the only irrigated crop during 1956-57 to 1964-65 but by period ending 1979-80, wheat and cotton had recorded increase in average area irrigated. On the whole in the State an average irrigated area under different crops had recorded impressive increase, especially in four years ending 1979-80.

Amongst the foodgrains, rice, wheat and *bajara* recorded relatively high and significant rates of growth in irrigated area in all the regions of Maharashtra State during the period of 1967-68 to 1975-76 when, as noted earlier, the same period recorded relatively high instability in the output of these crops. *Jowar,* however, did not show any such clear association. Amongst the non-foodgrains, groundnut had shown relatively high rates of growth in irrigated area and relatively high instability in the period of 1967-68 to 1975-76, while for sugarcane, growth rates in irrigated area had remained more or less the same in both the periods. For cotton, no clear-cut association was noted.

Kale (1992) in his study on water scarcity in Maharashtra mentioned that acreage of land under wheat had decreased by 0.95 lakh hectares, while that under *jowar* had decreased by over 5.8 lakh hectares in 1992, while the area under sugarcane cultivation increased by 0.58 lakh hectares.

Mishra (1993) studied agricultural extension in irrigation commands in India. He found that among important cereals, wheat contributed maximum irrigated area in its cropped area (73 per cent) followed by rice (41 per cent). Cereals as a whole recorded 36 per cent irrigated area of cropped area. Fruits and vegetables contributed 41 per cent irrigated area.

In 1994, Desarda studied Maharashtra's economy. He found that 76 per cent of the irrigation water was used for sugarcane, which was grown on just 2.5 to 3 per cent of the total cultivated area in Maharasthra.

Shete (1995) estimated share of irrigated area of different crops in gross irrigated in Maharashtra State area during the period of 1956 to 1990. For the Maharashtra state as a whole, the proportions of area irrigated in the total area under paddy, wheat, gram and *rabi jowar* were increased from 20.87 to 27.42 per cent, from 15.50 to 58.13 per cent, from 9.19 to 16.00 per cent and from 6.67 to 10.98 per cent, respectively during the study period. The pattern of allocating irrigation water to all theses crops, however, varied greatly among different regions. There was no significant change in the area irrigated of most of the crops in Konkan region during the period under consideration. The irrigated area of paddy, wheat and gram crops had increased at a faster rate in Western Maharashtra, Marathwada, and Vidarbha regions over the period of time.

Mahendradev and Mangekar(1996) in their study on Maharashtra's agricultural development stated that sugarcane was one of the least profitable crops if water was taken into account. Sugarcane had occupied less than 3 per cent of the cultivated area and consumed around 60 per cent of the total irrigation water in the state.

Sarawat (1996) studied the diversification in cropping pattern and farming system in Kota village of Himachal Pradesh

for a period of three decades from 1959-60 to 1989-90. He reported that change in the cropping pattern in village was marginal because of lack of irrigation facilities.

Birari (1997) in his study on resource use structure, recourse productivities and allocation efficiency on farms of Western Maharashtra stated that sugarcane, wheat, gram, summer groundnut and horticultural crops such as fruits and vegetables consumed a major portion of the irrigation water. The gross irrigated area of Western Maharashtra was 16.05 lakh hectares and it constituted about 50 per cent of the gross irrigated area of the state. Excluding other crops, the maximum share of the area irrigated in the gross irrigated area was noticed in the case of sugarcane (19.26 per cent) followed by *rabi jowar* (18.24 per cent), wheat (16.85 per cent) gram (6.94 per cent) and groundnut (5.98 per cent).

The proportion of irrigated area under *kharif jowar* and *bajara* in Western Maharashtra to irrigated area of the Maharashtra state was 100 per cent. It was 75.29 per cent in sugarcane, about 60 per cent in case of *rabi jowar* and gram, 53.95 per cent in the case of wheat and 46.41 per cent in the case of cotton.

Kasar *et al.* (1997) studied region-wise variation in development of irrigation and its utilization in Maharashtra. The study revealed that the significant increase in allocation of irrigated area was noted in the case of wheat, pulses, sugarcane, fruits and vegetables, while the proportionate decline in allocation of irrigated area was noticed in case of paddy, *jowar (rabi)*, *jowar (kharif)*, bajra, maize and cotton during the period under study.

Mitra (1998) studied development and management of irrigation in Maharashtra. He found that significant change was observed in the mix cropping in the irrigated area over four decades (1960-90) in favour of foodgrains. Among the foodgrains, the pulses recorded significant increase and *jowar* and rice lost considerably their respective shares in the total irrigated area under foodgrains category between the period early 1960s and early 1990s. The irrigated mix cropping under the non-foodgrains category revealed that sugarcane continued to account for around one-third of the irrigated area since 1960s to early 1990s. While its share in total water use by crops in the non-foodgrains category had increased considerably during this period to reach a level of 76 per cent in early 1990s. Taking all crops into consideration, in early 1990s while sugarcane accounted for nearly one-sixth of the gross irrigated area used up a little over half of the irrigation water made available.

Singh (1999) studied the potential of diversification towards high value crops in Maharashtra for agricultural year 1996-97. Herfindahl and Entropy indices were used to measure crop diversification level. He observed that in general, foodgrains accounted for about 33 per cent of gross cropped area, followed by cash crops with 30 per cent, vegetables about 16 per cent and fruits 12 per cent. Farmers growing foodgrains, cash crops, vegetable crops and fruit crops were allocating large portion of the gross cropped area mainly to ensure food security and availability of cash. The Herfindahl index ranged from 0.207 for foodgrain, cash crops, vegetables and other crops scenarios where about seven crops were grown to 0.361 for

foodgrains and vegetable crops scenario where about three crops were grown. He concluded that farmers were practicing diversification. The scope for diversification of foodgrains with vegetables, fruits and flowers was observed to be vast both in terms of farm profitability and employment of farm labour.

Anonymous (2003) studied irrigation development in India. He estimated percentage share of irrigated area to total area under major crops. Percentage share of rice, wheat, *jowar*, sugarcane and cotton was 38.40, 54.30, 3.60, 70.40 and 17.30 in 1970-71, respectively, which had increased to 50.10, 85.00, 7.40, 90.70 and 35.90 during 1997-98, respectively.

The above reviews have clearly indicated that there have been changes in crop mix over a period of time because of change in availability of irrigation water at different locations. Different cropping patterns have been observed in different regions. On availability of irrigation the cropping pattern had been diversified towards commercial crops like sugarcane and cotton in Western Maharashtra. Sugarcane has been the most water-consuming crop, which alone shared 15 to 20 per cent of total irrigated area. It is pointed out that total area under irrigation could be increased by reducing area under sugarcane in Maharashtra. In Marathwada, *jowar* contributed highest share in irrigated area. While in Konkan, it was under rice. Contribution of irrigation resulted in diversification.

2.3 Potential and Utilization of Irrigated Area.

In this section, studies concerning to irrigation potential and utilization are reviewed and briefly abstracted as below.

Desarda (1983) studied winking at water. He stated that at the Jayakwadi, Purna, Bhima and Mula Projects, water utilization was less than 50 per cent because of skewed distribution of land, inequitious access to credit, processing, marketing and other supportive services.

Lohar in 1989 studied the impact of lift irrigation schemes on the economy of the cultivators in Kolhapur district of Western Maharashtra. In his research study, he has estimated some parameters of Maharashtra which are relevant to present study. He found that the total irrigation potential created in the state was 41 lakh hectares of which 38.57 lakh hectares was utilized in 1980-81.

Verma (1991) studied risk and uncertainty in agriculture of Vidarbha Region. He found that the irrigation potential created in Vidarbha region was 80.96 per cent by surface irrigation and 19.04 per cent was contributed by wells. Only about 40 per cent of potential created under surface irrigation was actually utilized.

Mitra (1996) reported on irrigation sector reforms. It was stated that the percentage of utilization of irrigation water was 100 per cent in pre-plan period, which had decreased to 90.60 per cent in Seventh Plan. This decrease was by 87.00

per cent in major and medium schemes and 92.50 per cent in minor schemes in Seventh Plan, which indicated utilization of irrigation was being decreased over a period of 40 years.

Bahekar and Bhole(1997) in their study on growth and utilization of irrigation in Akola district stated that in surface irrigation hardly one fourth of the potential created was utilized.

Mitra (1998) in his study on development and management of irrigation in Maharashtra reported that low utilization of irrigation potential from major, medium surface irrigation projects was largely due to concentration of water use in sugarcane. Large tracts of irrigable command area in the middle and specially in the tail did not get adequate water and hence the canal network was dysfunctional.

Anonymous (1999) reported that the total area under irrigation projects in India was 38 million hectares, in 1970-71 which constituted 17.3 million hectares under major and medium projects and 20.7 million hectare under minor projects. This has increased to 83 million hectares in 1997-98 comprising 29.3 million hectares under major and medium projects and 53.7 million hectares under minor irrigation projects in the country.

Nagaraj *et al.* (1999) in their study on groundwater utilization of US and India had taken Karnataka State as a representative sample of India. In this study they estimated some parameters of Karnataka and concluded that between 1971 to 1991 groundwater utilization had increased by three fold from 2 lakh hecto metres to 6 lakh hecto metres.

Shivanappan (2000) studied irrigation potential in India. India had the world's largest irrigated area i.e. 84 million hectares. The increase in irrigated area was observed, on an average, by 2.1 million hectares per annum during sixth FYP and 2.6 million hectares per annum during seventh plan period. In 1999-2000, major irrigation projects occupied 40 per cent of area and rest of the area was covered by minor irrigation projects.

Anonymous (2003) studied irrigation in India. It was estimated that potential created of irrigation was 22.60 million hectares in pre-plan period (1951), which increased to 94.73 million hectares in the Annual Plan of 2000-01. Utilization of irrigation has also been raised from 22.60 million hectares to 84.70 million hectares over the same period in the country.

Wangikar and Nadre (2003) quoted various reasons for under utilization of irrigation water. These reasons were inadequate supply of irrigation water, untimely supply of water, inadequate finance with the cultivators, lack of synchronization of completion of the main dam and the canal and distributaries, lack of infrastructural facilities in the command areas, poor planning of the projects, lack of coordination between irrigation and agriculture department at the time of formulation of irrigation projects, apathetic behaviour of irrigation authorities, farmer's unwillingness to take upland development works before water release, unscientific management in command areas leading to wastage of water, difficulty of reaching water supply to tail end, enforcement of prescribed cropping pattern, inadequate levelling of fields, etc.

The above said studies on irrigation potential utilization revealed that the potential and utilization of irrigation over a period of time showed an increase in the country. Gap between potential and utilization is increasing because of untimely and improper management, incomplete work of project and lack of co-ordination amongst management system of projects and farmers.

2.4 Factors Influencing Irrigation Growth

The literature on irrigation suggests that growth in irrigation is influenced by certain factors. It is important to understand the effects of such factors, which in turn could be managed for expediting the growth in irrigation. The studies relevant to this theme are briefly reviewed here as below.

Giriappa (1983) studied water use efficiency in agriculture in India. He stated that establishment of Water Users Association could evaluate plan for cropping pattern and allocation of water, extended benefits of irrigation to large area and brought diversification in cropping productivity.

Satpurthy (1984) in his study on irrigation and economic development concluded that level of irrigation development in Orrisa was low as compared to all India average because the minor irrigation programme had not been accorded the appropriate priority. The state had given priority to rural electrification programme, which constituted an important infra-structural pre-requisite for successful realization of minor irrigation targets.

Chopra and Kandekodi(1993) in their study on watershed development in India observed that due to the performance of the National Rural Employment Programme, the area under minor irrigation had increased from 0.48 lakh hectares in 1986-87 to 0.67 lakh hectares in 1988-89 in the country. The number of wells had also increased to 0.12 lakhs in 1988.

Pant (1999) in his study on impact of irrigation management transfer in Maharashtra noted reasons for not establishment of water co-operatives (a part of irrigation development) in Konkan region as very small size of land holding, high rainfall and terrain with steep slope. Paddy was the main crop, which did not require any precise water management. In contrast, in case of Vidarbha region, land holdings were large and old *Malgujari* tanks existed in the area. Since farmers were accustomed to getting free water for centuries, they did not find any attraction toward irrigation development. He also stated that sugarcane was a higher water consuming crop. In spite of low irrigated area of state, Maharashtra contributed 12 per cent of India's sugarcane produced and therefore sugarcane was also a reason for low growth of irrigation in the state.

Mitra (1998) in his study on development and management of irrigation in Maharashtra pointed out that more concentration on investment in major and medium projects during sixth, seventh and eighth plan periods doubled net irrigated area under canal during 1970-71 to 1990-91. On the other side, irrigated area under wells was also increased through private investments during the same period. All these resulted in significant changes in cropping pattern.

Government of Maharashtra (2000) stated in its status report on *Sinchan* that rainfall in the state varied over 350 blocks and among them 85 blocks received less than 75 per cent rainfall. Rainfall in each part of the state highly affected water storage in all reservoirs.

Patel (2003b) in his study on techno-socio-economic consequences of drip adopter association in south Gujarat stated that cropping intensity and cropping pattern had changed on the drip adopter farmers' fields. Many farmers had diverted their cropped and wasteland area to orchards. Moreover, the drip adopters had reaped many other benefits related to this agricultural development from Drip Adopter Association. These drip adopters had income upto Rs. 50,000/- and had medium level of economic motivation, innovativeness, risk preference and scientific orientation and moderately favourable attitude towards drip irrigation.

Desai *et al.* (2003) in their study on on-farm water management studies in summer Paddy in Ukai-Karapar Command concluded that with the change in water depth and water management practices in paddy fields, the irrigation authority reduced the delta for paddy in the minor projects. During last three years, 15 per cent more area was brought under cultivation, especially in tail-end portion of the minor projects. The farmers also did not get any reduction in the yield due to lesser use of water. The increase in area was with the same quantity of water allotted to the minor normally.

Patel (2003a) studied extension strategies for efficient water management in Gujarat. He estimated that only 28

per cent cultivated area was under irrigation in the state of Gujarat, of which ground water contribution was 78 per cent and remaining area was irrigated by the surface water sources. With the contribution of Sardar Sarovar Project, 50 per cent of the cultivated area of the state would be left at the mercy of the God.

From these studies concerning to factors influencing growth of irrigation, it is observed that improvement in irrigation technology, construction of projects, rainfall, government schemes and programmes and regional cropping pattern by and large influenced the growth of irrigation in general.

2.5 Strategies for Growth and Development of Irrigation

An attempt is made in this section to abstract the past studies concerning to strategies for growth and development of irrigation at various locations. It is expected that the recommendations, suggestions made by the researchers, irrigation experts in the earlier studies would identify serve as a basis to make some concrete suggestions by the present study for growth and development of irrigation in the state as policy measures. In this context, this section is devoted to present such policy statements or strategies based upon past studies in irrigation.

Dandekar *et al.* (1979) mentioned in committee report on eight month water supply that in Maharashtra the cultivation of long durational or water intensive crops could be restrained quite effectively by restricting the total quantum of water supplied in different seasons. Water could be delivered on the basis of volume.

Giriappa (1983) recommended formulation of water users association and co-operatives for optimum utilization of water and periodic evaluation of potential area in the country. He also recommended higher water rates for high water consuming crops.

Satparthy(1984) studied irrigation and economic development of Orissa. He suggested higher priority for groundwater resources and major irrigation projects. Gestation period of all types of dams should be reduced.

Mishra (1988) figured out some policies for irrigation development in Bihar state. He recommended annual growth rate of irrigation should be at least 10 per cent. Diversion of water from surplus to scarcity region should be made. Water duty should vary from crop to crop, time to time and place to place. Cropping pattern should be pre-planned. Water rates should be fixed on the basis of land holding of farmers.

Dhawan (1989) recommended that groundwater in drought-prone areas should be reserved as buffer stock. He also recommended for increase in height of dams to increase potential and buffer stock of water.

Mitra (1991) in his study on irrigation development analysis stated the challenges and facts in irrigation development to be faced by India. First, management was deep and widespread, especially in surface irrigation. People's participation in such developmental projects was at the moment minimal. Secondly, groundwater irrigation sources, which accounted to more than 40 per cent of net irrigated area in the

country was largely exploited privately by individuals. Thirdly, issue of "protective" versus "productive" irrigation, which gave rise to conflict between social goals and private gains. Fourthly, the absence of well coordinated and integrated approach to comprehensive land and water management and finally, there was a question of bringing about some sort of synthesis in the privately operated groundwater and public surface irrigation leading too much continue use of water. So even though the expansion and improvement of irrigation facilities occupied a prominent place in India's programmes for agriculture development and in this, growth in investment even in real term was increasing considerably during different plans the challenge facing such development had not been met squirmly.

Mitra (1998) recommended that water rates in the Maharashtra should be raised to cover rising cost of irrigation services. Establishing financial and functional autonomy for irrigation development would reduce constraints in management of irrigation systems.

Nagraj (1999) stated that water saved because of use of drip system in Karnataka state was 38 per cent in grapes, 39 per cent in coconut and 48 per cent in sapota. Therefore, he suggested to popularize the use of drip system for economization of irrigation water in crop product.

Patel (2003b) revealed in their study on consequences of drip adopters' association in Gujarat State that 72 per cent of drip owners could save the water from 25 to 50 per cent in drip method as well as reduced per hectare cost of fertilizer.

Thus, the above said reviews, by and large, suggested for volumetric distribution of water, formulation of Water Users' Association for effective utilization of irrigation water and raising of water rates besides diversion of irrigation water from river basins to water deficit areas. It also suggested the maintenance of growth rate of irrigation at par level to meet the future demand of water. Use of drip irrigation can increase use of water.

T-6012

METHODOLOGY

3. METHODOLOGY

This chapter is devoted to discuss in brief the methodology adopted for present study. It provides an insight into the sources of data, methods of obtaining data, selection of time periods and regions for detailed analysis, definitions of different variables chosen and analytical techniques deployed for analysis of data to accomplish the objectives of the study.

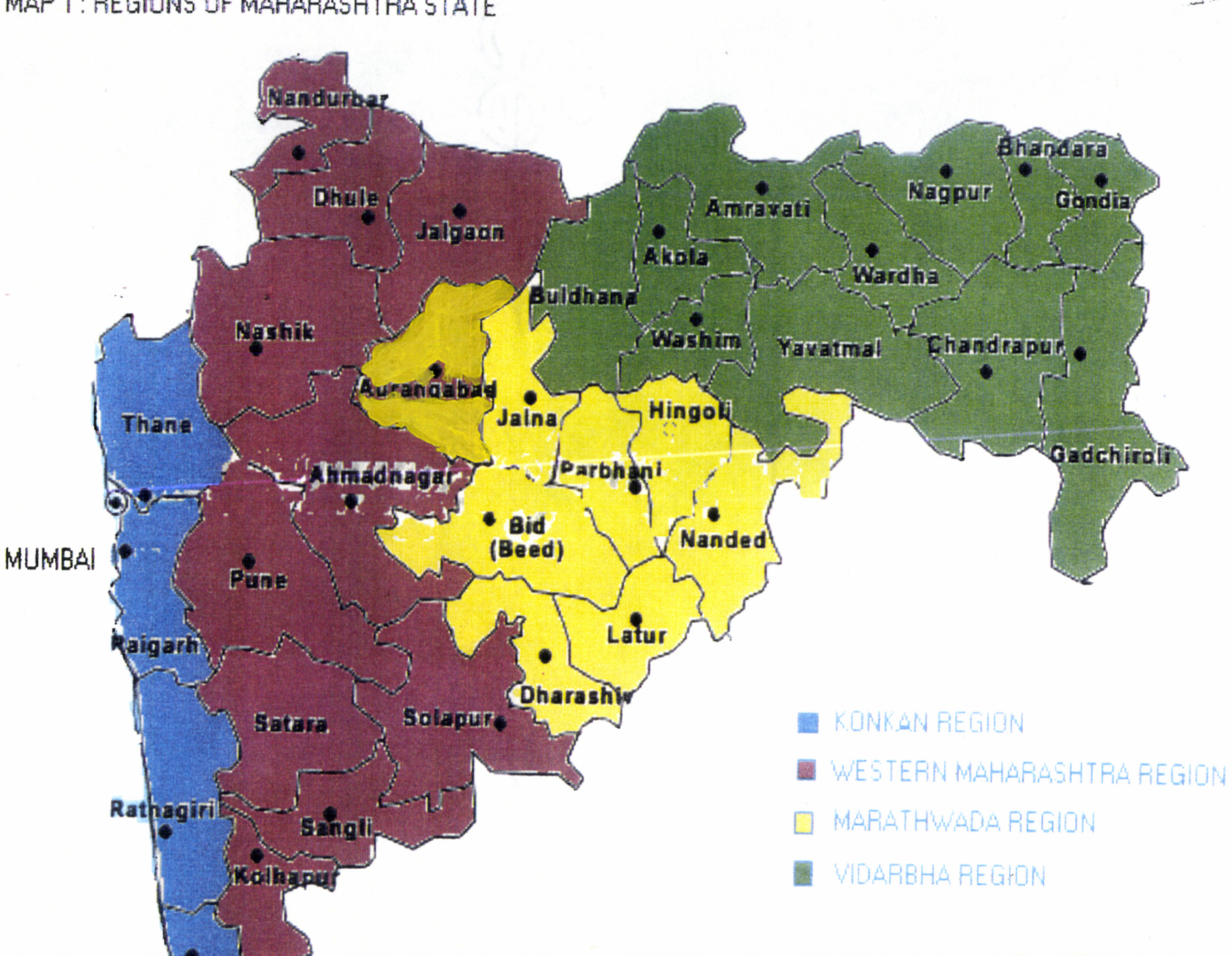
3.1 Basic Approach of the Study

In a predominantly agricultural economy, the overall rate of agricultural growth depends on physical, natural, economic and technological factors. Irrigation is an important factor, which significantly influences the growth of agricultural output. A wide variation in the growth of irrigation has been seen over different regions of the state and also allocation of irrigated area among different crops. In recognition of an importance of irrigation in agriculture, this study on "Growth and Development of irrigation in Maharashtra: A Regionwise Analysis" was undertaken. The study attempts to find out sourcewise irrigation growth, growth rates in irrigated area, shifts in irrigated area of different crops, diversification of irrigated crops, potential and utilization of irrigation over a period of time in different regions of the state. The methodology adopted to study the above said aspects have been briefly explained as below.

3.2 Selection of Regions

The state of Maharashtra was formed on May 1, 1960. On reorganization, the state was divided into four major revenue division *viz.*, 1. Western Maharashtra, 2. Konkan, 3. Marathwada

MAP 1 : REGIONS OF MAHARASHTRA STATE



and 4. Vidarbha on the basis of differing agro-climatic conditions, soil types, socio-cultural factors and other administrative and political considerations. Presently, the state is comprised of 35 districts as indicated in Table 3.1. Of these, the districts *viz.*, Sindhudurg, Latur, Gadchiroli, Nandurbar, Washim, Mumbai (Upnagar), Gondia and Hingoli have been newly formed by dividing Ratnagiri, Aurangabad, Osmanabad, Chandrapur, Dhule, Akola, Mumbai, Bhandara and Parbhani districts respectively. In the present study, these districts have been included in their respective parent districts for the reason that separate data were not available for these new districts for the entire period of study.

Table 3.1 Districts of Maharashtra State

Konkan	Vidarbha	Marathwada	Western Maharashtra
Mumbai	Buldhana	Aurangabad	Jalgaon
Mumbai (Upnagar)	Akola	Jalna	Dhule
Ratnagiri	Washim	Osmanabad	Nandurbar
Sidhudurg	Amaravati	Latur	Nashik
Raigad	Wardha	Beed	Ahmednagar
Thane	Yeotmal	Parbhani	Pune
	Nagpur	Hingoli	Solapur
	Bhandara	Nanded	Satara
	Gondia		Sangli
	Chandrapur		Kolhapur
	Gadchiroli		

3.3 Data Requirements and Sources of Data

To facilitate proper understanding of the process of irrigation development in the state, the entire period of 40 years from 1960-61 to 1999-2000 is divided into four decadal sub-periods. The individual period may have, however, witnessed different changes in irrigation in different regions of

Maharashtra. The break-up of the entire time period into sub-periods is expected to throw light on the regional pattern of short run irrigation growth in the state. The time periods selected for estimation of compound growth rates are as under.

Periods	**Years included**
1960-70	1960-61 to 1969-70
1970-80	1970-71 to 1979-80
1980-90	1980-81 to 1989-90
1990-2000	1990-91 to 1999-2000
1960-2000	1960-61 to 1999-2000

The changes in sourcewise irrigated area were estimated on the basis of triennial averages for the periods as indicated below.

Period	**Years included**
1960-63	1960-61,1961-62,1962-63
1970-73	1970-71,1971-72,1972-73
1980-83	1980-81,1981-82,1982-83
1990-93	1990-91, 1991-92, 1992-93
and	
1997-2000	1997-98, 1998-99,1999-2000

The shifts in area amongst irrigated crops on the basis of triennial averages, were estimated for the five specified periods as follows.

Period	**Years included**
1960-63	1960-61, 1961-62, 1962-63
1970-73	1970-71, 1971-72, 1972-73
1980-83	1980-81, 1981-82, 1982-83
1990-93	1990-91, 1991-92, 1992-93
and	
1995-98	1995-96, 1996-97,1997-98

The data in respect of gross irrigated area, net irrigated area, irrigated area of different crops, sourcewise irrigated area, potential and utilization of irrigated area in different regions were obtained from various published sources. The districtwise yearly data for entire period were obtained from the Season and Crop Reports and Epitome of Agriculture published by the Department of Agriculture, Maharashtra state. The Economic Survey, Statistical Abstracts of Maharashtra, Irrigation Commission and Committees reports and various government publications were also used to obtain the required data. The data on some of the variables were collected from the office records of Statistics Department, Department of Agriculture, Pune and also from the Ministry of Irrigation, Government of Maharashtra, Mumbai. The other sources of the data included various review articles published in Economic and Political Weekly, Indian Agriculture, Bhagirath, etc. It is thus clear that the present study is soley dependent upon the secondary data on irrigation published in various sources for the last forty years.

3.4 Analysis of the Data

The data were analysed both by adopting simple tabular method as well as regression analysis to accomplish the objectives under study. The aspects, which were taken into considerations for studying the growth in irrigation in the state are as under.

1. Gross and net cropped area
2. Gross and net irrigated area
3. Area under surface and well irrigation
4. Irrigated area under different crops and crop groups
5. Potential and utilization of irrigation

6. Annual rainfall and number of wells.
7. Area under drip irrigation, minor, medium and major irrigation projects.

The analytical framework included estimation of growth rates in gross and net irrigated area both regionwise and periodwise, triennial averages of surface and well irrigation and percentage change over different periods in irrigated area of crops. Percent share of irrigated crops in gross irrigated area and multiple linear regression analysis identify the factors responsible for growth in irrigation in the state. The details of analytical procedure adopted in the study are briefly outlined in the discussion that follows.

3.4.1 Estimation of Growth in Irrigated Area and Cropped Area

In the present study, the compound growth rates in gross and net irrigated area as well as gross and net cropped area have been estimated for different regions for five distinct periods *viz.*, 1960-61 to 1969-70, 1970-71 to 1979-80, 1980-81 to 1989-90, 1990-91 to 1999-2000 and for the entire study period 1960-61 to 1999-2000. The exponential equation of the following type was used.

$Y=ab^t$

Where

Y = irrigated area in hectares

t = time period in years

b = trend value (coefficient)

a = intercept

Compound growth rate= (Antilog b-1) x 100.

The significance of the estimated compound growth rates was tested with the help of 't' test.

For the estimation of changes, triennial averages of in sourcewise irrigated area, net and gross irrigated area, net and gross sown area are taken. The percentage shares of net and gross irrigated area in net and gross cropped area were estimated respectively. The two main sources of irrigation i.e. surface and well irrigation were considered for the study. Surface irrigation included canals, tanks, lift, ponds etc. as sources of irrigation. Percentage share of area under each source of irrigation in gross irrigated area has been computed for all regions in the state. Percentage change over a period of time has been obtained by taking the 1960-63 (triennial average) as a base period; where figures were not available in base period, the next period figures have been considered as base period.

3.4.2 Estimation of Changes in Area Amongst Irrigated Crops by Percentage Share

To throw light on variation in cropwise irrigated area, change in irrigated area under different crops has been computed at five points of time as mentioned in paragraph 3.3 for different regions of the state. The data on irrigated area for all crops as well as crop groups were available upto year 1997-98. The crops grown in respective regions were taken into account and the same were grouped into major groups as follows.

1. Cereals
2. Pulses
3. Sugarcane
4. Condiments
5. Fruit crops
6. Vegetable crops
7. Miscellaneous food crops

8. Food crops
9. Fibre crops
10. Oilseeds
11. Drugs and narcotics
12. Fodder crops
13. Miscellaneous non-food crops and flowers
14. Non-food crops
15. Gross irrigated area

To reveal the shifts of irrigated area under each crop, percentage share of each irrigated crop and crop groups in gross irrigated area has been computed. On the basis of percentage share, comparison is made over periods of time.

3.4.3 Estimation of Shift Amongst Area of Irrigated Crops by Correlation and Compound Growth Rates

In previous section, shifts have been found on the basis of percentage share of each crop in gross irrigated area. However, it is not sure of getting results of shift in area for all crops. Actually only area under a number of crops is shifted to some specific crops. For getting exact shifts amongst irrigated areas of selected crops, some statistical tools have been used. The procedure adopted for this purpose is briefly given in seven steps as below.

1. Obtain correlation coefficients of irrigated area of all crops during the period of 40 years.

$$r = \frac{\Sigma XY - (\Sigma X\ \Sigma Y/n)}{\sqrt{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}\ \sqrt{\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}}}$$

Where, the X and Y are the irrigated areas under crop.

2. Identify negatively correlated crops amongst the all correlation coefficients obtained from irrigated area of each and every crop.
3. Develop multiple regression model by taking irrigated area of negatively correlated crops as independent variables for each crop (dependent variable) under question.

$y = a + b_1X_1 + b_2X_2 \ldots\ldots b_n X_n + u$

y = Area of irrigated crop (independent crop)

a = intercept

$X_1X_2 \ldots X_n$ = Area of negatively correlated crops varying with dependent crop Y

b_{is} = coefficients of negatively competitive crops

u = error term

4. Testing the regression coefficients, using 't' test for deciding significantly competition crops
5. Obtain compound growth rates of crops, which are significantly and negatively correlated.
6. Compound growth rate of gross irrigated area of the region is subtracted from compound growth rate of each crop.
7. Obtain percentage share of subtracted values of crops in total of negative figures separately and positive figures separately to know percentage area shifted from one crop to others.

3.4.4 Estimation of diversification of irrigated crops by Indices

For the estimation of diversification in irrigation, area of the different regions in the State are taken. The period

of 38 years data of gross irrigated area have been considered. Decadal indices are estimated.

3.4.4.1 **Herfindahl Index:**

Herfindahl Index as given below was computed by taking sum of square of area proportion of each crop in total irrigated area.

$$\text{Herfindahl Index} = \sum_{i=1}^{N} P_i^2$$

Where, N is the total number of irrigated crops and P_i represents acreage proportion of the i^{th} crop in total irrigated area. With the increase in diversification, the Herfindahl index would decrease. This index takes value one when there is a complete specialization and approaches zero as 'N' gets large i.e. if the diversification is perfect. Thus, the Herfindahl index is transferred by subtracting from one i.e. 1-H.I. to avoid confusion to compare it with other indices. (Tress, 1938)

3.4.4.2 **Entropy Index:**

Entropy index is regarded as an inverse measure of concentration having logarithmic character.

$$EI = \sum_{i=1}^{N} P_i \times \text{Log } (1/P_i)$$

The index would increase with the increase in diversification and it approaches zero when there is perfect concentration i.e. when P_i equal one. The upper bound of the index is log N. However, the base chosen for taking logarithms and the number of crops determines the upper limit of entropy index. The upper value of index exceeds one, when the number of

crops is higher than the value of the logarithm base and it can be less than one when the number of crops is lower than base of logarithms. (Tress, 1938)

3.4.4.3 Modified Entropy Index:

Modified Entropy Index is used to overcome the limitation of entropy index by using variable base of logarithm instead of fixed base of logarithm. It can be computed as

$$MEI = \sum_{i=1}^{N} (P_i \times Log_N P_i)$$

The MEI, however, is equal to EI/Log N. It is worth mentioning that the base of logarithm is shifted to N number of crops. This index has a lower limit equal to zero when there is complete concentration, and it assumes upper limit of one in case of perfect dispersion i.e. it is bounded by zero and one. (Tress, 1938)

3.4.4.4 Composite Entropy Index:

This index possesses all desirable properties of modified entropy index, and is used to compare diversification across situations having different and large number of activities as crops of the study. It gives due weight to number of crops. The formula is

$$CEI = \left[- \sum_{i=1}^{N} (P_i \times Log_N P_i) \times (1-(1/N))\right]$$

or CEI = Modified Entropy Index x (1-1/N))

The CEI has two components *viz.*, distribution and number of crops or diversity. The value of CEI increases with decrease in concentration and rises with the number of crops. Both the components of index are bounds by zero

and one and thus the value of CEI ranges between zero and one. Since the index uses $\log_N P$ as weights, it assigns more weight to lower quantity and less weight to higher quantity. (Tress, 1938)

3.4.4.5 Ogive Index:

This index measures deviation from bench mark given by equal proportion of each crop

$$\text{Ogive Index} = \frac{\sum_{i=1}^{N} [P_i - (1/N)]^2}{(1/N)}$$

Like HI, the ogive index measures concentration, its upper value can go upto any level. Hence, it was transformed as 1-OI. The major limitation of this index is that bound tends to approach zero in case of perfect concentration i.e. N □ 1. Since P_i □ 1 and (1/N)□1. Thus, it implies that the index approaches zero in case of perfect concentration as well as perfect diversification. (Tress, 1938)

To get consistent results, all these five indices are used in the analysis of diversification of irrigated area for different crops.

3.4.5 Estimation of Changes in Potential Created and Utilization of Irrigation

To find gap between increasing potential and utilization of irrigation, it is important to study changes in potential and utilized irrigated area. In present study, potential and utilization of major, medium and minor irrigation projects have been considered for analysis. Figures of area under major and medium irrigation projects have been clubbed together. Gap between potential and utilized irrigated area have been estimated at five points of time as taken for sourcewise

irrigated area. Regionwise data on potential created were available from year 1970 and that on utilization of irrigation were available from 1990. Only decadal figures for regions were available. Decadal data for percentage change over period were used for regionwise estimation. Triennial averages have been estimated for percentage change over period of time for the state. Percent share of utilized irrigated area in potential created is estimated for minor, major and medium irrigation projects. The share of each region's potential and utilization in the total potential and utilization of state is also computed.

3.4.6 Factors Influencing Growth of Irrigation in Maharashtra

An attempt is made in this section to identify the factors responsible for growth of irrigation in Maharashtra. This is accomplished by taking gross irrigated area (ha) of a state or a region as dependent variable such as surface irrigation (ha), well irrigation (ha), rainfall (mm), area under major and medium irrigation projects (ha), area under minor irrigation projects (ha), area under drip irrigation (ha) and area under major crops of the selected regions are taken as independent variable for knowing functional relationship by way of a multiple linear regression analysis. To find the problem of multicollinearity, correlation matrices were estimated. In the present study, estimates of factors contributed in growth for irrigation have been estimated. The explanatory variables, which are responsible for growth of irrigation were different from region to region and the state as a whole. Period from 1960-61 to 1990-2000 is taken for analysis. The equations fitted to the data were as under.

a) For the state

$y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + u$

y = Gross Irrigated Area (ha)

a = Intercept

X_1 = Area under surface irrigation (ha)

X_2 = Area under well irrigation (ha)

X_3 = Rainfall (mm)

X_4 = Area under major and medium irrigation projects (ha)

X_5 = Area under minor irrigation projects (ha)

X_6 = Area under drip irrigation (ha)

X_7 = Area under sugarcane (ha)

X_8 = Area under irrigated fruit crops (ha)

X_9 = Area under irrigated vegetable crops (ha)

b_i (1 to 9) = Coefficients of respective factors or variables (X_1 to X_9)

u = Error term

b) For the Konkan region

$y = a + b_1X_1 + b_2X_2 + b_3 X_3 + b_4X_4 + b_5X_5 + u$

y = Gross irrigated area (ha)

a = Intercept

X_1 = Area under surface irrigation (ha)

X_2 = Area under well irrigation (ha)

X_3 = Rainfall (mm)

X_4 = Area under irrigated fruit crops (ha)

X_5 = Area under irrigated vegetable crops (ha)

b_i (1 to 5)= Coefficients of respective factor/variables (X_1 to X_5)

u= Error term

c) For Vidarbha region

$y = a + b_1X_1 + b_2X_2 + b_3 X_3 + b_4X_4 + b_5X_5 + b_6X_6 + u$

y = Gross irrigated area (ha)

a = Intercept

X_1 = Area under surface irrigation (ha)

X_2 = Area under well irrigation (ha)

X_3 = Rainfall (mm)

X_4 = Area under irrigated cotton (ha)

X_5 = Area under irrigated fruit crops (ha)

X_6 = Area under irrigated vegetable crops (ha)

b_i (1 to 6)= Coefficients of respective variables (X_1 to X_6)

u= Error term

d) For Marathwada and Western Maharashtra regions.

(Same type of function is fitted for both regions)

$y = a + b_1X_1 + b_2X_2 + b_3 X_3 + b_4X_4 + b_5X_5 + b_6X_6 + u$

y = Gross irrigated area (ha)

a = Intercept

X_1 = Area under surface irrigation (ha)

X_2 = Area under well irrigation (ha)

X_3 = Rainfall (mm)

X_4 = Area under sugarcane (ha)

X_5 = Area under irrigated fruit crops (ha)

X_6 = Area under irrigated vegetable crops (ha)

b_i (1 to 6)= Coefficients of respective variables (X_1 to X_6)

u = Error term

The above techniques of analysis have been used to obtain numerical estimates to accomplish the objectives of the study. The results of analysis so obtained have been presented in chapter-5

IRRIGATION POLICY FOR AGRICULTURAL DEVELOPMENT IN MAHARASHTRA

4. IRRIGATION POLICY FOR AGRICULTURAL DEVELOPMENT IN MAHARASHTRA STATE

Since the historical period, irrigation and water management got importance in the Maharashtra state. Water tanks in the reign of Yadav, Canal construction in the period of Tughlag, Phad System in Khandesh, Malgujari tanks in Vidarbha, Khajana well in Beed district are the main historical events of irrigation development in Maharashtra.

The irrigation development is not only the construction of irrigation projects and wells, but it includes investment, soil management, watersheds, changes in cropping pattern, water saving technologies *viz.*, drip and sprinkler irrigation systems, management system, policy implications, canal construction etc. Since the evolution of Maharashtra as a separate state, irrigation has been adopted as technology i.e. application of water to the growth of different crops, suiting to soil features and crop requirement. It also involves the active role of Non Government Organizations, Water Users' Association and Self Help Groups.

Different committees and commissions were set up to analyze potential of irrigation, to improve water management, to recommend policies regarding the growth and development of irrigation. Five corporations were established in the last decade to exploit potential of surface irrigation from respective rivers. In this chapter, our intension is to undertake review of all types of activities initiated by the Government for development of irrigation. Before we go in depth of irrigation development, it is necessary to know the profile of Maharashtra State in brief.

4.1 Maharashtra State Profile

Maharashtra is the second largest and populous state in India. Maharashtra's share in India's Gross Domestic Product is 13.60 per cent. Share of agriculture and allied sector in state income is 15 per cent. It's area is around 308 lakh square kilometers and contributed nearly 10 per cent of total geographical area of the Indian Union. It's population was 967.52 lakh in 2000-01. Population Density is 314 per sq.km. It's share in India's population is 9.42 per cent. Percentage share of agriculture workers in total workers is 61.51 per cent. Climate of the state is very uncertain. Rainfall in the state varies from 300mm to 2540 mm. Temperature varies between 26°C to 44°C. Soil types found in the state are deep black cotton soil, lateritic soil and alluvial soil. On the basis of soil type, rainfall, topography and cropping patterns, state is divided into nine agro-climatic zones. Out of total geographical area, forest area is 17.44 per cent, gross cropped area is 68.70 per cent and gross irrigated area is 16.00 per cent. Share of cereals in gross cropped area is 45 per cent and that of pulses is 16.42 per cent. Annual generation of electricity is 62317 million KWH and consumption is 47289 million KWH. Livestock population of the state is 397.93 lakh as per 1997 census. Major agriculture development programmes implemented in the State were Intensive Agriculture Development Programme, HYVs programme, Small Farmer's Development Agency, Marginal Farmer's and Agricultural Laborers Programme, Employment Guarantee Scheme, Integrated Watershed Development Progrmme, Crop Insurance Scheme. Production of food grains in the state was 101.2 lakh tonnes during 2000-01.

4.2 Irrigation History of Mahatrashtra State

Before independence, the main objective was to provide protective irrigation facilities in drought area. No doubt these objectives have served the purpose but, after independence the approach got changed from protective to productive. During drought situation, irrigation does not serve only for protective measures but also achieve the optimal productivity. Now a days, variety of crops and also hybrid varieties are coming up. The crop water requirement is changed and the irrigation system is designed to fulfill the crop water requirement.

Maharashtra has old tradition of irrigation. The phad system is a most economical method of management of irrigation water. The system is based on the co-operation of farmers whose fields are to be irrigated. Malgujari Tanks in Vidarbha were constructed near about two centuries back. Dams like Khadakwasla, Dama, Bhandardara were constructed before 1926. Nira canal system is constructed way back around 1880 and is functioning effectively even today.

Radhanagari dam in Kolhapur districts was constructed by the then ruler of Kolhapur State. Water is released from this dam into the river and stored in series of Kolhapur Type Weirs (popularly known as KT weirs) constructed on the rivers. Water released is lifted by members of co-operative societies of farmers and main crop of sugarcane is harvested in this area. These co-operative societies have been functioning successfully for the last more than 80 years.

Maharashtra has very strong history of co-operative movement. Co-operative movement is seen in all fields. The co-operative lift irrigation schemes at Panchaganga and Bhogavati rivers are successfully managed by co-operative societies.

The water allocation to the members of co-operative societies is based on volumetric basis and is shared during the allocated time. The water use is very efficient and economical and also the productivity of the crops is increased.

4.3 Committees and Commissions for Irrigation in Maharashtra State

Reference of irrigation in history of economics is found in Kautilya's 'Arthashastra' (350 BC) as erie or karmai (Water tank). In 1902-03, Vishweshwarayya, the doyen of civil engineering has suggested establishment of co-operative society in respect of Khadakwasla canals. British engineer, Mr. Bill (1905) recommended a plan for projects construction. British researcher Sir C.S. Englis (1916) suggested draining technology. In 1938, Irrigation Inquiry Committee suggested establishment of Water Panchayat and pointed out under—utilization of canal water. In 1947, the then Bombay Government had set up Canal Advisory Committee for Pani Panchayat Committee and Bagayatdar Sangh. The Barve Commission (1962) had even suggested that "it is necessary to keep a close vigil on the implementation of irrigation policy and for that a need will be felt to studying the price fluctuations in the irrigated crop production and reviewing water rates after a certain period. The Irrigation Commission recommended supply of water on volumetric basis, handing over of water management to farmers' groups and estimated 52 lakh hectares as surface irrigation potential and 9 lakh hectare as ground water potential i.e. total 61 lakh hectares can be brought under irrigation. Kokila Committee suggested a strategy based on inter-disciplinary approach to establish water users' societies on a large scale. The Sukathankar Committee (1973) suggested use of drip sets,

construction of watersheds and protective irrigation based on soil type of dryland area. Eight-month Water Use Committee (1979) suggested equal distribution of water and freedom for selecting type of crop and proportions for different season i.e. one-third water for *kharif* and two-third for *rabi*. Dr. Swaminathan, Chairman of Konkan Committee (1987) emphasized on development of water management technology based on soil type. Shri. S.B. Jain recommended block irrigation system in Vidarbha to increase water use in *rabi*, ban on emergency permission for sugarcane and to raise rate of water. Kasbekar Group (1986) recommended not to reserve water of rabi and summer for next kharif. Second Irrigation Commission (1999) under chairmanship of Chitale estimated ultimate potential of 126 lakh hectares in Maharashtra, which included share of surface irrigation (85 lakh hectares). It suggested valleywise recommendation for Godavari and Tapi valleys, and also for enroute and tail storages, use of drip and sprinkler sets and to increase water use efficiency. In Krishna Valley, it recommended compulsory drip irrigation system. In Konkan, it suggested minor irrigation projects with use of drip and sprinkler system. Changes in cropping pattern i.e. instead of rice, it recommended production of vegetables and other crops to maintain soil fertility.

Recapitulation of recommendations of various Committees and Commissions reveal that the most of their recommendations have not been implemented. These recommendations still need to be implemented. M. Vishweshwarayya in his report (1937) had also made one recommendation among others to the effect that the Government should create an independent cell for implementation of recommendations made by his Committee.

4.4 Irrigation Projects

In all, there are 400 river flows in the state of Mahatrashtra. Out of that Godavari, Krishna, Tapi and Narmada are the main rivers in the State. Average rainfall in the state is 1360 mm. From all surface irrigation resource, second irrigation commission estimated 85 lakh hectares as a potential of surface irrigation. A number of irrigation projects has been taken up by the State Government to tap the maximum possible area under irrigation. At the end of June 2002, with all types of irrigation projects taken together the gross irrigated area was 49.26 lakh hectares. It included share of major, medium and minor irrigation projects as 45.80, 12.70 and 41.50 per cent respectively. At the end of June 2002, 48778 projects were constructed. To accelerate the completion of the construction of irrigation projects in the State, Government has established following five irrigation development corporations.

1. Maharashtra Krishna Valley Development Corporation
2. Godavari-Marathwada Irrigation Development Corporation
3. Vidarbha Irrigation Development Corporation
4. Tapi Irrigation Development Corporation
5. Konkan Irrigation Development Corporation

Table 4.1 presents the information on total number of major, medium and minor irrigation projects planned and completed by different corporations in the state. Among all the Corporations in Maharashtra, the Krishna Valley Development Corporation had created largest number of irrigation projects. Out of total irrigation potential created in the State, only

Table 4.1 Number of irrigation projects incorporated by different Corporations in Maharashtra State

Corporation	Major	Medium	Minor	Total
1. Maharashtra Krishna Valley Development Corporation	23	50	324	397
2. Godavari-Marathwada Irrigation Development Corporation	13	24	237	274
3. Vidarbha Irrigation Development Corporation	12	27	55	94
4. Tapi Irrigation Development Corporation	8	37	115	160
5. Konkan Irrigation Development Corporation	1	4	33	38
Total	57	142	764	963

(Source: Economic Survey of Maharashtra 2002-03, pp.167)

62 per cent was utilized. Percentage of utilization of irrigation has been reduced over a period of 40 years. In case of investments on irrigation projects, there has been a quantum jump in investment on major and medium projects during the sixth, seventh and eighth five year Plans (Mitra, 1998).

4.5 Maharashtra State Water Policy

Government of Maharashtra designed state water policy in the year (2004) with an intension to ensure sustainable development and optimal use and management of state's water resource. Policy has given first priority to domestic use, second for industrial and third to agriculture. As per policy, farmer's participation in irrigation management should be made mandatory and water will be supplied on volumetric basis to Water Users' Associations (WUAs) only. The irrigation system shall be managed through WUAs as per provisions made in the appropriate Act. The participation of the private sector, in

partnership with the Government for the financing and implementation of water projects will be encouraged. Water harvesting shall be given consideration in planning water resources. Viable projects especially in scarce groundwater areas shall be investigated and implemented. Recycling and reuse of water have to be attempted for augmentation of water resources. Integrated Watershed Development Programme shall be encouraged in Drought-Prone Areas. In these areas, viable watershed programme shall be identified and planned for development. Water charges determined on the basis of the approved water tariff system, which will be levied on a volumetric basis. In order to alleviate the impact of such charges on those farmers who are unable to pay the complete charge, the State may allow cross-subsidies and allocate Governmental funds. Groundwater recharge projects shall be developed and implemented for augmenting the available supplies. Integrated and coordinated development of surface water and groundwater and their conjunctive use shall be envisaged right from the project planning stage and shall form an integral part of the project. Project priorities and selection shall be consistent with current and projected limits of available financing to ensure the timely completion of projects and programmes. While deciding the investment priorities, preference shall be given to the projects, which are at advantage. The State shall undertake to promote the development, adaptation and dissemination of affordable and appropriate water and agricultural technology for the benefit of its farming community.

4.6 Water Users' Association

Mr. Vishweshwarayya had suggested for the establishment of co-operatives in respect of Khadakwasla canals. Later in the report of Irrigation Inquiry Committee, it suggested for establishment of Water Panchayat. During 1988-90, Government of India conducted pilot schemes in Khadakwasla and Jayakwadi and two Action Research Programmes with NGOs in Mula and Waghad irrigation projects were undertaken. With positive results of research programme in 1994, Maharashtra Government launched the programme of establishing Water Users' Co-operatives. Different studies on Water Users' Associations revealed that Water Users' Associations are making profits from the water charges collected from users. They increased their irrigated area mostly using less water. Recovery of water changes was improved by Water Users' Associations. Water charges of Water Users' Associations are higher, but it is a good sign for the development of irrigation in the state as well as development of associations itself. With accumulated funds, Water Users' Associations maintain their microstructures. With the positive impact of Water Users' Associations, the state government has taken Policy-2001 for formulating co-operative Water Users' Associations and handing over the irrigation management to Water Users' Associations for three years. The policy seeks:

1. to reduce gap between irrigation potential created and actual area irrigated,
2. to increase water use efficiency,
3. to restrict expenditure on maintenance and repairs of irrigation systems and
4. to recover government water charges effectively.

At present, 283 Water Users' Associations are operational and 414 are registered. Major role of Water Users' Associations is evident in management and efficient use of water, collection of water charges to overcome the burden on recovery and subsidies.

4.7 Watershed Development

As agricultural production in the state is mainly based on rainfed farming, works of soil conservation are being carried out on a large scale in the state. With a view to increasing the production from dry land farming, maintaining continuity in it and preventing deterioration of natural resources, watershed based soil and water conservation works are being implemented in the State since 1983. There are in all 1505 major watersheds, 5500 mini-watersheds and 15000 micro-watersheds in the state. Various programmes are reframed and implemented under Integrated Water Development Programme with a target of 20460 watersheds. In watershed development programme, geographical information system is being used to identify suitable sites.

4.8 Costs and Receipts from Irrigation Projects

Gross receipts per hectare matched the corresponding working expenses till early 1980s, but thereafter while working expenses per hectare increased significantly, the gross receipts per hectare remained constant and increased marginally in post 1980s period. After reviewing the recommendations of earlier Commissions, Tenth Finance Commission adopted a norm of Rs. 300 per hectare for utilized potential and Rs. 100 per hectare for unutilized potential. The Commission mentioned that irrigation projects should cover not only operating and maintenance costs,

but also give returns of at least one per cent per annum on capital. By the end of 30thJune 2003, the state had 1,046 projects worth a whopping Rs. 1,94,972 cores, in various stages of planning and implementation.

4.9 Water Pricing

Pricing of water has to be considered in terms of both efficiency and equity aspects of irrigation development. To cover the operating and maintenance charges of projects, Government charges price for water. It varies from Rs. 65 to Rs. 1000 per hectare depending upon the type of crop. For sugarcane, it varies from Rs. 750 to Rs. 1000 per hectare. Around 90 per cent of irrigated area is charged by Rs. 65 per hectare, which has created a negative gap between receipts and expenses on irrigation. Vaidyanathan Committee made recommendation on the basis of three approaches *viz.*, cost, benefit and ability to pay of farmer. Mitra mentioned that existing water rates are abysmally low and need to be enhanced with immediate effect so as to improve financial health of the state irrigation department and to eliminate burden of subsidies on government.

Construction of modern field ponds is also new trend to irrigate farm with drip irrigation system. Government conducts various schemes through Block Agricultural Offices for irrigation development *viz.*, Employment Guarantee Scheme, River Valley Project, construction of watertanks, Nala bunding, field ponds etc. Though there is a progress in irrigation development, it is realized that gains from development efforts are not compensating to investment made and irrigation network created. It is because of the increase in investment on major and medium irrigation projects, less utilization of potential created,

reduction in water use efficiency, low water rates and high burden of subsidies (Mitra, 1998).

4.10 Micro Irrigation

Drip irrigation is a scientific method of irrigation carrying desired water and nutrients direct to the root zone of the plant. Drip Irrigation Systems is highly suitable for terrain and problematic soils and water. It saves labour cost and increases yield upto 20-90 per cent. It saves water up to 70 per cent. It can successfully work with 40 crops(Anonymous 2003b). Maharashtra contributed the highest in total area under drip irrigation in India. In 2001, area under drip and sprinkler irrigation was 1,93,226 and 19,891 hectares, respectively. Major crops under drip irrigation are banana, grape, sugarcane, cotton, pomegranate, mango and citrus. Of the total area under drip irrigation in the country, 60 per cent is in Maharashtra. The drip irrigation method is successfully used for fruit and vegetables, flowers and also for Sugarcane in Maharashtra. There are about 35675 drip project units in Maharashtra. Jalagaon district ranked first (16469 ha) in area under drip irrigation, followed by Nashik district (16258 ha). The area covered by State and Central Schemes was only 430 hectares in 1986-87, which has increased to 1,93,226 hectares in 2001.

Sprinkler irrigation system is also becoming popular in Maharashtra. Sprinkler can save upto 35 per cent of the water and promotes 15 per cent increase in yield. Sprinkler system is used all over Maharashtra except Konkan. It is best suited to close spacing crops especially groundnut, gram, vegetables, wheat and lucern. The area covered under sprinkler irrigation in Maharashtra by Sinchan Mahamandal and Central Scheme was 14303 and 5588 hectares, respectively in 2001-02.

Sinchan Mandal had given subsidy of Rs. 1675 lakhs. The State has good potential for micro irrigation systems, but lack of investment and care and maintenance after installation created problems in fast growth of micro irrigation in the State.(Government of Maharashtra, 2003)

Major constraints in adoption of micro irrigation systems are high cost of drip and sprinkler sets, less durability of sets as compared to cost, lack of technical knowledge, non availability of timely subsidies etc.

4.11 Panipanchayat (Water Council)

Shri. Vilasrao Salunkhe, a social worker from Purandhar (Pune) proposed that water is a common property resource and therefore all the villagers should have equal rights and access to the utilization of the water harvested in the area. Landless person can also apply for equal share of water. He practised fruit plantation on rocky and hilly lands successfully and conducted micro watershed projects in Saswad block of Pune district through his established institution *viz.*, "Gram Gourav Pratisthan." He stated that barren land can produce one seasonal crop per year through water conservation schemes and percolation tanks.(anonymous,2003a)

4.12 Irrigation in the Regions of the State

4.12.1 Konkan Region

The Western Ghat (Sahyadri range) runs from north to south separating the coastal districts of Thane, Mumbai, Mumbai Upnagar, Ratnagiri, Raigad and Sindhudurg from the rest of Maharashtra. At the ridge run across at right angle mansoon stream, it forms an important climatic divide. In this region the rainfall is very high ranging from 2000 to 2500 mm. Gross

irrigated area of the region is 0.64 lakh hectares. Main irrigated crop is only paddy. In the past, water oozing from lateritic rocks was being brought by canals for irrigation. Reference of "hundred tanks" in north Konkan Region was found in Gazetteer.

The region has sloppy area and highly porous lateritic soils which make difficult to arrest water flow and trickling water. As per the recommendation of Shri Barve, Chairman of First Irrigation Commission, it is highly difficult to develop irrigation system in the Konkan region but with the development of modern technology, new Committees and Commissions recommended some technologies for irrigation development. Shri Swaminathan Committee recommended Water Users' Association, Soil testing for water management in lateritic soil, diversification in water related business etc. to increase the irrigated area. Second Irrigation Commission recommended drip and sprinkler irrigation system, changes in cropping pattern as per level of slopes and emphasized on village level water management system.

4.12.2 Vidarbha Region

Tropical rainy climate is observed in this region. Moderate to moderately high rainfall ranges from 900 to 1700 mm. In all, eleven districts of the region are Buldhana, Yeotmal, Akola, Washim, Amravati, Wardha, Nagpur, Bhandara, Gondia, Chandrapur and Gadchiroli. Gross irrigated area of the region is 8.00 lakh hectares. Main irrigated crops of the region are paddy, wheat and cotton. Malgujari tanks are the famous part of irrigation history of this region. Malgujari tanks were specially concentrated in Chandrapur, Gadchiroli, Bhandara as well as Nagpur districts. Today also, 7000 malgujari tanks are found in working condition. In the period of British Empire,

irrigation system on tanks was developed in Ramtek, Ghodazari, Asolamendhu and Naleshwer during the year 1909, 1910, 1911 and 1919 respectively. Jain Committee (1981) recommended block irrigation system in Vidarbha. Main irrigation projects of the regions are Purna and Painganga.

4.12.3 Marathwada Region

Marathwada is the region of assured rainfall which ranges from 700 to 900 mm. It includes eight district *viz.*, Aurangabad, Jalana, Beed, Osmanabad, Latur, Parbhani, Hingoli and Nanded. Gross Irrigated Area of the region is 9.03 lakh hectares. Main irrigated crops of the region are jowar, wheat, sugarcane and cotton. Irrigation facilities of the region have been increased with the completion of Jayakwadi irrigation project. A well known historical part of the region is 'Khajana Well' of Beed district, which had a large potential of irrigation of more than 200 hectares. During the reign of Mohammad Tughlaq (17^{th} Century), he digged out a series of tanks and constructed canal in Daulatabad and Aurangabad. Malgujari tanks are also found in Nanded, Osmanabad, Parbhani and Latur districts. Second Irrigation Commission recommended the construction of tail storages, canals on flood level, use of drip and sprinkler sets, watershed development and groundwater development in this region.

4.12.4 Western Maharashtra Region

Western Maharashtra lies to east of the Western Ghats. It comprises of ten districts *viz.*, Jalgaon, Dhule, Nandurbar, Nasik, Ahmednagar, Pune, Solapur, Satara, Sangli and Kolhapur. Rainfall in the region ranges from 300 to 2000mm. All important rivers such as Godavari, Krishna and Bhima which originate from

waterfall of ghats flow eastwards across this region contributing to the economic benefits of this region. Gross irrigated area of the region is 18.95 lakh hectares. Main irrigated crops are sugarcane, wheat, jowar, fruits and vegetable. Area under sugarcane carries large quantity of water and shares around 23 per cent in gross irrigated area of the region. Area under sugarcane crop consumes around 70 per cent water. The gross irrigated area of the region account for 50 per cent of the state's gross irrigated area. Development of modern irrigation system in the region was initiated with the recommendation of Bill (1905). In the period of Bill, construction of Bhandara, Bhatgar, Nira, Gangapur, Dhom were the major irrigation works. Krishna valley, Bhima, Koyana, Mula and Mutha etc. are the main irrigation projects completed with large irrigation potential in this region.

5. GROWTH AND DEVELOPMENT OF IRRIGATION IN MAHARASHTRA STATE

The development of irrigation in Maharashtra State during last forty years has contributed significantly in productivity improvement, diversification, risk reduction, rise in income, social upliftment etc. There has been variation in irrigation growth among the regions of the State. Past literature revealed that there is continuous variation in sourcewise irrigation, shift amongst area of irrigated crops, potential and utilization trends. Irrigated area is being continuously diverted towards cash crops including fruits and vegetables.

In the light of variation in irrigation growth amongst different regions, it is imperative to probe in detail regionwise analysis of irrigation growth, sourcewise irrigation growth and regionwise shifts in allocation of irrigated area amongst the crops, potential and utilization of irrigation and contribution of other factors in irrigation growth in the State of Maharashtra .

5.1 Temporal and Spatial Growth of Irrigation

The present section attempts to analyse regionwise and sourcewise irrigation growth during different time periods. The empirical evidences relating to changes in irrigation growth have been derived from the decadal growth rates of net cropped area, gross cropped area, net irrigated area and gross irrigated area as well as triennial averages of the same parameters have been estimated for the five points of time *viz.*, 1960-63, 1970-73, 1980-83, 1990-93 and 1997-2000 in different regions of the

State as well as the State as whole. The growth in sourcewise irrigated area i.e. well and surface irrigation at five points of time and their share in the total irrigated area for different regions of the State as well as for the State as a whole were examined for temporal and spatial growth in irrigation.

5.1.1 Changes in cropped and irrigated area

The percentage share of net and gross irrigated area in the net and gross cropped area in the State remained less as compared to other States in the country.

As gross irrigated area under different crops has been increasing, it leads to diversification in the cropping pattern of the State. Major reason for these changes is an increase in irrigated area over a period of time. The contribution of net and gross irrigated area in net and gross cropped area is determined on triennial averages of net and gross cropped area as well as irrigated area and results are presented in Table 5.1. At the State level as a whole, the share of gross irrigated area in gross cropped area has increased from 6.38 per cent during 1960-63 to 16.46 per cent in 1997-2000. Increase in share of net irrigated area in the net cropped area is similar to that of gross irrigated area. An increase in the share of gross irrigated area in gross cropped area for the period from 1980-83 to 1990-93, was conspicuous in the State. However, in the case of share of net irrigated area in net cropped area, quite a good increase was seen during 1990-93 and 1997-2000 in the State. It was because of completion of some major projects like Jayakwadi Irrigation Project as well as due to exploitation of ground water through dugout wells, tubewells etc.

Among the regions, Western Maharashtra shared major chunk of irrigated area (21.12 per cent) in cropped area, followed by Marathwada (14.41 per cent) region during the period

Table 5.1. Coverage of irrigation in Maharashtra State

(Lakh hectares)

Region	Particulars	Period				
		1960-63	1970-73	1980-83	1990-93	1997-2000
Konkan	Net cropped area	8.71	7.63	7.98	9.23	8.18
	Net irrigated area	0.18	0.21	0.27	0.44	0.54
	Percent of NIA to NCA	2.07	2.75	3.38	4.77	6.60
	Gross cropped area	9.03	7.88	8.57	9.65	8.91
	Gross irrigated area	0.19	0.22	0.33	0.51	0.62
	Percent of GIA to GCA	2.10	2.79	3.85	5.28	6.96
Vidarbha	Net cropped area	47.29	50.17	49.98	50.92	50.23
	Net irrigated area	2.70	3.46	4.30	5.19	6.35
	Percent of NIA to NCA	5.71	6.90	8.60	10.19	12.64
	Gross cropped area	49.70	52.87	54.35	58.62	60.62
	Gross irrigated area	2.72	3.55	5.23	6.42	7.94
	Percent of GIA to GCA	5.47	6.71	9.62	10.95	13.10
Marathwada	Net cropped area	44.58	44.45	48.18	48.83	46.55
	Net irrigated area	1.57	2.18	4.10	6.64	7.02
	Percent of NIA to NCA	3.52	4.90	8.51	13.60	15.08
	Gross cropped area	48.22	47.29	53.01	58.70	62.16
	Gross irrigated area	1.79	2.43	5.43	8.39	8.96
	Percent of GIA to GCA	3.71	5.14	10.24	14.29	14.41
Western Maharashtra	Net cropped area	75.30	66.95	73.34	72.60	72.30
	Net irrigated area	6.23	7.56	10.46	14.58	15.52
	Percent of NIA to NCA	8.27	11.29	14.26	20.08	21.47
	Gross cropped area	80.24	71.51	80.31	83.66	89.11
	Gross irrigated area	7.24	9.30	13.34	17.43	18.82
	Percent of GIA to GCA	9.02	13.01	16.61	20.83	21.12
Maharashtra State	Net cropped area	175.89	169.21	179.49	181.59	177.27
	Net irrigated area	10.69	13.42	19.14	26.87	29.45
	Percent of NIA to NCA	6.08	7.93	10.66	14.80	16.61
	Gross cropped area	187.21	179.56	196.26	210.64	220.81
	Gross irrigated area	11.94	15.50	24.33	32.75	36.34
	Percent of GIA to GCA	6.38	8.63	12.40	15.55	16.46

1997-2000. The Marathwada region was third in 1960-63 and 1970-73 but came to second rank during 1997-2000, owing to completion of Jayakwadi and Painganga Irrigation Projects. The extent of irrigated area in Konkan region remained on lower side as

compared to other regions of the State because of undulating terrain, high land slopes etc. To make more specific, proportion of net irrigated area in the net cropped area was 21.47, 15.08, 12.64 and 6.60 per cent in the Western Maharashtra, Marathwada, Vidarbha and Konkan region respectively during the period 1997-2000. Graphical presentation is depicted in Fig. 5.1.

5.1.2 Growth rates of irrigation and cropped acreage in *different regions of Maharashtra State*

The annual rates of compound growth in net cropped area, gross cropped area, net irrigated area and gross irrigated area for the four regions as well as the State of Maharashtra as a whole for different time periods are presented in Table 5.2. For the State as a whole, the net cropped area has mostly remained more or less the same during the period of last forty years since the growth rate was only 0.039 per cent which turned out to be non-significant. However, the net cropped area in the State showed a significant increase during the decade 1960-70 to 1980-90 but subsequently declined significantly by 0.38 per cent per annum. This was mostly because of diversion of cultivated land towards different developmental activities such as roads, irrigation works, industrial establishments and house constructions. The gross cropped area in the State has increased at an annual growth rate of 0.46 per cent all throughout the periods under consideration showing continuous efforts of the farmers to increase cropping intensity in the irrigated as well as rainfed areas with assured rainfall. These findings confirmed the results reported by Shete (1995). The critical examination of the growth rates of net cropped area and gross cropped area, revealed that Western Maharashtra region experienced a marginal decrease in the net cropped area during the last forty years. In

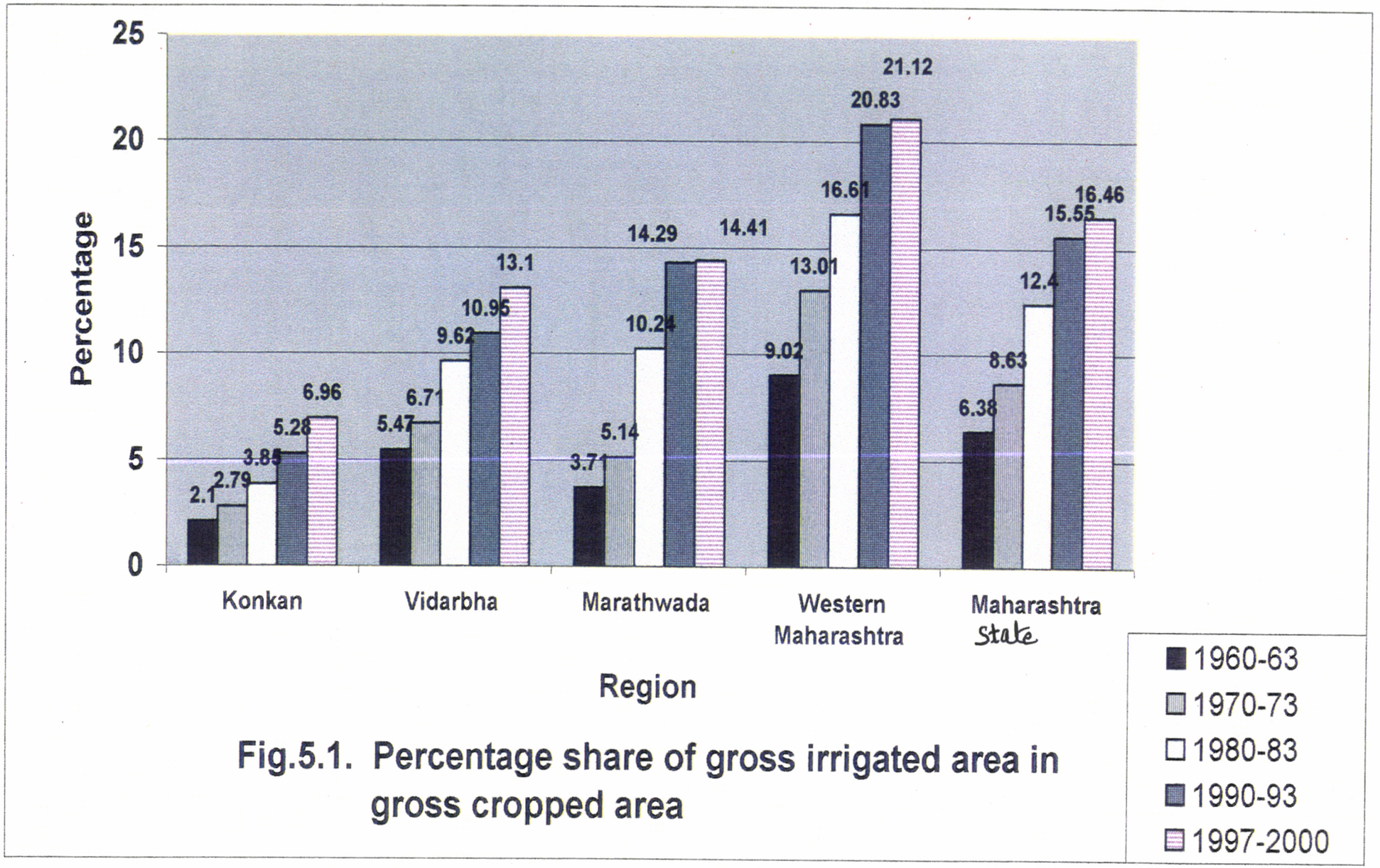


Fig.5.1. Percentage share of gross irrigated area in gross cropped area

Konkan, Vidarbha and Marathwada regions, however, both net and gross cropped areas have increased respectively, at the rate of 0.14, 0.10 and 0.14 per cent and 0.22, 0.50 and 0.71 per cent, annually during the period under consideration.

Looking to conditions of scanty rainfall in some parts and seasonality of rainfall in other parts, Maharashtra could be considered as one of the water resource scare States in India.

Table 5.2.Compound growth rates of irrigated and cropped acreage in Maharashtra State

Region	Period					
	Particulars	1960-70	1970-80	1980-90	1990-2000	1960-2000
Konkan	NCA	0.0739	0.8810**	1.7050**	-1.4375**	0.1410*
	GCA	0.0386	1.1444***	1.2861***	-0.8990	0.2244***
	NIA	3.6250**	6.1210***	5.3660***	3.4880**	3.1210***
	GIA	4.4720*	6.1070***	4.5810	3.7630***	3.3140***
Vidarbha	NCA	0.7810***	0.3090**	0.3113**	-0.3127	0.1070***
	GCA	0.7644**	0.6930***	1.0808***	0.4134	0.5080***
	NIA	2.7360***	3.2870***	0.7290	3.2380***	2.2040***
	GIA	3.0130***	5.6010***	1.1570	3.2540***	2.8875***
Marathwada	NCA	1.1326***	1.0480	0.4028	-0.0693**	0.1480**
	GCA	1.0134**	1.5201**	2.1450***	0.7580	0.7133***
	NIA	7.4890***	11.8910***	6.2370***	0.8372	4.291***
	GIA	7.0220***	12.6280***	6.0530***	0.9806	4.7661***
Western Maharashtra	NCA	0.0668	1.0464*	-0.0400	-0.1107	-0.0875*
	GCA	-0.1972	1.5390**	0.6570**	0.8370***	0.3020***
	NIA	2.4280***	3.7780***	2.1080**	1.2220**	2.6550***
	GIA	3.0730***	4.4477***	1.4330***	1.4110***	2.6710***
Maharashtra State	NCA	0.5480***	0.8198*	0.2593**	-0.3861***	0.0394
	GCA	0.3929**	1.2670**	1.2124***	0.6330**	0.4659***
	NIA	3.3660***	5.2720***	2.8760***	1.5580***	2.8890***
	GIA	3.7340***	6.2630***	2.5920**	1.6980***	3.1550***

(*, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

The growth rates of net irrigated area and gross irrigated area, spell out the efforts of the State government and of the farmers as well in exploiting surface and ground water resources for irrigation purpose with the massive investment in minor, medium

and major irrigation works under public and private sectors. For Maharashtra as a whole, net irrigated area and gross irrigated area have increased significantly at the rate of 2.88 and 3.15 per cent per annum, respectively, during the period of last forty years. The rate of increase in irrigation was comparatively higher during the earlier decades *viz.*, 1960-70 and 1970-80 as compared to the decades later. Among the four regions in Maharashtra State, the growth in net irrigated area as well as gross irrigated area was most conspicuous during the earlier decades viz., 1960-70, 1970-80 and 1980-90 in Marathwada as compared to other regions. The rate of compound growth during the period under study was 4.29 and 4.76 per annum in Marathwada region, which was highly significant. The significant growth in the irrigated area was also observed in other regions *viz.*, Western Maharashtra, Vidarbha and Konkan during the period under study. This happens because of persistent efforts made by the State government to increase area under irrigation by completion of irrigation projects with massive investment.

5.1.3 Regionwise changes in sourcewise irrigated area

The details of source-wise irrigation according to regions and periods is given in Table 5.3 and 5.4. Since the carvation of Maharashtra State in 1960, area under surface and well irrigation is continuously rising. Construction of irrigation tanks, watershed, canals, project work, wells etc. led to increase in area under irrigation. Regular efforts were made through various Irrigation Corporations and Directorate of Groundwater Development for development of irrigation potential, which resulted into an increase in irrigated area in Maharashtra State.

Table 5.3. Growth in surface and well irrigation in Maharashtra State

(lakh hectares)

Region	Periods					
	Source	1960-63	1970-73	1980-83	1990-93	1997-2000
Konkan	Surface Irrigation	NA	0.11	0.22	0.38	0.44
			(100.00)	(100.00)	(245.45)	(300.00)
	Well Irrigation	NA	0.11	0.11	0.13	0.18
			(100.00)	(0.00)	(18.18)	(63.64)
	Gross Irrigated Area	0.19	0.22	0.33	0.51	0.62
		(100.00)	(15.78)	(73.68)	(168.42)	(226.32)
Vidarbha	Surface Irrigation	NA	2.66	3.31	3.68	4.38
			(100.00)	(24.43)	(38.35)	(64.66)
	Well Irrigation	NA	0.89	1.92	2.74	3.56
			(100.00)	(115.73)	(207.87)	(300.00)
	Gross Irrigated Area	2.72	3.55	5.23	6.42	7.94
		(100.00)	(30.51)	(92.28)	(136.03)	(191.91)
Marathwada	Surface Irrigation	NA	0.48	1.64	2.44	2.20
			(100.00)	(241.66)	(408.33)	(358.33)
	Well Irrigation	NA	1.95	3.79	5.95	6.76
			(100.00)	(94.35)	(205.12)	(246.66)
	Gross Irrigated Area	1.79	2.43	5.43	8.39	8.96
		(100.00)	(35.75)	(203.35)	(368.71)	(400.55)
Western Maharashtra	Surface Irrigation	NA	3.21	4.32	4.82	5.59
			(100.00)	(34.58)	(50.15)	(74.14)
	Well Irrigation	NA	6.09	9.02	12.61	13.23
			(100.00)	(48.11)	(106.90)	(117.24)
	Gross Irrigated Area	7.24	9.30	13.34	17.43	18.82
		(100.00)	(28.45)	(84.25)	(140.74)	(159.94)
Maharashtra State	Surface Irrigation	NA	6.46	9.49	11.32	12.61
			(100.00)	(46.90)	(75.23)	(95.20)
	Well Irrigation	NA	9.04	14.84	21.43	23.74
			(100.00)	(64.15)	(137.05)	(162.50)
	Gross Irrigated Area	11.94	15.50	24.33	32.75	36.34
		(100.00)	(29.98)	(103.76)	(174.28)	(204.35)

NA : Not available

(Figures in the parentheses are the percentage changes over the respective base year)

Table 5.4. Share of surface and well irrigation in gross irrigated area in Maharashtra State

(Lakh hectares)

Region	Source	Period			
		1970-73	1980-83	1990-93	1997-2000
Konkan	Surface Irrigation	0.11 (50.00)	0.22 (66.67)	0.38 (74.50)	0.44 (70.97)
	Well Irrigation	0.11 (50.00)	0.11 (33.33)	0.13 (25.50)	0.18 (29.03)
	Gross Irrigated Area	0.22 (100.00)	0.33 (100.00)	0.51 (100.00)	0.62 (100.00)
Vidarbha	Surface Irrigation	2.66 (74.93)	3.31 (63.29)	3.68 (57.32)	4.38 (55.16)
	Well Irrigation	0.89 (25.07)	1.92 (36.71)	2.74 (42.68)	3.56 (44.84)
	Gross Irrigated Area	3.55 (100.00)	5.23 (100.00)	6.42 (100.00)	7.94 (100.00)
Marathwada	Surface Irrigation	0.48 (19.75)	1.64 (30.26)	2.44 (29.08)	2.20 (24.55)
	Well Irrigation	1.95 (80.25)	3.79 ((69.74)	5.95 (70.92)	6.76 (75.45)
	Gross Irrigated Area	2.42 (100.00)	5.42 (100.00)	8.39 (100.00)	8.96 (100.00)
Western Maharashtra	Surface Irrigation	3.21 (34.52)	4.32 (32.38)	4.82 (27.65)	5.59 (29.70)
	Well Irrigation	6.09 (65.48)	9.02 (67.62)	12.61 (72.35)	13.23 (70.30)
	Gross Irrigated Area	9.30 (100.00)	13.34 (100.00)	17.43 (100.00)	18.82 (100.00)
Maharashtra State	Surface Irrigation	6.46 (41.68)	9.49 (39.00)	11.32 (34.56)	12.61 (34.70)
	Well Irrigation	9.04 (58.32)	14.84 (61.00)	21.43 (65.44)	23.73 (65.30)
	Gross Irrigated Area	15.50 (100.00)	24.33 (100.00)	32.75 (100.00)	36.34 (100.00)

(Figures in the parentheses are the percentage share of surface and well irrigation in the respective Gross Irrigated Area.)

In the State as a whole, irrigated area under surface irrigation has increased by 95 per cent, while area under well irrigation has gone up by 162.50 per cent during the period under study. It indicates that exploitation of ground water is high as it is exploited at more places than surface water.

In the case of surface irrigation, the highest change was observed in 1997-2000 over 1970-73 in Marathwada (358.33 per cent), followed by Konkan region (300 per cent). It was because of weak base period (1970-73) as compared to Vidarbha and Western Maharashtra region. The well irrigation has shown an excellent growth in all the regions of the State except Konkan region during the past 30 years.

In Konkan region, though there is abundance of water, it is not possible to divert it to irrigation easily due to the geographical features of the region *viz.*, sloppy land, rocks and soil conditions. Further there features make difficult the exploitation of ground water and arrest of surface water. Special efforts and practices are required to increase irrigated area in Konkan region.

Percentage share of well irrigation in gross irrigated area (see table 5.4) was high during all the periods in Marathwada and Western Maharashtra regions, while reverse trend was found in Konkan and Vidarbha regions.

In Vidarbha region, there is a good potential for ground water exploitation and therefore a consistent good growth was observed in well irrigation but there is less scope to harvest surface water as compared to other regions of the State.

For the State as a whole, the share of well irrigation increased from 58.32 to 65.30 per cent, as against the share of surface irrigation which decreased from 41.68 to 34.70 percent during the past three decades. Graphical presentation of share

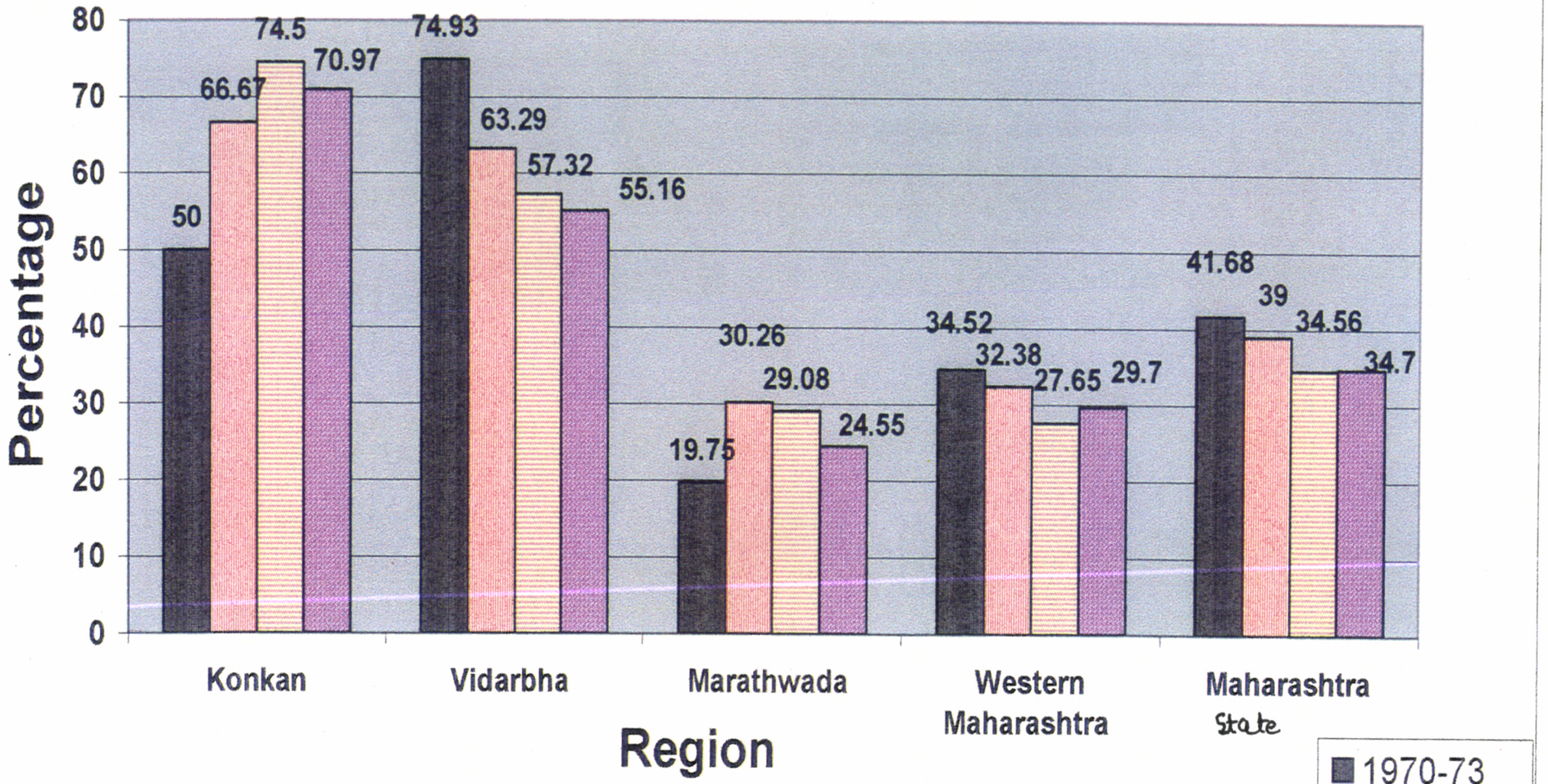


Fig.5. 2 . Percentage share of surface irrigation in respective gross irrigated area

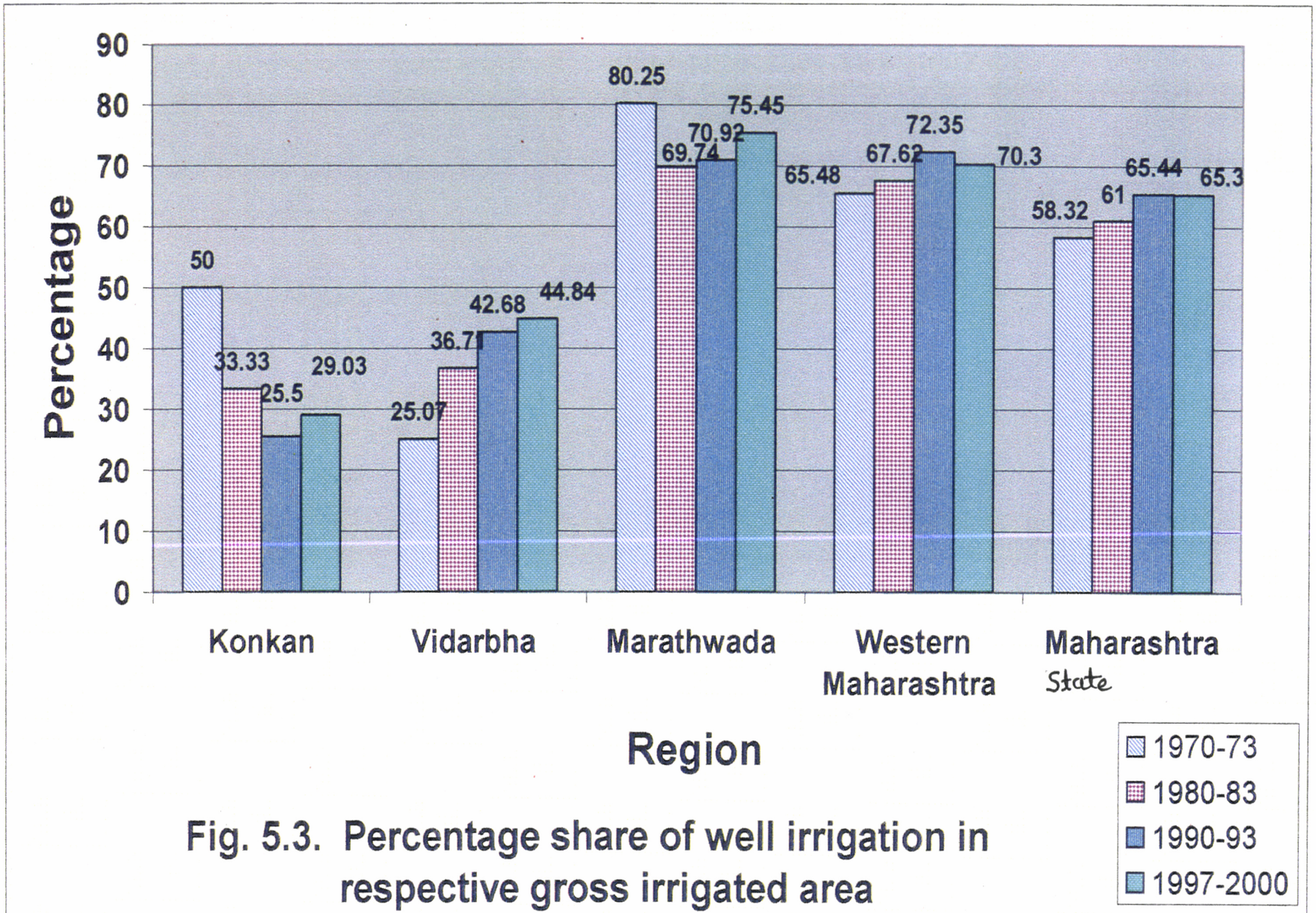


Fig. 5.3. Percentage share of well irrigation in respective gross irrigated area

of surface and well irrigation in gross cropped area is given in Fig. 5.2 and Fig. 5.3.

Construction of irrigation projects of various types, irrigation tanks, watersheds, canals etc. can be done only through public investments by the State Government, which is a base for surface irrigation development. Expenditure of State government is lower on irrigation project as compared to is requirement. therefore this has resulted in to a slow growth of surface irrigation in the State. Wells can be digged and constructed by farmers on their own which has helped to boost the area under well irrigation in the State.

5.2 Regional Differences in Area Shift Amongst Irrigated Crops in Maharashtra State.

It is well known that Maharashtra State possesses limited natural water resources and at the same time, all the available potential water have not yet been developed to the fullest extent for irrigation and other uses. Besides, the irrigation water allocation practices for individual crops at the farm and regional levels have been governed largely by the factors such as seasonality in water availability, relative profitability of individual crops grown under irrigated conditions and easy access to marketing and processing facilities for crop products. As a result, most of seasonal irrigation water supplies in the vicinities of urban areas seem to have been used for vegetable crops, whereas the perennial irrigation water supplies have been allocated more in favour of commercially important crops. Vegetable crops, fruit crops, sugarcane and summer groundnut have been grown exclusively under irrigated conditions.

The percentage shares of irrigated area under major foodgrain and non-foodgrain crops have been changing over different periods.

A wide range of irrigated crops of different types are grown in Maharashtra State. Shift in irrigated area amongst major crops and groups have been estimated on the basis of percentage share of each crop in gross irrigated area at five points of time. The percentage shares are estimated on triennial averages of irrigated area and the shifts are analyzed for all regions of the State.

5.2.1 Percentage change in area amongst irrigated crops in Konkan region

From the results of percentage share of each crop in gross irrigated area as presented in Table 5.5, it is revealed that major crops under irrigation in Konkan region have been paddy, coconut and mango. It is observed that area under banana, wheat, jowar, pulses, onion, sweet potato and sugarcane has been negligible. The share of irrigated area under paddy has declined from 31.53 to 23.20 per cent during 1960-63 to 1997-98. There is also a decline in percentage share of irrigated area under coconut, banana, sugarcane, chilli, betal nut, onion, sweet potato and sesamum in 1995-98 over 1960-63, which has shifted to mango, sapota, gram and groundnut being the major crops of the region. Importantly, share of irrigated area under these crops was found almost nil in Konkan region during 1960-63. A major shift in irrigated area was found from paddy and coconut to groundnut, gram, mango and sapota during the period of past 38 years. The shifts in irrigated areas of crop groups *viz.*, cereals, pulses, sugarcane, condiments, fruits, vegetables, fibres, oilseeds and fodder crops during the period under study

Table 5.5.Absolute and Percent area of major crops in Gross Irrigated Area in Konkan region.

(00 hectares)

Crop	Periods				
	1960-63	1970-73	1980-83	1990-93	1995-98
Paddy	60.93 (31.53)	52.34 (23.71)	130.67 (39.36)	140.66 (27.79)	163.33 (23.20)
Wheat	0.00	0.33 (0.15)	0.00	0.67 (0.13)	1.00 (0.14)
Jowar	0.00	0.00	1.33 (0.40)	0.00	0.00
Gram	0.53 (0.27)	0.67 (0.30)	4.33 (1.30)	6.67 (1.32)	22.00 (3.12)
Red gram	0.27 (0.15)	0.67 (0.30)	2.00 (0.60)	1.33 (0.26)	2.00 (0.28)
Udid	0.40 (0.21)	1.00 (0.45)	2.33 (0.70)	2.67 (0.53)	0.00
Sugarcane	1.60 (0.83)	3.33 (1.51)	3.33 (1.00)	2.00 (0.40)	2.66 (0.39)
Betal nuts	0.00	0.00	19.67 (5.92)	13.33 (2.64)	18.33 (2.60)
Chilie	12.00 (6.21)	14.34 (6.50)	12.00 (3.61)	9.67 (1.91)	12.33 (1.75)
Banana	0.00	16.67 (7.55)	13.00 (3.92)	11.67 (2.31)	11.67 (1.65)
Mango	0.00	2.00 (0.91)	14.67 (4.42)	110.66 (21.87)	135.00 (19.18)
Sapota	0.00	2.33 (1.06)	7.67 (2.31)	17.00 (3.36)	48.33 (6.86)
Onion	0.00	8.00 (3.63)	4.33 (1.31)	4.33 (0.86)	4.33 (0.61)
Sweet potato	0.00	0.00	0.67 (0.20)	0.67 (0.13)	1.00 (0.14)
Groundnut	0.00	0.33 (0.15)	0.33 (0.10)	41.67 (8.23)	51.66 (7.34)
Sesamum	4.94 (2.56)	0.00	1.67 (0.50)	3.00 (0.59)	0.33 (0.05)
Coconut	46.27 (23.95)	56.00 (25.38)	72.33 (21.80)	78.67 (15.55)	92.52 (13.15)
Drugs and narcotics	0.00	2.33 (1.06)	1.00 (0.30)	4.00 (0.79)	4.00 (0.57)
Fodder crops	0.53 (0.27)	0.33 (0.15)	5.00 (1.51)	0.00	52.66 (7.48)
Other	65.73 (34.02)	60.00 (27.19)	35.67 (10.74)	57.33 (11.33)	80.85 (11.49)
Gross irrigated area	193.20 (100.00)	220.67 (100.00)	332.00 (100.00)	506.00 (100.00)	704.00 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Table 5.6.Percent share of irrigated area of different crop groups in Gross Irrigated Area in Konkan region.

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Total cereals	65.20 (33.75)	54.67 (24.77)	136.67 (41.16)	141.33 (27.93)	164.34 (23.34)
Total pulses	2.00 (1.04)	8.00 (3.63)	14.67 (4.42)	20.67 (4.08)	29.67 (4.21)
Sugarcane	1.60 (0.83)	3.34 (1.51)	3.33 (1.00)	2.00 (0.40)	2.66 (0.39)
Total condiments	12.13 (6.27)	15.00 (6.80)	32.00 (9.64)	25.33 (5.00)	32.66 (4.64)
Total fruits	0.00	32.00 (14.50)	37.67 (11.35)	145.00 (28.66)	206.33 (29.31)
Total vegetables	0.00	37.33 (16.92)	26.66 (8.03)	40.67 (8.04)	66.00 (9.37)
Misc food crops	46.27 (23.95)	7.33 (3.32)	0.00	0.00	0.00
Total food crops	127.20 (65.84)	157.67 (71.45)	251.00 (75.60)	375.00 (74.11)	501.66 (71.26)
Total fibers	0.40 (0.21)	3.00 (1.36)	0.33 (0.10)	0.00	0.00
Total oilseeds	51.20 (26.50)	56.34 (25.53)	74.67 (22.49)	124.67 (24.64)	144.67 (20.56)
Drugs and narcotics	0.00	2.33 (1.06)	1.00 (0.30)	4.00 (0.79)	4.00 (0.56)
Fodder crops	0.53 (0.28)	0.33 (0.15)	5.00 (1.51)	0.00	52.67 (7.48)
Miscellaneous non food crops &flowers	13.87 (7.17)	1.00 (0.45)	0.00	2.33 (0.46)	1.00 (0.14)
Total non-food crops	66.00 (34.16)	63.00 (28.55)	81.00 (24.40)	131.00 (25.89)	202.34 (28.74)
Gross irrigated area	193.20 (100.00)	220.67 (100.00)	332.00 (100.00)	506.00 (100.00)	704.00 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

are depicted in Table 5.6. It is revealed that the share of irrigated area under total cereals declined from 33.75 per cent in 1960-63 to 23.34 per cent in 1995-98. A decline in share was also observed in condiments, fibres and oilseeds. Sugarcane revealed a varying trend over the last 38 years. Irrigated area under these groups was shifted to pulses, fruits, vegetable and fodder crops. Percentage share of irrigated area under fruit

crops showed a decline upto 1980-83 and then it showed an increasing trend. Percentage share of irrigated area under non-food crops declined from 34.16 in 1960-63 to 28.74 in 1995-98 and was shifted to food crops, which showed an increase in percentage share from 65.84 to 71.26 over the same period. The percentage share of food crops in the gross irrigated area has increased during 1960-63 to 1980-83, however, it showed a slight decline during the period of last two decades i.e. from 1980-83 onwards.

In 1960-63, area under irrigation of fruits and vegetable crops was almost nil. However, during the recent periods, fruit crops and also vegetables have emerged as the most important irrigated crops in Konkan region. The irrigated area under cereals, oilseeds and condiments, by and large, has been shifted to pulses, fruits and vegetable crops.

5.2.2 Percentage change in area amongst irrigated crops in Vidarbha region.

The allocation of irrigated area amongst different crops of selected points of time in Vidarbha region is given in Table 5.7. It can be revealed that though the share of paddy in gross irrigated area has been reduced from 82.42 per cent in 1960-63 to 45.11 per cent in 1995-98, it looks that paddy is a major claimant in gross irrigated area in Vidarbha. It is largely grown in Gadchiroli, Bhandara, Gondia and Chandrapur districts in the region. Percentage share of irrigated area under paddy, turmeric and jowar in gross irrigated area showed a decline which seem to be shifted to wheat, gram, sugarcane and oranges. Newly emerged irrigated crops in the region were sunflower, groundnut and soybean. Both absolute as well as proportionate share in gross irrigated area have significantly increased in

the case of wheat, gram, sugarcane, chillies groundnut and mandarin oranges. Importantly, the percentage share of cotton, onion and ginger has remained more or less the same over a period of past 38 years. It is also noted that the absolute area under irrigation of all crops jowar and ginger showed

Table 5.7.Absolute and Percent area of major crops in Gross Irrigated Area in Vidarbha region.

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Paddy	2241.73 (82.42)	2496.67 (70.18)	2900.33 (55.42)	3336.00 (51.92)	3575.67 (45.11)
Wheat	112.53 (4.14)	405.00 (11.38)	1131.01 (21.61)	1015.00 (15.80)	1523.67 (19.21)
Jowar	5.47 (0.20)	14.67 (0.42)	17.01 (0.32)	19.00 (0.30)	2.33 (0.02)
Gram	12.40 (0.46)	33.33 (0.95)	88.00 (1.68)	237.66 (3.70)	436.67 (5.49)
Sugarcane	28.00 (1.03)	35.67 (1.01)	62.67 (1.20)	232.00 (3.61)	224.33 (2.83)
Chilies	116.00 (4.26)	112.00 (3.15)	156.33 (2.99)	241.67 (3.76)	396.33 (5.00)
Ginger	0.27 (0.01)	1.00 (0.02)	0.00	1.67 (0.03)	2.00 (0.02)
Turmeric	5.87 (0.22)	9.33 (0.26)	8.67 (0.17)	9.00 (0.14)	6.67 (0.07)
Banana	0.00	24.00 (0.67)	34.33 (0.66)	46.67 (0.73)	39.66 (0.50)
Sweet oranges	0.00	1.67 (0.05)	2.00 (0.04)	8.00 (0.12)	9.00 (0.11)
Mandarin oranges	0.00	54.00 (1.52)	259.33 (4.96)	460.67 (7.17)	802.33 (10.12)
Onion	0.00	34.67 (0.97)	66.33 (1.27)	85.00 (1.32)	71.67 (0.90)
Cotton	33.47 (1.23)	71.33 (2.00)	197.67 (3.78)	144.33 (2.25)	82.00 (1.03)
Groundnut	0.00	2.00 (0.06)	102.33 (1.94)	162.33 (2.52)	127.01 (1.60)
Sunflower	0.00	0.00	0.00	37.67 (0.59)	49.00 (0.63)
Soybean	0.00	0.00	0.00	46.00 (0.72)	40.66 (0.51)
Others	164.13 (6.03)	261.99 (7.36)	207.66 (3.96)	342.66 (5.32)	536.33 (6.85)
Gross irrigated area	2719.87 (100.00)	3557.33 (100.00)	5233.67 (100.00)	6425.33 (100.00)	7925.33 (100.00

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

an increase in Vidarbha region during the period under study. However, the increase in irrigated area under the crops viz., wheat, gram, sugarcane, chillies, groundnut and madarin oranges was most conspicuous.

Table 5.8. Percent share of irrigated area of different crop groups in Gross Irrigated Area in Vidarbha Region

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Total cereals	2362.80 (86.87)	2920.66 (82.10)	4053.33 (77.45)	4375.00 (68.08)	5121.00 (64.62)
Total pulses	13.20 (0.49)	35.33 (0.99)	98.00 (1.86)	278.67 (4.34)	460.34 (5.80)
Sugarcane	28.00 (1.03)	35.67 (1.00)	62.67 (1.20)	232.00 (3.61)	224.34 (2.83)
Total condiments	122.13 (4.49)	124.66 (3.50)	178.00 (3.40)	287.67 (4.48)	459.33 (5.79)
Total fruits	0.00	209.67 (5.89)	314.33 (6.01)	557.67 (8.68)	900.00 (11.36)
Total vegetables	1.47 (0.06)	144.67 (4.07)	184.00 (3.52)	272.33 (4.24)	447.66 (5.65)
Misc food crops	151.60 (5.57)	6.67 (0.19)	3.67 (0.07)	0.33 (0.01)	0.00
Total food crops	2679.20 (98.51)	3477.33 (97.74)	4894.00 (93.51)	6003.67 (93.44)	7612.67 (96.05)
Total fibers	33.46 (1.23)	71.33 (2.01)	199.67 (3.82)	146.33 (2.28)	82.67 (1.04)
Total oilseeds	0.67 (0.02)	3.67 (0.10)	128.00 (2.45)	265.33 (4.13)	216.67 (2.74)
Drugs and narcotics	0.00	1.00 (0.03)	4.00 (0.07)	1.33 (0.02)	2.33 (0.04)
Fodder Crops	1.47 (0.05)	2.33 (0.07)	7.00 (0.13)	4.67 (0.07)	5.66 (0.07)
Miscellaneous non food crops &flowers	5.07 (0.19)	1.67 (0.05)	1.00 (0.02)	4.00 (0.06)	5.33 (0.06)
Total non-food crops	40.67 (1.49)	80.00 (2.26)	339.67 (6.49)	421.66 (6.56)	312.66 (3.95)
Gross irrigated area	2719.87 (100.00)	3557.33 (100.00)	5233.67 (100.00)	6425.33 (100.00)	7925.33 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Table 5.8 presents the data on changes in the share of irrigated area under different groups of crops in Vidarbha region during 1960-63 to 1995-98. It is very clear that the

proportion of irrigated area under total pulses, sugarcane, condiments, fruits and vegetables and oilseed crops has increased significantly while the same has declined in the case of total cereals and miscellaneous food crops during the period under study. Importantly, the area under total fiber crops showed an increase during 1980-83, but subsequently showed a decline to 1.04 per cent in the year 1995-98 which means that the area under cotton which is an important cash crops did not show much change in Vidarbha.

5.2.3 Percentage change in area amongst irrigated crops in Marathwada region

The results presented in Table 5.9, revealed that jowar, wheat, gram, red gram, sugarcane, cotton and groundnut were the major irrigated crops grown in Marathwada region. The horticultural crops such as banana, sweet orange and onion have been introduced during seventies in the region. As regards the changes in percentage share in irrigated area under different crops, both absolute as well as percentage share in the irrigated area have increased in the case of wheat, gram, sugarcane, cotton and groundnut during the whole period under study in Marathwada region. Eventhough the absolute area showed an increase the proportion in gross irrigated area showed a decline in paddy, jowar, bajra, maize and chillies during the period under study. Thus it looks that in the process of allocation of irrigated area in Marathwada region, the crops like wheat, gram, sugarcane, cotton, sweet orange, groundnut and banana got relatively more preference during the period under study.

Table 5.10 presents the data on changes in percent share of different crop groups in gross irrigated area during

Table 5.9.Absolute and Percent area of major crops in Gross Irrigated Area in Marathwada region

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Paddy	80.00 (4.47)	146.00 (6.00)	371.33 (6.85)	194.00 (2.31)	175.00 (1.95)
Wheat	309.61 (17.31)	456.33 (18.75)	1478.67 (27.26)	1490.00 (17.75)	1701.00 (18.88)
Jowar	692.40 (38.70)	726.01 (29.85)	1438.33 (26.51)	1386.00 (16.51)	1814.33 (20.15)
Bajara	14.67 (0.82)	61.33 (2.52)	104.67 (1.92)	40.33 (0.48)	57.60 (0.64)
Maize	20.13 (1.13)	33.67 (1.38)	55.33 (1.02)	112.67 (1.34)	82.00 (0.91)
Gram	95.87 (5.36)	157.00 (6.45)	303.33 (5.59)	589.33 (7.02)	656.66 (7.29)
Red gram	5.07 (0.29)	0.33 (0.01)	34.33 (0.64)	112.67 (1.35)	84.33 (0.94)
Sugarcane	223.33 (12.48)	219.33 (9.01)	663.67 (12.23)	1367.00 (16.28)	1292.00 (14.34)
Chilli	146.53 (8.19)	120.00 (4.93)	159.67 (2.94)	278.00 (3.31)	231.66 (2.57)
Turmeric	14.13 (0.79)	48.67 (2.00)	29.67 (0.55)	40.00 (0.48)	29.00 (0.32)
Banana	0.00	33.33 (1.37)	71.00 (1.31)	208.00 (2.48)	124.00 (1.38)
Sweet orange	0.00	11.33 (0.47)	15.67 (0.29)	34.00 (0.40)	123.66 (1.37)
Onion	0.00	28.00 (1.15)	32.33 (0.60)	65.00 (0.77)	60.66 (0.67)
Cotton	30.67 (1.71)	118.33 (4.86)	255.67 (4.71)	458.00 (5.46)	763.66 (8.48)
Groundnut	2.40 (0.13)	35.00 (1.44)	178.00 (3.28)	731.00 (8.71)	458.66 (5.09)
Sunflower	0.00	0.00	0.00	592.67 (7.06)	622.00 (6.90)
Fodder crops	26.53 (1.48)	62.67 (2.58)	18.00 (0.33)	102.00 (1.21)	152.33 (1.69)
Other	127.73 (7.14)	176.00 (7.23)	215.33 (3.97)	594.66 (7.08)	578.45 (6.43)
Gross irrigated area	1789.07 (100.00)	2433.33 (100.00)	5425.00 (100.00)	8395.33 (100.00)	9007.00 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Table 5.10. Percent share of irrigated area of different crop groups in Gross Irrigated Area in Marathwada Region

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Total cereals	1129.73 (63.15)	1435.00 (58.97)	3460.00 (63.78)	3235.00 (38.53)	3829.33 (42.52)
Total pulses	113.74 (6.36)	165.67 (6.82)	348.00 (6.41)	744.67 (8.87)	751.00 (8.34)
Sugarcane	223.33 (12.48)	219.33 (9.01)	663.67 (12.24)	1367.00 (16.28)	1292.00 (14.35)
Total condiments	160.80 (8.98)	183.33 (7.54)	224.00 (4.13)	451.67 (5.38)	354.00 (3.93)
Total fruits	0.00	102.00 (4.19)	107.33 (1.98)	302.33 (3.60)	344.00 (3.81)
Total vegetables	0.13 (0.01)	88.67 (3.64)	90.66 (1.67)	320.33 (3.82)	402.00 (4.46)
Misc food crops	77.07 (4.31)	8.33 (0.34)	1.67 (0.03)	0.00	0.00
Total food crops	1704.80 (95.29)	2202.33 (90.51)	4895.33 (90.24)	6421.00 (76.48)	6972.33 (77.41)
Total fibers	35.74 (2.00)	122.33 (5.03)	264.67 (4.88)	464.00 (5.53)	778.34 (8.64)
Total oilseeds	16.00 (0.89)	43.67 (1.79)	246.00 (4.53)	1406.33 (16.75)	1102.33 (12.24)
Drugs and narcotics	0.00	0.33 (0.01)	1.00 (0.02)	0.67 (0.01)	0.67 (0.01)
Fodder crops	26.53 (1.48)	62.67 (2.58)	18.00 (0.33)	102.00 (1.21)	152.33 (1.69)
Miscellaneous non food crops &flowers	6.00 (0.34)	2.00 (0.08)	0.00	1.33 (0.02)	1.00 (0.01)
Total non-food crops	84.27 (4.71)	231.00 (9.49)	529.67 (9.76)	1974.33 (23.52)	2034.67 (22.59)
Gross irrigated area	1789.07 (100.00)	2433.33 (100.00)	5425.00 (100.00)	8395.33 (100.00)	9007.00 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

the past 38 years in Marathwada region of Maharashtra State. The area under irrigated crops has increased but percentage share of cereals, condiments, miscellaneous food crops and flowers in gross irrigated area has depicted a decline in Marathwada. However, cereals had the predominance in the allocation of irrigated area. Importantly, both absolute as well as percent share of the crops *viz.*, pulses, sugarcane, vegetables, fibres and oilseed showed a significant increase during the period

under study. The share of food crops in gross irrigated area has declined from 95.29 per cent in 1960-63 to 77.41 per cent in 1995-98, whereas the share of non-food crops increased substantially from 4.71 to 22.59 per cent during the same period with a greater allocation of irrigation towards cotton and sunflower during the recent decades.

5.2.4 Percentage change in area amongst irrigated crops in Western Maharashtra region

The trends of changes in allocation of irrigated area to different crops presented in Table 5.11 revealed that jowar, sugarcane and wheat were the major irrigated crops during the period of study since the percentage share of these crops was relatively more in Western Maharashtra. As regards the changes in allocation of irrigated area over a period of study, it is noted that both absolute as well as percent area in the case of wheat, maize, gram, sugarcane, groundnut and horticultural crops such as grapes, mango, onion and sapota have increased significantly in Western Maharashtra. Interestingly, eventhough the absolute irrigated area showed an increase the percent share of irrigated area declined in certain crops viz., paddy, jowar, bajara and fodder crops in Western Maharashtra. Also, percent area depicted a decline in the case of cotton and chilli. It must be pointed out that Western Maharashtra has specialized in cultivation of sugarcane, which is evidenced by a persistent increase in allocation of irrigated area to this crop during the entire period under study. It looks that the increase in irrigated area has been allocated to the crops viz., sugarcane, wheat, gram, onion and fruit crops of grapes, mango, pomegranate, sapota etc. during the period under study.

T-6012

Table 5.11. Absolute and Percent area of major crops in Gross Irrigated Area in Western Maharashtra Region

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Paddy	316.54 (4.37)	566.00 (6.09)	577.33 (4.33)	411.00 (2.36)	329.66 (1.73)
Wheat	965.74 (13.33)	1879.00 (20.20)	2562.33 (19.20)	2725.33 (15.63)	3081.66 (16.15)
Jowar	2080.27 (28.72)	1823.33 (19.60)	3024.00 (22.66)	3304.00 (18.95)	3264.33 (17.11)
Bajara	310.93 (4.29)	384.66 (4.13)	414.67 (3.11)	679.00 (3.90)	765.00 (4.01)
Barely	3.73 (0.05)	2.66 (0.02)	2.00 (0.01)	0.00	54.33 (0.28)
Maize	82.93 (1.14)	138.67 (1.49)	192.67 (1.44)	262.67 (1.51)	290.00 (1.52)
Gram	243.33 (3.36)	289.67 (3.11)	461.00 (3.45)	1054.00 (6.05)	1318.33 (6.91)
Red gram	30.93 (0.43)	7.00 (0.08)	39.67 (0.30)	86.67 (0.50)	88.66 (0.46)
Sugarcane	1211.34 (16.72)	1751.33 (18.83)	2861.67 (21.44)	3941.33 (22.61)	4440.00 (23.27)
Chilli	375.47 (5.18)	331.00 (3.56)	299.00 (2.24)	377.33 (2.16)	363.00 (1.90)
Turmeric	112.13 (1.55)	38.00 (0.41)	27.00 (0.20)	21.67 (0.12)	21.66 (0.11)
Garlic	0.00	2.67 (0.03)	19.67 (0.15)	28.33 (0.16)	33.33 (0.17)
Grapes	0.00	5.67 (0.06)	34.33 (0.26)	189.00 (1.08)	257.00 (1.34)
Banana	0.00	261.00 (2.81)	423.00 (3.17)	540.33 (3.10)	518.33 (2.71)
Mango	0.00	4.33 (0.05)	8.33 (0.06)	24.00 (0.14)	35.00 (0.18)
Sapota	0.00	0.00	2.33 (0.02)	12.00 (0.07)	33.00 (0.17)
Potato	98.13 (1.35)	79.67 (0.86)	116.00 (0.870)	133.01 (0.76)	136.33 (0.71)
Onion	0.00	363.67 (3.91)	471.67 (3.53)	714.33 (4.10)	839.66 (4.40)
Cotton	405.47 (5.60)	502.67 (5.40)	605.33 (4.55)	308.00 (1.77)	419.33 (2.19)
Groundnut	126.40 (1.74)	183.00 (1.97)	399.67 (2.99)	996.67 (5.72)	879.33 (4.66)
Sunflower	0.00	0.00	0.00	284.33 (1.63)	245.66 (1.28)
Fodder Crops	259.73 (3.59)	248.00 (2.67)	291.00 (2.18)	328.00 (1.88)	449.00 (2.35)
Other	621.86 (8.58)	439.33 (4.72)	513.00 (3.84)	1011.33 (5.80)	1212.73 (6.36)
Gross irrigated area	7244.93 (100.00)	9301.33 (100.00)	13345.67 (100.00)	17432.33 (100.00)	19075.33 (100.00

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Table 5.12. Percent share of irrigated area of different crop groups in Gross Irrigated Area in Western Maharashtra region

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Total cereals	3760.13 (51.90)	4802.33 (51.63)	6787.00 (50.86)	7389.33 (42.38)	7735.33 (40.55)
Total pulses	292.00 (4.03)	321.00 (3.45)	558.33 (4.18)	1233.34 (7.08)	1469.33 (7.70)
Sugarcane	1211.33 (16.72)	1751.33 (18.83)	2861.67 (21.45)	3941.33 (22.61)	4430.32 (23.23)
Total condiments	488.94 (6.75)	377.67 (4.06)	370.33 (2.77)	491.67 (2.82)	496.36 (2.60)
Total fruits	0.00	380.33 (4.09)	560.67 (4.20)	1005.33 (5.77)	1290.00 (6.76)
Total vegetables	98.13 (1.35)	647.33 (6.96)	841.00 (6.30)	1321.33 (7.58)	1542.33 (8.09)
Misc food crops	435.07 (6.01)	29.00 (0.31)	0.00	0.00	0.00
Total food crops	6285.60 (86.76)	8309.99 (89.33)	11979.00 (89.76)	15382.33 (88.24)	16963.67 (88.93)
Total fibers	420.40 (5.80)	513.34 (5.52)	618.00 (4.63)	345.33 (1.98)	456.34 (2.39)
Total oilseeds	129.07 (1.78)	202.00 (2.17)	437.34 (3.28)	1341.00 (7.69)	1170.33 (6.14)
Drugs and narcotics	0.00	4.33 (0.05)	17.33 (0.13)	20.67 (0.12)	9.33 (0.05)
Fodder Crops	259.73 (3.59)	248.00 (2.66)	291.00 (2.18)	328.00 (1.88)	449.00 (2.35)
Miscellaneous non food crops &flowers	150.13 (2.07)	24.67 (0.27)	3.00 (0.02)	15.00 (0.09)	26.66 (0.14)
Total non-food crops	959.33 (13.24)	992.34 (10.67)	1366.67 (10.24)	2050.00 (11.76)	2111.66 (11.07)
Gross irrigated area	7244.93 (100.00)	9301.33 (100.00)	13345.67 (100.00)	17432.33 (100.00)	19075.33 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

The changes in allocation of irrigated area over a period of time two different crop groups in Western Maharashtra are showed in Table 5.12.

With the increase in availability of water, allocation of irrigation water resources has been diverted from cereals, condiments, fodder crops towards pulses, sugarcane, fruits, vegetables and oilseeds. It is clear from table that the crops

such as pulses, sugarcane, fruits and vegetable, oilseeds have found to be the gainers of irrigated area during the study period in Western Maharashtra. However, a clear cut decline in the percentage share of irrigated area was noticed in the crops such as cereals, condiments, fiber crops and fodder crops in this region of Maharashtra State.

5.2.5 Percentage change in area amongst irrigated crops in Maharashtra State

The details of share of irrigated area of major crops in gross irrigated area are presented in Table 5.13. It can be revealed that by and large irrigated area of all crops in absolute terms has increased during the period under consideration. The percent share of irrigated area in gross irrigated area in the case of paddy, banana, jowar, chilli and onion showed decline, whereas that of wheat, maize, gram, sugarcane, mandarin oranges and groundnut has been increased during the period under study in Maharashtra. An increase in percentage share was quite conspicuous in wheat, gram, sugarcane and groundnut. The growth in irrigated area under wheat was quite substantial during period 1980-83 onwards in the state. The percent share of irrigated area under bajara, onion and cotton did not show much change but remained more or less the same in Maharashtra during the whole period under study. Results presented in Table 5.14 indicated that the share of irrigated area under cereals, condiments, fibre and fodder crops has shifted towards pulses, sugarcane, fruits, vegetable crops and oilseeds. The share of irrigated area has shifted from food crops to non-food crops by 3 per cent during the period under study. These results are consistent with the results of Mitra (1990).

Table 5.13.Absolute and Percent area of major crops in Gross Irrigated Area in Maharashtra

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Paddy	2699.21 (22.59)	3261.00 (21.02)	3979.66 (16.35)	4081.66 (12.46)	4243.67 (11.56)
Wheat	1387.87 (11.61)	2740.67 (17.67)	5172.00 (21.25)	5231.00 (15.97)	6307.33 (17.18)
Jowar	2778.13 (23.25)	2564.01 (16.53)	4480.66 (18.41)	4709.00 (14.37)	5081.00 (13.84)
Bajara	325.60 (2.73)	446.67 (2.88)	519.67 (2.14)	720.00 (2.20)	822.00 (2.24)
Maize	104.93 (0.88)	175.00 (1.13)	251.67 (1.03)	379.33 (1.16)	392.00 (1.06)
Gram	352.13 (2.95)	480.67 (3.10)	856.67 (3.52)	1887.67 (5.76)	2433.67 (6.63)
Sugarcane	1464.27 (12.26)	2009.67 (12.95)	3591.33 (14.76)	5542.33 (16.92)	5959.00 (16.23)
Chilli	650.00 (5.44)	577.33 (3.72)	627.00 (2.58)	906.67 (2.77)	1003.33 (2.73)
Banana	0.00	335.00 (2.16)	541.33 (2.22)	806.67 (2.46)	693.67 (1.90)
Mandarin orange	0.00	62.33 (0.40)	270.67 (1.11)	482.00 (1.47)	823.67 (2.25)
Onion	0.00	434.33 (2.80)	574.67 (2.36)	868.67 (2.65)	976.33 (2.65)
Cotton	469.60 (3.93)	692.33 (4.46)	1058.67 (4.35)	910.33 (2.78)	1265.00 (3.44)
Groundnut	128.80 (1.08)	220.32 (1.42)	680.33 (2.80)	1931.67 (5.90)	1516.67 (4.14)
Sunflower	0.00	0.00	0.00	914.66 (2.79)	916.67 (2.50)
Other	1586.53 (13.27)	1513.33 (9.76)	1732.01 (7.12)	3387.33 (10.34)	4277.65 (11.65)
Gross irrigated area	11947.07 (100.00)	15512.66 (100.00)	24336.34 (100.00)	32758.99 (100.00)	36711.66 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Table 5.14.Percent share of irrigated area of different crop groups in Gross Irrigated Area in Maharashtra.

(00 hectares)

Crop	Period				
	1960-63	1970-73	1980-83	1990-93	1995-98
Total cereals	7317.87 (61.25)	9212.67 (59.38)	14437.00 (59.32)	15140.67 (46.22)	16850.00 (45.91)
Total pulses	420.93 (3.53)	530.00 (3.42)	1019.00 (4.19)	2277.34 (6.95)	2710.33 (7.38)
Sugarcane	1464.27 (12.26)	2009.67 (12.95)	3591.33 (14.76)	5542.33 (16.92)	5959.00 (16.24)
Total condiments	784.00 (6.56)	700.67 (4.52)	804.33 (3.31)	1256.33 (3.84)	1342.67 (3.66)
Total fruits	0.00	724.00 (4.67)	1020.00 (4.19)	2010.33 (6.14)	2740.34 (7.46)
Total vegetables	99.73 (0.83)	918.00 (5.92)	1142.34 (4.69)	1954.67 (5.96)	2458.00 (6.69)
Misc food crops	710.00 (5.94)	51.33 (0.33)	5.33 (0.02)	0.33 (0.001)	0.00
Total food crops	10796.80 (90.37)	14146.34 (91.19)	22019.33 (90.48)	28182.00 (86.03)	32060.34 (87.34)
Total fibers	490.00 (4.10)	710.00 (4.58)	1082.67 (4.44)	955.67 (2.92)	1317.34 (3.58)
Total oilseeds	196.93 (1.65)	305.67 (1.97)	886.00 (3.64)	3137.33 (9.57)	2634.00 (7.17)
Drugs and narcotics	0.00	8.00 (0.05)	23.33 (0.10)	26.67 (0.08)	16.32 (0.05)
Fodder crops	288.27 (2.41)	313.33 (2.02)	321.01 (1.32)	434.66 (1.33)	649.66 (1.77)
Miscellanious non food crops &flowers	175.07 (1.47)	29.32 (0.19)	4.00 (0.02)	22.66 (0.07)	34.00 (0.09)
Total non-food crops	1150.27 (9.63)	1366.32 (8.81)	2317.01 (9.52)	4576.99 (13.97)	4651.32 (12.66)
Gross irrigated area	11947.07 (100.00)	15512.66 (100.00)	24336.34 (100.00)	32758.99 (100.00)	36711.66 (100.00)

(Figures in the parentheses are the percentages to the respective Gross Irrigated Area)

Higher income from the production of high value crops diverted irrigated area towards commercial crops *viz.*, sugarcane, fruits, vegetables etc. There are many reasons for such a shift in the share of irrigated area among crops in the State. These are especially the price, varietal change, change in technology, climatic changes, irrigation technology, market

infrastructure and post harvest technology which enable the farmers to make decisions about change in allocation of irrigated area among the crops.

5.2.6 Shift in area amongst irrigated crops in Konkan region

In Konkan region, as there is less diversification in irrigated crops, a very few crops are competing significantly. From the results presented in Table 5.15, it can be revealed that area under paddy, ragi, betalvine and chilli has been

Table 5.15. Shift in the acreage of irrigated crops in Konkan region during 1960-61 to 1997-98

Crop	Growth rate of GIA of the crop	Growth rate of GIA of the crop - growth rate of GIA	Percent loss	Percent gain
Gram	10.975	7.661	-	30.71
Groundnut	20.600	17.286	-	69.29
Paddy	3.064	-0.24	1.29	-
Ragi	-6.000	-9.314	50.12	-
Betalvine	-1.526	-4.840	26.04	-
Chilli	-0.876	-4.190	22.55	-
GIA	3.314	-	-	-

diverted towards their competing crops *viz.*, gram and groundnut during the period of last 38 years. Water requirement of paddy is highest only in Konkan region as compared to other regions (1800-2000 mm per season), followed by chilli (800-900 mm), whereas water requirement of gram and groundnut is less as compared to paddy and chilli which led to reduction in compound growth rate of paddy and chilli. Though the rate of compound growth of paddy was positive but its growth rate was less than

the compound growth rate of gross irrigated area, indicated higher growth rate of other crops *viz.*, gram and groundnut. Paddy and chilli lost their area by 1.29 and 22.55 per cent, respectively. A crop of ragi lost its area by 50.12 per cent while that of betelvine has reduced by 26.04 per cent. It looks that the area reduced under the crop of ragi, betalvine, chilli and paddy has been gain of crops of gram and groundnut. The reasons for such a shift in allocation of irrigated area in Konkan region would be the water requirement of a crop, short duration, market demand and availability of market. Actually the area of paddy (1.29 per cent) diverted was greater than that of ragi (50.12 per cent) because of the original area under paddy was quite higher than that of ragi during the entire period under study in Konkan region. To be sum up, the crops of gram and groundnut are significant gainers in share of irrigated area, while ragi, betalvine, chilli and paddy are loosers. Graphical presentation of the same is shown in Fig. 5.4.

5.2.7 Shift in area amongst irrigated crops in Vidarbha region

Table 5.16 presents the data on shift in acreage of irrigated crops in Vidarbha region during 1960-60 to 1997-98.It is noted that though the rate of compound growth of paddy, maize and chilli were positive, the growth rate of gross irrigated area was higher than the growth rate in the irrigated area of paddy, maize and chilli in Vidarbha region during the period under study. It is also seen that growth of irrigated area under other crops *viz.*, wheat, red gram, groundnut, gram, cotton and sugarcane was higher than these crops. The negative growth rate of jowar resulted in loss of its area to a greater extent

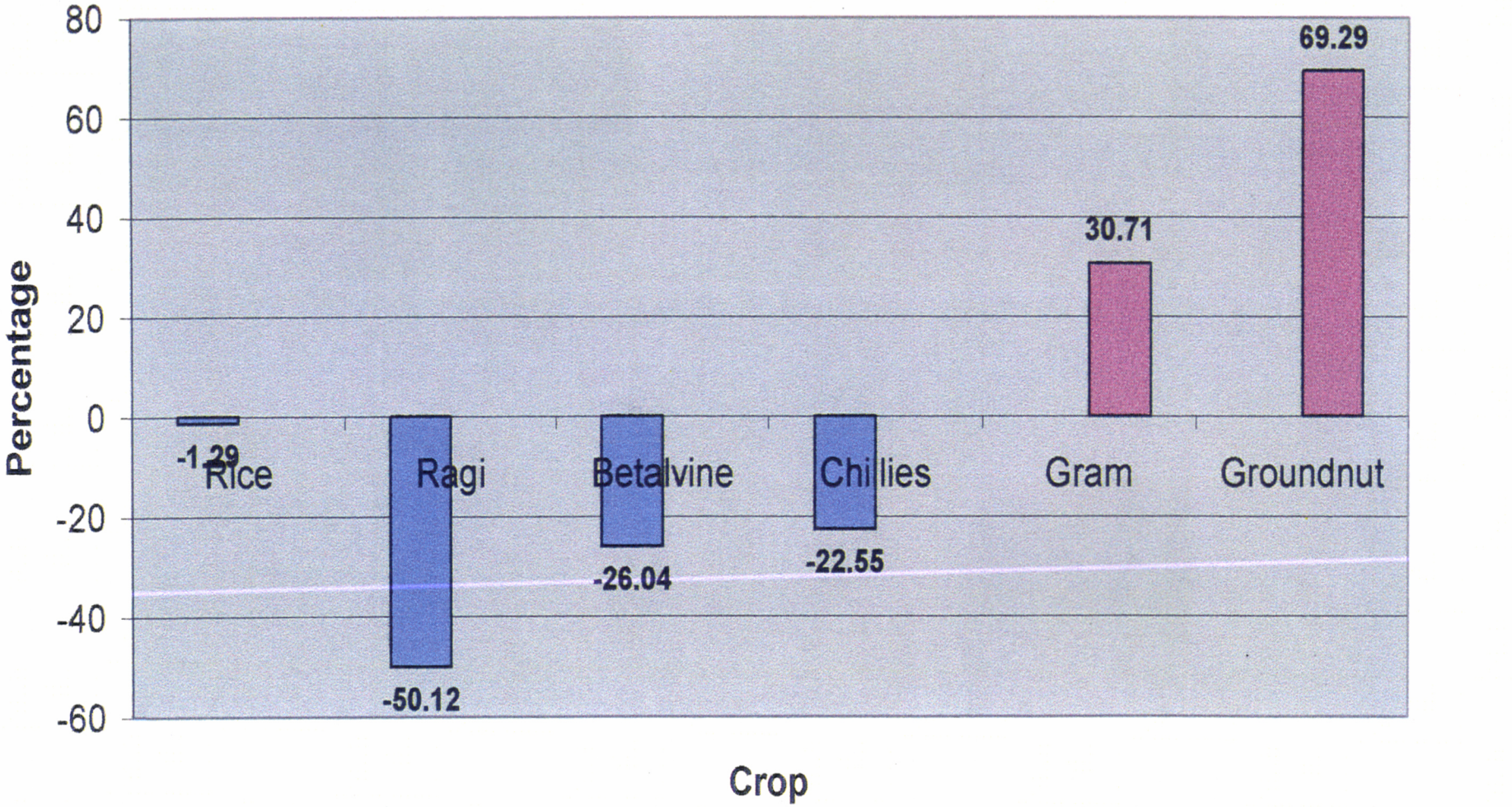


Fig. 5.4. Shift in the acreage of irrigated crops in Konkan Region

i.e. 66.31 percent of its total area, followed by paddy (19.08 per cent). The proportion of irrigated area under paddy, maize,

Table 5.16. Shift in the acreage of irrigated crops in Vidarbha during 1960-61 to 1997-98

Crop	Growth rate of GIA of the crop	Growth rate of GIA of the crop - growth rate of GIA	Percent loss	Percent gain
Wheat	4.988	2.101	-	4.62
Red gram	17.324	14.437	-	31.72
Groundnut	16.307	13.413	-	29.47
Gram	10.986	8.099	-	17.80
Cotton	7.181	4.294	-	9.44
Sugarcane	6.052	3.165	-	6.95
Paddy	1.199	-1.678	19.08	-
Jowar	-2.940	-5.832	66.31	-
Maize	2.732	-0.155	1.76	-
Chilli	1.757	-1.130	12.85	-
GIA	2.887	-	-	-

chilli and jowar had been significantly shifted to red gram, groundnut, gram, cotton, sugarcane and wheat. Among these crops, irrigated area of red gram has significantly increased by 31.72 per cent, followed by groundnut (29.47 per cent) during the period of last 40 years. It was due to higher price and more demand for pulses and oilseeds. Cotton is the main commercial crop of the region. Irrigated area under cotton has increased by 9.44 per cent during period of past 40 years in Vidharbha region. It is thus clear that the irrigated area has been diverted towards crops of red gram, gram, wheat, groundnut, cotton and sugarcane during the past 40 years in Vidarbha region

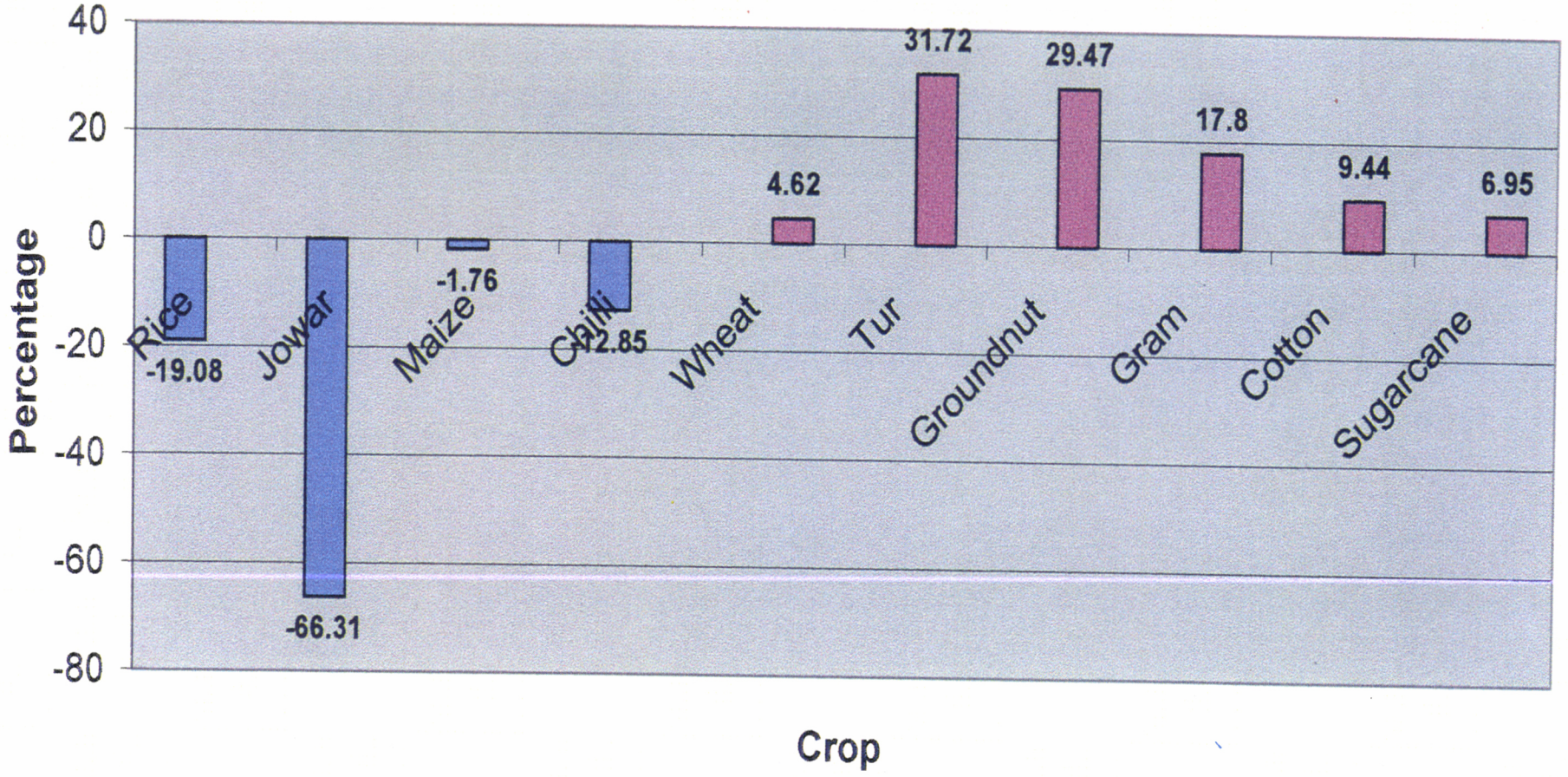


Fig. 5.5. Shift in the acreage of irrigated crops in Vidarbha region

in Maharashtra. Graphical presentation of the same is given in Fig. 5.5.

5.2.8 Shift in area amongst irrigated crops in Marathwada region

The relevant data on shift of area amongst irrigated crops in Marathwada region during the period from 1960-61 to

Table 5.17. Shift in the acreage of irrigated crop in Marathwada region during 1960-61 to 1997-98

Crop	Growth rate of GIA of the crop	Growth rate of GIA of the crop - growth rate of GIA	Percent loss	Percent gain
Wheat	4.988	0.222	-	0.70
Gram	5.870	1.104	-	3.46
Red gram	17.324	12.558	-	39.37
Sugarcane	6.052	1.286	-	4.04
Potato	7.536	2.770	-	8.68
Cotton	7.181	2.45	-	7.57
Groundnut	16.308	11.540	-	36.18
Paddy	2.872	-1.894	11.43	-
Jowar	2.341	-2.425	14.63	-
Maize	2.732	-2.034	12.27	-
Mung	-1.063	-5.829	35.17	-
Udid	3.385	-1.381	8.33	-
Chilli	1.757	-3.001	18.17	-
GIA	4.766			

1997-98 have been presented in Table 5.17. It is very clear that crop of green garm, chilli, jowar, paddy, maize and black gram were the loosers while the red gram, groundnut, potato, cotton and wheat were gainers of irrigated area in Marathwada region

during the period under study. It must be said that the percent loss of irrigated area in green gram, chilli, jowar and maize was most conspicuous which has been diverted to the crops of red gram, groundnut, potato and cotton in Marathwada region. To sum up, it can be said that the irrigated area lost by crops of green gram, chilli, maize, jowar and paddy has been by and large, gained by the crops of red gram, groundnut, cotton, potato, wheat and gram in Marathwada region during the last 38 years. Graphical presentation of the same is given in Fig. 5.6.

5.2.9 Shift in area amongst irrigated crops in Western Maharashtra

Western Maharashtra region has diversification of crops to a large extent as compared to other regions of the Maharashtra State. It is revealed from Table 5.18 that 15 crops were claimant in allocation of irrigated land amongst them. Irrigated area under paddy, jowar, bajara, barley, chilli, garlic, potato, cotton and turmeric has been diverted towards wheat, gram, red gram, sugarcane, ginger and groundnut in Western Maharashtra during the period under study. The gain of irrigated area by the crops of groundnut, ginger and gram was slightly higher as compared to other crops particularly the sugarcane, red gram and wheat. Turmeric lost highest percentage (25.91) in irrigated area and groundnut gained highest percentage (33.28) of its irrigated area over a period of last 38 years in Western Maharashtra. In view of a higher degree of diversification in irrigated crops the use of irrigated water remained all the while in demand by farmers. Water from rivers and wells has been utilized to a large extent as compared to other regions in the state. It must be noted that even though the rates of growth in cereal were positive, they were less than

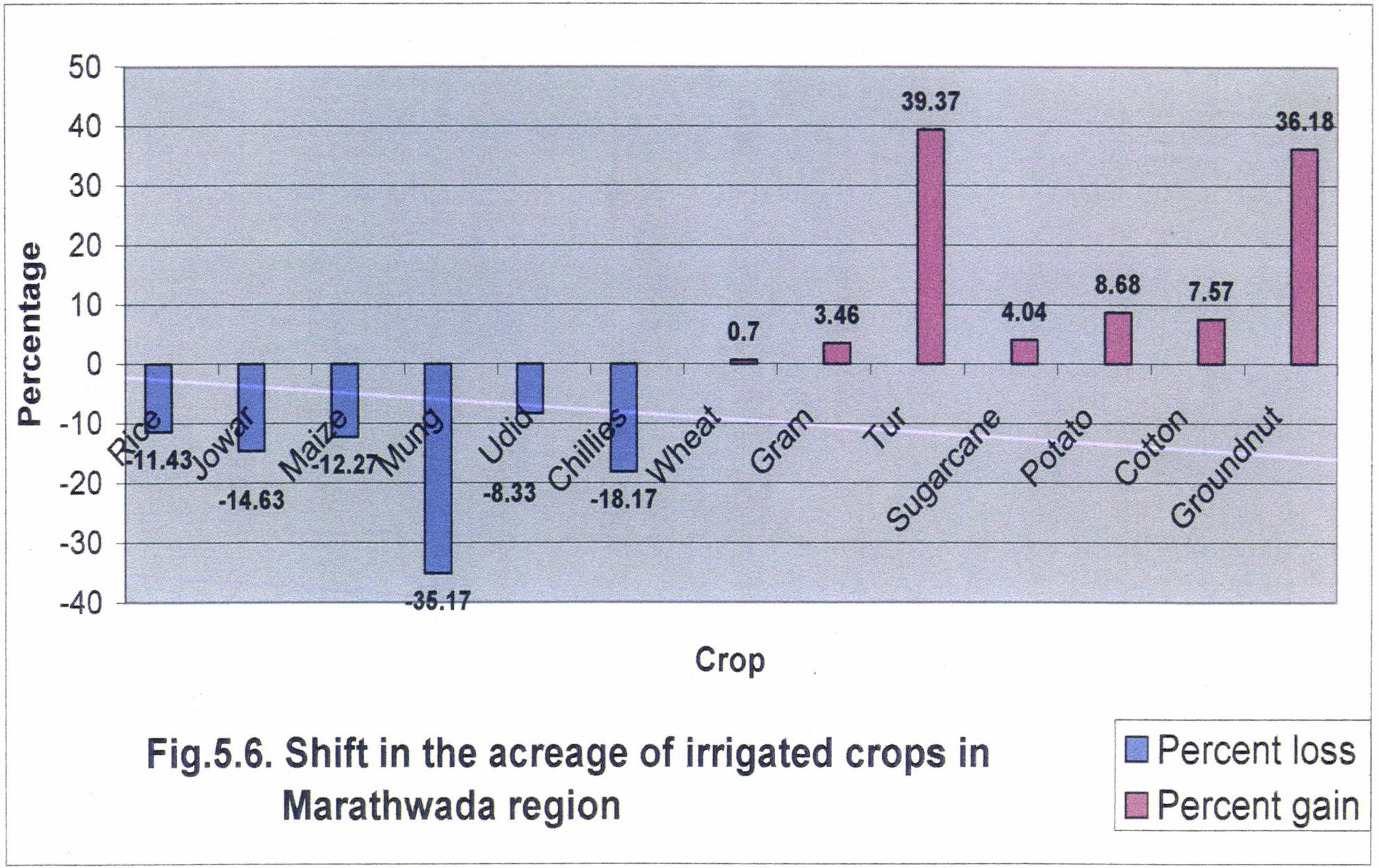


Fig.5.6. Shift in the acreage of irrigated crops in Marathwada region

Table 5.18. Shift in the acreage of irrigated crop in Western Maharashtra region during 1960-61 to 1997-98

Crop	Growth rate of GIA of the crop	Growth rate of GIA of the crop - growth rate of GIA	Percent loss	Percent Gain
Wheat	2.928	0.257	-	2.05
Gram	5.213	2.542	-	20.25
Red gram	3.864	1.193	-	9.50
Sugarcane	3.879	1.208	-	9.62
Ginger	5.848	3.177	-	25.30
Groundnut	6.849	4.178	-	33.28
Paddy	-0.696	-3.367	13.08	-
Jowar	-.375	-1.296	5.04	-
Bajara	2.591	-0.08	0.31	-
Barley	-3.963	-6.634	25.78	-
Chillies	-0.379	-3.050	11.85	-
Garlic	2.329	-0.342	1.33	-
Potato	1.569	-1.102	4.28	-
Cotton	-0.526	-3.197	12.42	-
Turmeric	-3.996	-6.667	25.91	-
GIA	2.671	-	-	-

growth rate of gross irrigated area. Graphical presentation of the same is given in Fig. 5.7.

5.2.10 Shift in area amongst irrigated crops in Maharashtra State

A table 5.19 presents the data on shift in acreage of irrigated crops in Maharashtra during the period from 1960-61 to 1997-98. The reduction in irrigated area was quite prominent in the case of turmeric, tobacco, barley, paddy, jowar, bajra and ragi in Maharashtra. It is important to note that quite a

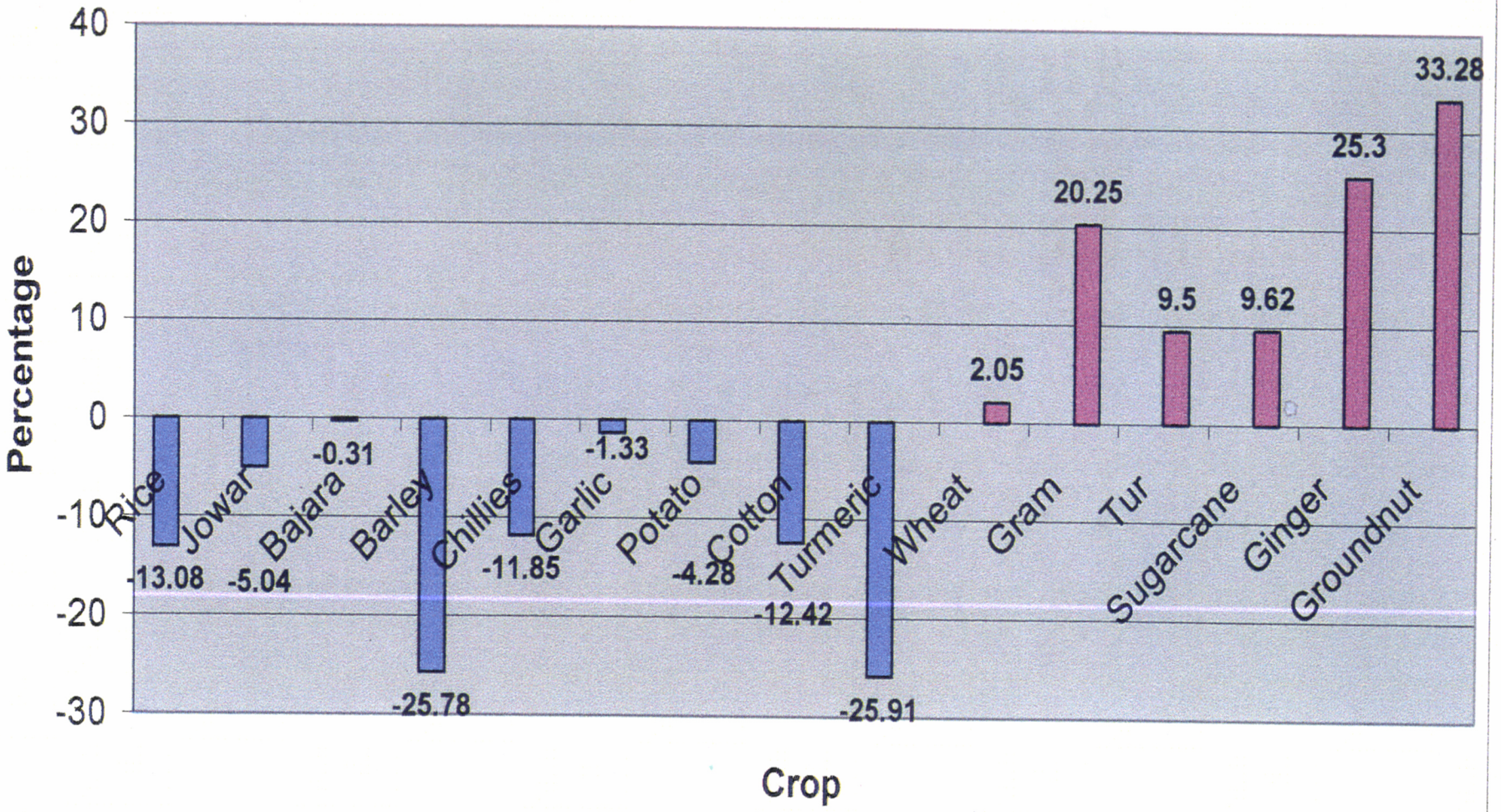


Fig.5.7. Shift in the acreage of irrigated crops in Western Maharashtra Region

Percent loss
Percent gain

considerable increase in irrigated area of wheat, gram, sugarcane, ginger and groundnut was observed during the last 38 years in Maharashtra.

Table 5.19.Shift in the acreage of irrigated crop in Maharashtra during 1960-61 to 1997-98

Crop	Growth rate of GIA of the crop	Growth rate of GIA of the crop - growth rate of GIA	Percent loss	Percent Gain
Wheat	3.998	0.843	-	3.61
Gram	5.828	2.673	-	20.01
Sugarcane	4.332	1.177	-	8.81
Ginger	6.243	3.088	-	23.71
Groundnut	8.733	5.578	-	41.76
Paddy	1.091	-2.064	6.10	-
Jowar	0.276	-2.873	8.49	-
Bajara	2.416	-0.739	2.18	-
Barley	-2.278	-5.433	16.05	-
Ragi	1.049	-2.106	6.22	-
Udid	0.882	-2.273	6.71	-
Chillies	0.976	-2.179	6.44	-
Turmeric	-1.561	-4.716	13.93	-
Potato	1.722	-1.433	4.23	-
Cotton	1.842	-1.313	3.88	-
Sesamum	1.056	-2.099	6.20	-
Tobacco	-3.471	-6.626	19.57	-
GIA	3.155	-	-	-

The highest gain of irrigated area was observed in groundnut (41.76 per cent) whereas highest loss in irrigated area was observed in the case of tobacco (19.57 per cent) followed by barley (16.05) from their total irrigated area. Besides, reduction in

irrigated acreage in cereals was also same. The negative growth in acreage was found in barley, turmeric and tobacco in Maharashtra. There is a reflection of a trend of changes in irrigated area in Western Maharashtra at the State level. The important irrigated crops *viz.*, wheat, sugarcane, gram, groundnut, red gram, fruits and vegetable were found competing for water resources available in the State and regions of the State. Graphical presentation of the same is given in Fig. 5.8.

From the overall results of all the regions, it can be revealed that the irrigated area under cereals depicted a lions share but over a period of time, it showed a share in gross irrigated area of the State with an exception of wheat. The crops *viz.*, gram, groundnut, ginger and sugarcane showed gain in irrigated area. Chilli and udid showed loss in irrigated area. The gain in irrigated area of cotton was observed in Vidarabha and Marathwada, but irrigated area of cotton in Western Maharashtra got diverted to other crops.

5.3 Diversification of Irrigated Crops in Different Regions of the State

Results of diversification in acreage of irrigated crops are presented in Table 5.20. Five types of indices were used to find out diversification of crops under irrigated area. Diversification in irrigated crops was observed in all the regions and periods of time. At the State level, entropy index has been increased from 0.98 during the period 1960-63 to 1.17 during period 1995-98 indicating higher degree of diversification in irrigated acreage in Maharashtra. To be specific, all the value of indices of diversification used in the present study were found higher during the period of 1995-98

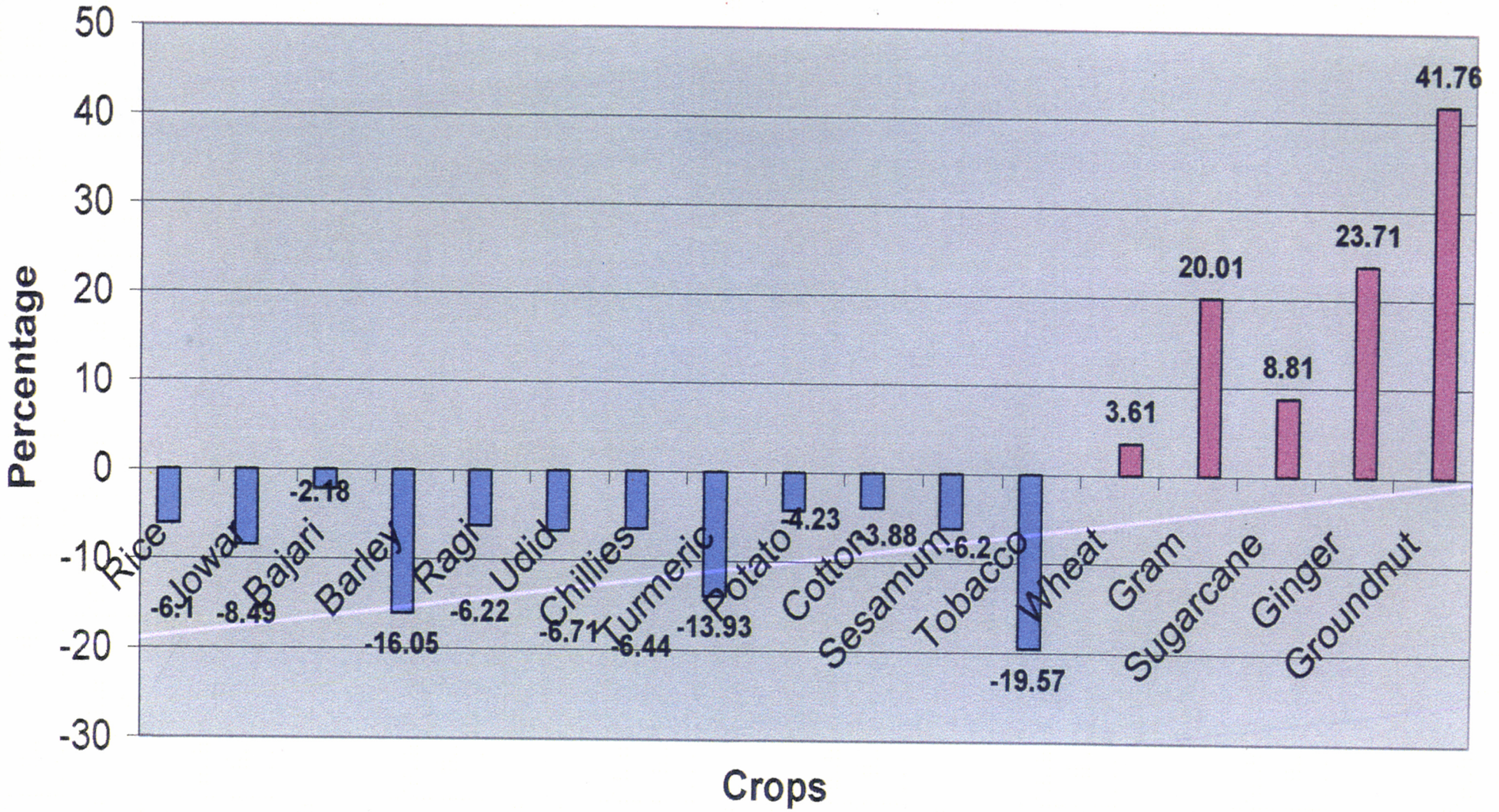


Fig. 5.8. Shift in the acreage of irrigated crops in Maharashtra State.

as compared to the initial period 1960-63 in all the regions of the state. The Western Maharashtra region ranks first with the

Table-5.20 Regionwise indices indicating diversification in irrigated area in Maharashtra State

Indices	Periods				
	1960-63	1970-73	1980-83	1990-93	1995-98
Herfindahl Index					
Konkan	0.77	0.85	0.78	0.84	0.87
Vidarbha	0.31	0.49	0.64	0.69	0.74
Marathwada	0.79	0.85	0.83	0.89	0.88
Western Maharashtra	0.85	0.87	0.85	0.87	0.89
Maharashtra State	0.86	0.87	0.87	0.90	0.90
Entropy Index					
Konkan	0.75	0.98	0.91	0.96	1.00
Vidarbha	0.34	0.55	0.68	0.79	0.80
Marathwada	0.87	1.04	0.96	1.11	1.08
Western Maharashtra	1.00	1.05	1.02	1.10	1.11
Maharashtra State	0.98	1.06	1.05	1.16	1.17
Modified Entropy Index					
Konkan	0.43	0.56	0.52	0.55	0.57
Vidarbha	0.19	0.31	0.39	0.45	0.46
Marathwada	0.50	0.59	0.54	0.63	0.61
Western Maharashtra	0.57	0.60	0.58	0.62	0.63
Maharashtra State	0.56	0.60	0.59	0.66	0.66
Composite Entropy Index					
Konkan	0.42	0.55	0.51	0.54	0.56
Vidarbha	0.19	0.30	0.38	0.44	0.45
Marathwada	0.49	0.58	0.53	0.62	0.60
Western Maharashtra	0.56	0.59	0.57	0.61	0.62
Maharashtra State	0.55	0.59	0.58	0.65	0.65
Ogive Index					
Konkan	-11.01	-6.94	-10.57	-7.52	-5.75
Vidarbha	-37.80	-27.55	-18.88	-15.75	-13.07
Marathwada	-10.16	-6.60	-8.00	-4.36	-4.96
Western Maharashtra	-6.41	-5.51	-6.41	-5.29	-5.20
Maharashtra State	-6.38	-5.40	-5.80	-3.96	-3.86
N = 58	Log 58	1.7634			

highest values of all indices during the period under study indicating more diversification in irrigated area as compared to other regions of the state. Marathwada region ranks second followed by Konkan region and Vidarbha region. It looks that, by and large, the values of all indices showed an increase during the period 1970-73 but subsequently showed a decline during 1980-83 in all regions except Vidarbha region. Similarly during 1990-93 and 1995-98 values of all indices found increasing for all regions except Marathwada region.

On the basis of ratings of the values of Modified Entropy Index in all the regions, it is concluded that Western Maharashtra ranks first for all the periods except 1990-93 followed by Marathwada, Konkan and Vidarbha regions. Graphical presentation of the same is given in Fig. 5.9.

5.4 Potential and Utilization of Irrigation in Maharashtra State

Since the formation of Maharashtra as a separate State, a large number of projects were completed for increasing the State irrigation potential. It was, however, realized that the irrigation potential is not being fully utilized and that a substantial gap exists between potential created and utilized. The Krishna, Jayakwadi, Mula, Purna, Girna, Tapi, Godavari, Kukadi, Pench, Manjara and Bhima projects are the major projects of the State.

5.4.1 Projectwise potential and utilization of irrigation in Maharashtra

The information on the growth in potential created and utilization of irrigation in minor, major and medium irrigation projects during the period of last 40 years is given in Table

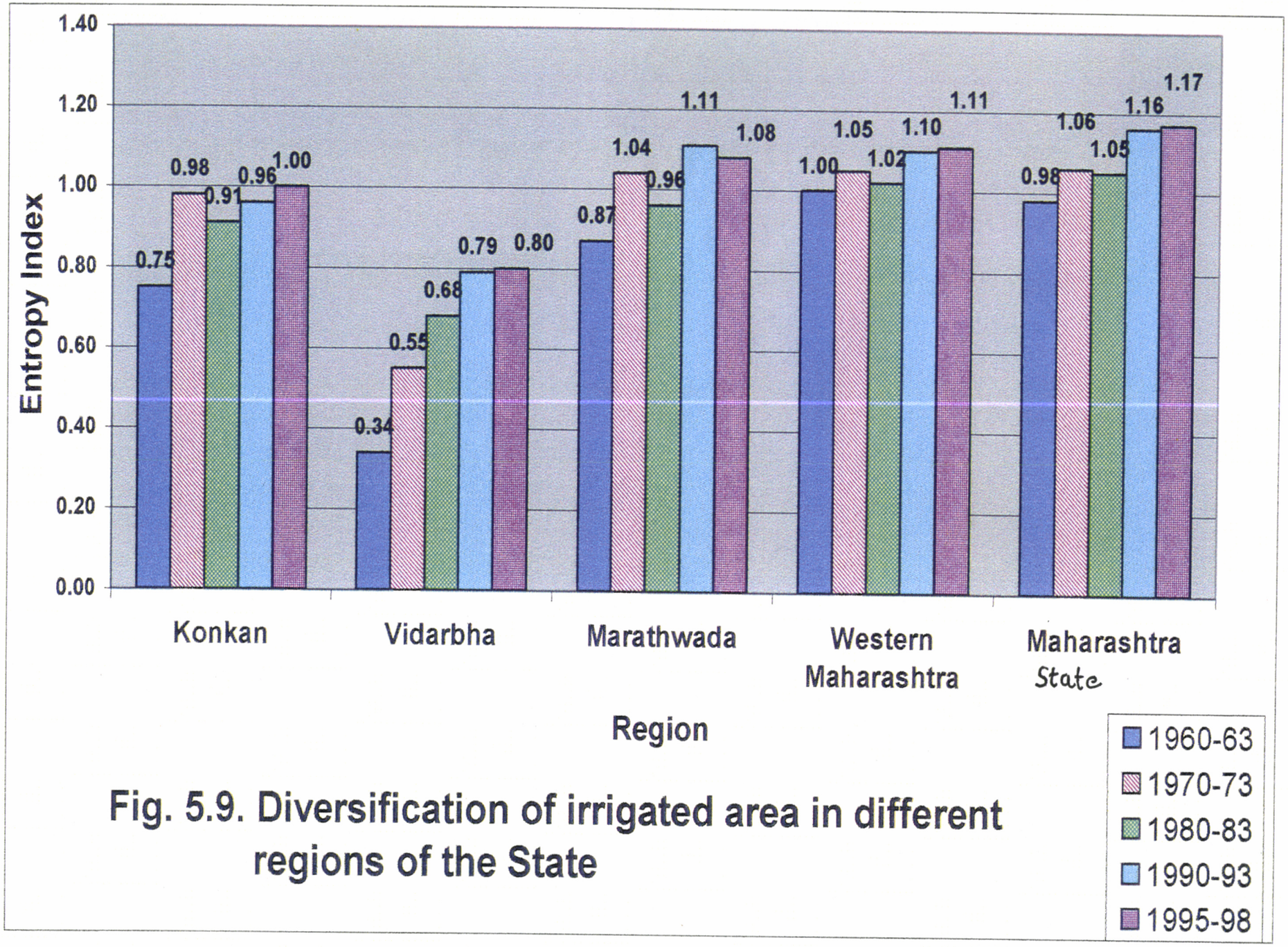


Fig. 5.9. Diversification of irrigated area in different regions of the State

5.21. The potential created through major and medium irrigation projects has increased by 705.92 per cent in 1997-2000 over 1960-63, but utilization of irrigation potential showed an increase just by 329.34 per cent during the same periods in the State.

Table-5.21.Growth in potential and utilization of irrigation in major, medium and minor projects over a period of time in Maharashtra State.

(lakh hectares)

Particulars	Period				
	1960-63	1970-73	1980-83	1990-93	1997-2000
Potential					
Major& Medium projects	3.21 (100.00)	6.56 (104.36)	13.19 (310.90)	19.63 (511.52)	25.87 (705.92)
Minor projects	5.76 (100.00)	10.78 (87.15)	19.93 (246.00)	28.47 (394.27)	31.67 (449.83)
Total Potential	8.97 (100.00)	17.34 (93.31)	33.12 (269.30)	48.10 (436.23)	57.54 (545.47)
Utilization					
Major& Medium projects	2.42 (100.00)	3.64 (50.41)	5.74 (137.19)	8.53 (252.48)	10.39 (329.34)
Minor projects	5.39 (100.00)	9.77 (81.26)	16.27 (201.85)	23.06 (327.83)	25.72 (377.18)
Total Utilization	7.81 (100.00)	13.41 (71.70)	22.01 (181.18)	31..59 (304.48)	36.11 (362.35)
Gap					
Major& Medium projects	0.79 (100.00)	2.92 (269.62)	7.45 (843.03)	11.10 (1305.06)	15.48 (1859.49)
Minor projects	0.37 (100.00)	1.01 (170.97)	3.66 (808.10)	5.41 (1362.16)	5.95 (1508.10)
Total Gap	1.16 (100.00)	3.93 (238.10)	11.11 (857.75)	16.51 (1323.27)	21.43 (1747.41)

(Figures in parentheses are the percentage changeover their respective base period)

The potential created under minor irrigation projects showed a increase by 449.83 per cent and its utilization by 377.18 per cent during same period. This has indicated that utilization of potential created under minor irrigation projects was relatively higher as compared to major and medium irrigation projects. The

gap in potential created and utilization of irrigation under major and medium irrigation projects was high as compared to minor irrigation projects. The increase in completion of minor

Table 5.22. Percentage share of major, medium and minor projects in total potential created and utilization in Maharashtra State.

(lakh hectares)

Particulars	Period				
	1960-63	1970-73	1980-83	1990-93	1997-2000
Potential Created					
Major& Medium	3.21 (35.78)	6.56 (37.83)	13.19 (39.82)	19.63 (40.79)	25.87 (44.96)
Minor	5.76 (64.22)	10.78 (62.17)	19.93 (60.18)	28.47 (59.21)	31.67 (55.04)
Total Potential	8.97 (100.00)	1734 (100.00)	33.12 (100.00)	48.12 (100.00)	57.54 (100.00)
Utilization					
Major& Medium	2.42 (30.98)	3.64 (27.14)	5.74 (26.08)	8.53 (27.00)	10.39 (28.77)
Minor	5.39 (69.02)	9.77 (72.86)	16.27 (73.92)	23.06 (73.00)	25.72 (71.23)
Total Utilization	7.81 (100.00)	13.41 (100.00)	22.01 (100.00)	31.59 (100.00)	36.11 (100.00)
Gap					
Major& Medium	0.79 (68.10)	2.92 (74.30)	7.45 (67.06)	11.10 (67.23)	15.48 .(72.24)
Minor	0.37 (31.90)	1.01 (25.70)	3.66 (32.94)	5.41 (32.77)	5.95 (27.76)
Total Gap	1.16 (100.00)	3.93 (100.00)	11.11 (100.00)	16.51 (100.00)	21.43 (100.00)

(Figures in parentheses are the percentage to the respective total)

irrigation projects during the seventies was more as compared to other periods, which resulted in increased utilization of water under minor irrigation projects in the State. Table 5.22 presents the data on percentage share of major, medium and minor irrigation projects in the total potential created and utilization of irrigation during the period of last 40 years in Maharashtra. Percentage share of major and medium irrigation projects in total potential created increased from 35.78 in

1960-63 to 44.96 in 1997-2000. However, reverse trend has been observed in the case of minor irrigation projects. Share of potential utilized of major and medium irrigation projects in total utilization of irrigation has declined from 30.98 per cent in 1960-63 to 28.77 per cent in 1997-2000 while reverse trend has been observed in the case of minor irrigation projects. Percentage share of gap between potential created and utilized of major and medium increased

Table 5.23. Percentage share of utilization and gap in the total Potential created of irrigation in Maharashtra State.

(lakh hectares)

Particulars	Period				
	1960-63	1970-73	1980-83	1990-93	1997-2000
Potential					
Major& Medium	3.21 (100.00)	6.56 (100.00)	13.19 (100.00)	19.63 (100.00)	25.87 (100.00)
Minor	5.76 (100.00)	10.78 (100.00)	19.93 (100.00)	28.47 (100.00)	31.67 (100.00)
Total Potential	8.97 (100.00)	17.34 (100.00)	33.12 (100.00)	48.12 (100.00)	57.54 (100.00)
Utilization					
Major& Medium	2.42 (75.16)	3.64 (55.40)	5.74 (43.52)	8.53 (43.43)	10.39 (40.16)
Minor	5.39 (93.41)	9.77 (90.60)	16.27 (81.63)	23.06 (81.00)	25.72 (81.21)
Total Utilization	7.81 (87.07)	13.41 (77.34)	22.01 (66.45)	31.59 (65.69)	36.11 (62.76)
Gap					
Major& Medium	0.79 (24.84)	2.92 (44.60)	7.45.12 (56.48)	11.10 (56.57)	15.48 (59.84)
Minor	0.37 (6.50)	1.01 (9.40)	3.66 (18.37)	5.41 (19.00)	5.95 (18.79)
Total Gap	1.16 (12.93)	3.93 (22.66)	11.11 (33.55)	16.51 (34.31)	21.43 (37.24)

(Figures in parentheses are the percentage share of utilization and gap to total utilization)

during the same period. The created potential has remained unexploited of some of major and medium projects because of lack

of reconstruction of canals and management for the utilization of created potential. Percentage share of utilization of irrigation in total potential created is depicted in Table.2.23. In the case of major and medium irrigation projects, share of utilized irrigated area in potential area has declined from 75 per cent in 1960-63 to 40 per cent in 1997-2000, while in case of minor irrigation projects, it has declined from 93.41 per cent to 81.21 per cent during same period. Share of total gap in total potential created was has increased from 12.93 per cent to 37.24 per cent in the State. It clearly indicates that 21.43 lakh hectares (37.24 per cent) of potential created remained unutilized. Graphical presentation of the same is given in Fig.5.10 and 5.11.

5.4.2 Region-wise changes in potential created and utilization of irrigation in Maharashtra State

The information on region-wise potential created and utilization of irrigation is presented in Table 5.24. It can be revealed that during the year 2000, an increase in irrigation potential created was highest in Konkan region (469.23 per cent) over the year 1970, whereas an increase in the potential created in the Western Maharashtra region was lowest (197.57 per cent) during same period. It revealed that the potential created in base period (1970) was highest in the Western Maharashtra region as compared to other regions. Only in the Marathwada region, the utilization of irrigation potential created has decreased in the year 2000 over year 1990. The irrigation potential created in Konkan region has been fully utilized in the year 2000 over year 1990.

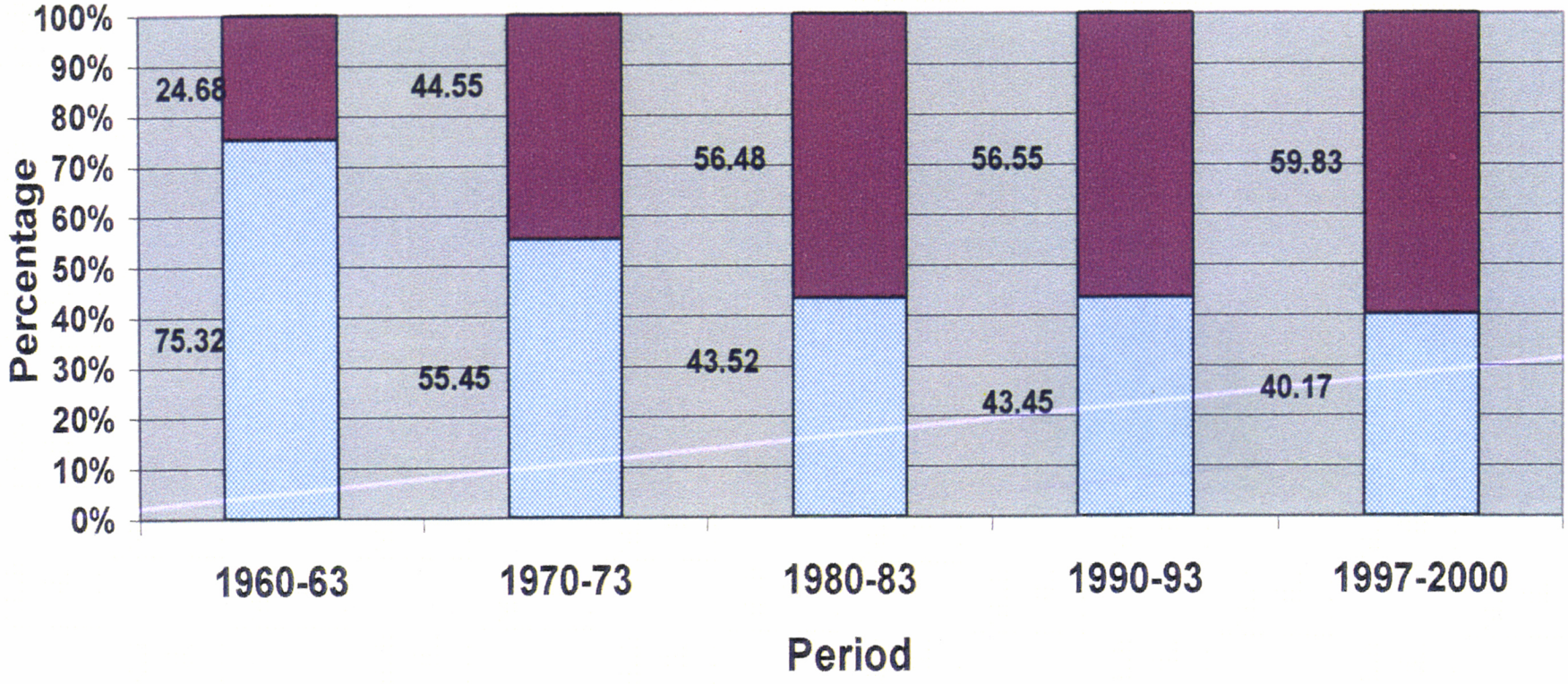


Fig.5.10 Diminishing utilization of potential created of major and medium irrigation projects in Maharashtra State

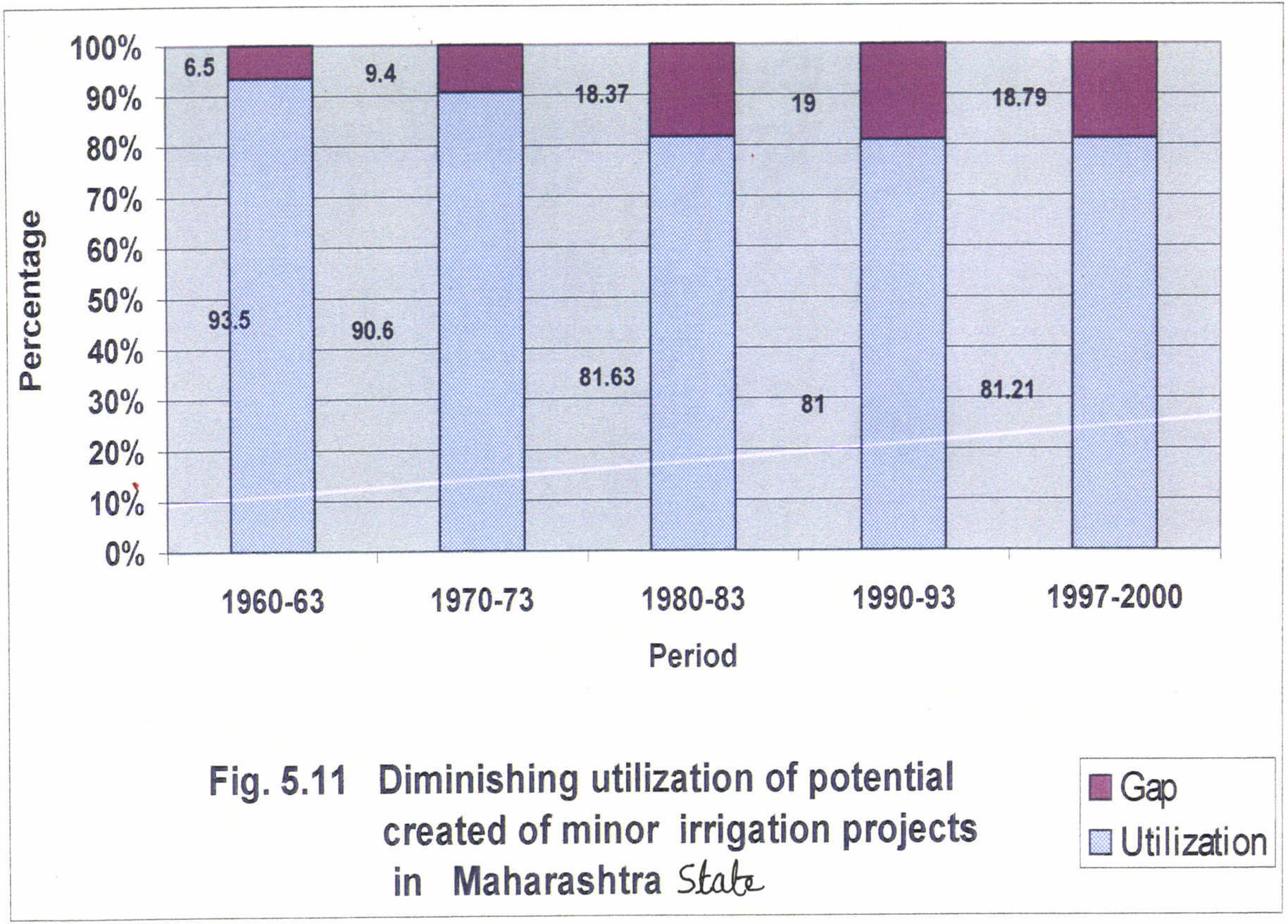


Fig. 5.11 Diminishing utilization of potential created of minor irrigation projects in Maharashtra State

Table 5.24. Regionwise growth in potential created and utilization of irrigation over a period of time.

(Lakh hectares)

Region	Potential Created				Utilization		Gap	
	Year				Year		Year	
	1970	1980	1990	2000	1990	2000	1990	2000
Konkan	0.13	0.44	0.83	0.74	0.23	0.51	0.60	0.23
	(100.00)	(238.46)	(538.46)	(469.23)	(100.00)	(121.74)	(100.00)	(-61.67)
Marathwada	3.42	7.74	13.18	14.88	8.63	8.47	4.55	6.41
	(100.00)	(126.32)	(285.38)	(335.09)	(100.00)	(-1.85)	(100.00)	(40.88)
Vidarbha	2.24	5.74	8.76	11.09	5.16	7.38	3.60	3.71
	(100.00)	(156.25)	(291.07)	(395.09)	(100.00)	(43.02)	(100.00)	(3.06)
Western Maharashtra	11.09	18.11	25.25	33.00	17.50	20.58	7.75	12.42
	(100.00)	(63.30)	(127.68)	(197.57)	(100.00)	(17.60)	(100.00)	(60.26)
Maharashtra State	16.88	32.03	48.02	59.71	31.52	36.94	16.50	22.77
	(100.00)	(89.75)	(184.48)	(253.73)	(100.00)	(17.20)	(100.00)	(38.00)

Note : 1.Regionwise breakup of utilization is not available for years 1970 and 1980.

2.Figures in parentheses are the percentage change over the respective base year.

Table 5.25.Percentage share of potential created and utilization of irrigation in regions of Maharashtra State

(Lakh hectares)

Region	Potential Created				Utilization		Gap	
	Year				Year		Year	
	1970	1980	1990	2000	1990	2000	1990	2000
Konkan	0.13	0.44	0.83	0.74	0.23	0.51	0.60	0.23
	(0.77)	(1.38)	(1.73)	(1.23)	(0.73)	(1.39)	(3.64)	(1.01)
Marathwada	3.42	7.74	13.18	14.88	8.63	8.47	4.55	6.41
	(20.26)	(24.16)	(27.45)	(24.93)	(27.37)	(22.92)	(27.58)	(28.15)
Vidarbha	2.24	5.74	8.76	11.09	5.16	7.38	3.60	3.71
	(13.28)	(17.92)	(18.24)	(18.57)	(16.37)	(19.97)	(21.82)	(16.29)
Western Maharashtra	11.09	18.11	25.25	33.00	17.50	20.58	7.75	12.42
	(65.69)	(56.54)	(52.58)	(55.27)	(55.53)	(55.72)	(46.96)	(54.55)
Maharashtra State	16.88	32.03	48.02	59.71	31.52	36.94	16.50	22.77
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Note : 1.Regionwise breakup of utilization is not available for years 1970 and 1980.

2. Figures in parentheses are the percentage to total of Maharashtra.

Table 5.26. Percentage share of utilization and gap in potential created of irrigation in different regions of Maharashtra State.

(Lakh hectares)

Region	Potential Created		Utilization		Gap	
	Year		Year		Year	
	1990	2000	1990	2000	1990	2000
Konkan	0.83	0.74	0.23	0.51	0.60	0.23
	(100.00)	(100.00)	(27.71)	(68.92)	(72.29)	(31.08)
Marathwada	13.18	14.88	8.63	8.47	4.55	6.41
	(100.00)	(100.00)	(65.48)	(56.92)	(34.52)	(43.08)
Vidarbha	8.76	11.09	5.16	7.38	3.60	3.71
	(100.00)	(100.00)	(58.90)	(66.55)	(41.10)	(33.45)
Western Maharashtra	25.25	33.00	17.50	20.58	7.75	12.42
	(100.00)	(100.00)	(69.31)	(62.36)	(30.69)	(37.64)
Maharashtra State	48.02	59.71	31.52	36.94	16.50	22.77
	(100.00)	(100.00)	(65.64)	(61.87)	(34.36)	(38.13)

Note : 1. Regionwise breakup of utilization is not available for years 1970 and 1980)

2. Figures in parentheses are the percentage share of utilization and gap to total utilization.

Table 5.25 presents the information on percentage share of irrigation potential created and utilization there in various regions of the state. The highest potential has been created in the Western Maharashtra region as compared to other regions during the entire period of the study, ranging percent from 55.27 in the year 2000 to 65.69 per cent in the year 1970 of the total potential created in the State. In case of utilization, share of Western Maharashtra region has been highest in total utilization of State. Lowest share of potential created and utilized in the State was of the Konkan region. The information on regionwise share of irrigation utilization in total irrigation potential created is given in Table 5.26. In year 1990, highest utilization of available water was in Western Maharashtra region(69.92 per cent), but in the year 2000 most efficient utilization of irrigation has been observed in Konkan region. Among the regions, share of highest gap in irrigation potential created and utilized has been observed in Konkan region during year 1990 (72.29 per cent), which was lowest in year 2000 (31.08 per cent). It indicated that large efforts were made to increase utilization in Konkan region as compared to Vidarbha region, while Western Maharashtra and Marathwada regions are lagging behind in making efforts to control over loss of potential created. Graphical presentation of the same is given in Fig 5.12.

5.5 Factors Responsible for Irrigation Growth in Different Regions of the Maharashtra State

The growth and development of agriculture is highly contributed by availability of irrigation. Irrigation has been major input in production of crops. Impact of irrigation led to not only development of primary sector but secondary and tertiary sectors also. As the

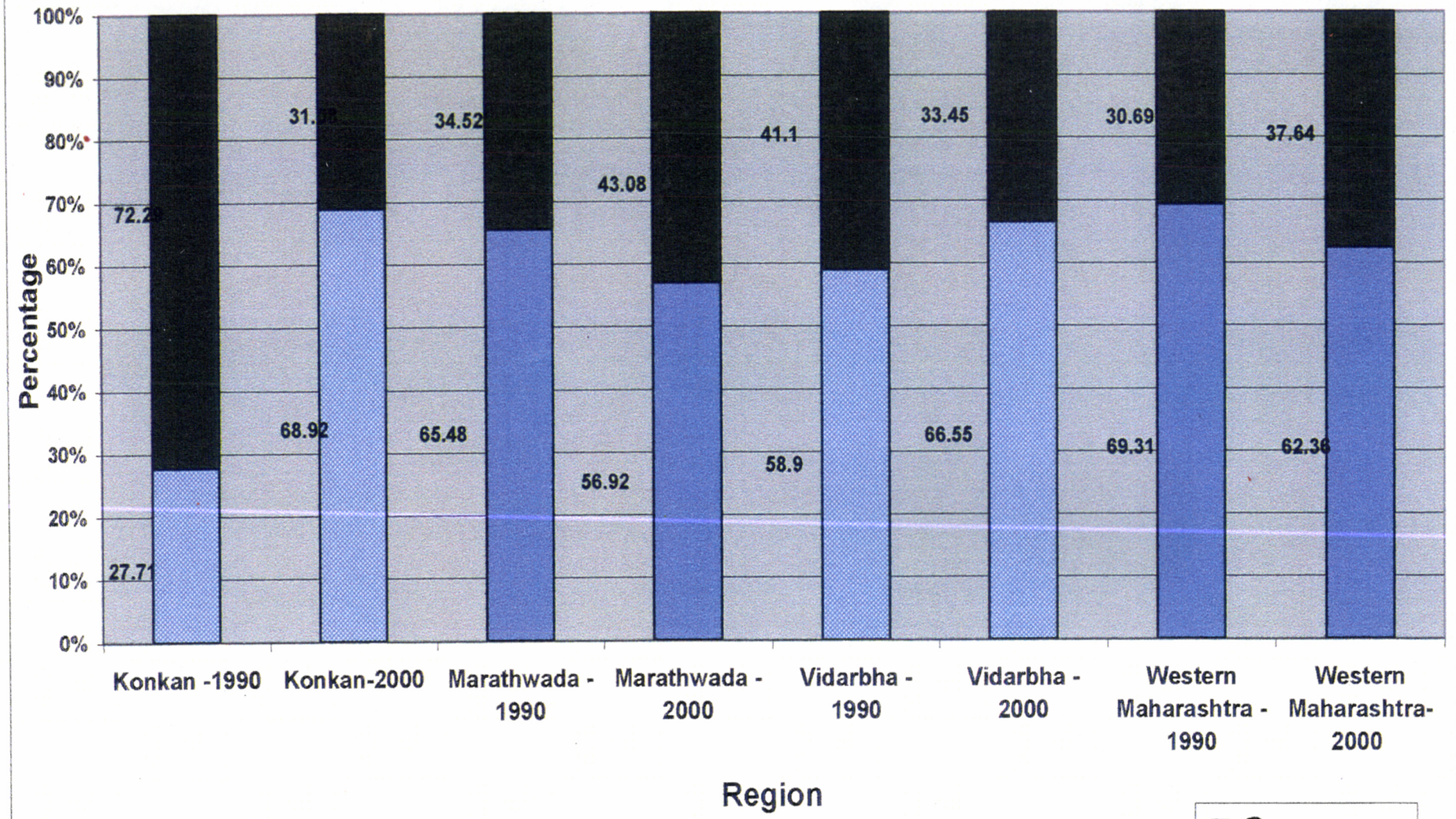


Fig.5.12 Gap in irrigation potential created and utilization in different regions of Maharashtra State

irrigation is important for growth of agriculture, it is also necessary to know the factors contributing in irrigation growth i.e. impact of different factors on irrigation. Factor develops such as increased income from increased production due to irrigation growth might be contributed in growth of gross irrigated area. Irrigation development is really very complex, depends on potential and of varied nature across regions, States and countries. The attempt has been made to know factors responsible for growth of irrigation in different regions of the State by using Multiple Regression Function Analysis with available data.

5.5.1 Factors responsible for irrigation growth in Konkan region.

Results of factors contributed in irrigation growth in Konkan region are presented in Table 5.27. It can be revealed that with the increase in area under surface irrigation by one hectare, gross irrigated area has increased by 0.78 hectare significantly during the period. The contribution of well irrigation has been positive and significant. With increase in one hectare area under well irrigation has increased gross irrigated area by 1.09 hectare indicating high contribution of wells in irrigation growth. Rainfall in the region has positively maintained a non-significant and positive contribution to the gross irrigated area. Negative coefficient of irrigated area under fruits witnessed the decrease in gross irrigated area. With the increase in area under irrigated fruit crops, it is resulted due to long duration of fruit crops, it occupies area for long period instead of it seasonal crops can be cultivated more times. Vegetable crops under irrigation has contributed positively and significantly as

Table 5.27.Factors responsible for irrigation growth in Konkan region

Sr. No.	Independent factors	Coefficient
1	Intercept	202.77
2	Surface Irrigation (ha)	0.7805*** (0.1135)
3	Well Irrigation (ha)	1.0999*** (0.0351)
4	Rainfall (mm)	0.0075 (0.0159)
5	Area under fruit crops (ha)	-0.6641 (0.6159)
6	Area under vegetable crops (ha)	0.5008** (0.2147)
7	R square	0.87

(1. Figures in parentheses are standard error of respective factors.
2. *, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

it is short duration crop. The factors considered have explained 87 per cent variation in growth of irrigation.

5.5.2 Factors responsible for irrigation growth in Vidarbha region.

It is evident from Table 5.28 that surface and well irrigated area has maintained positive and significant share in the growth of gross irrigated area. Gross irrigated area showed negative correlation with rainfall in the region. It might be due to occurance of recurrent floods due to high rainfall. In Vidarbha, there are always evidences of flood. Gross irrigated area has increased non-significantly with increase in irrigated area under cotton. Irrigated area under fruit crops has correlated negatively and non-significantly with gross irrigated area. Vegetable

Table 5.28.Factors responsible for irrigation growth in Vidarbha region.

Sr. No.	Independent factors	Coefficient
1	Intercept	2941.83
2	Surface Irrigation (ha)	0.8654*** (0.1336)
3	Well Irrigation (ha)	1.3289*** (0.0541)
4	Rainfall (mm)	-0.1526 (0.3964)
5	Area under cotton crops (ha)	4.3882 (2.9645)
6	Area under fruit crops (ha)	-3.5984 (2.9632)
7	Area under vegetable crops (ha)	3.3471** (1.2823)
8	R square	0.80

(1. Figures in parentheses are standard error of respective factors.
2. *, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

crops being short duration experienced positive and significant contribution in the gross irrigated area.

5.5.3 Factors responsible for irrigation growth in Marathwada region

In Table 5.29, results of factors responsible for irrigation development in Marathwada region are presented. It can be revealed that area under surface irrigation as well as well irrigation has correlated positively and significantly with gross irrigated area. The coefficient of surface irrigation (2.12) is greater than coefficient of significantly with gross irrigated area. The coefficient of surface irrigation (2.12) is greater than coefficient of

Table 5.29 Factors responsible for irrigation growth in Marathwada region.

Sr. No.	Independent factors	Coefficient
1	Intercept	2504.38
2	Surface Irrigation (ha)	2.1206*** (0.1759)
3	Well Irrigation (ha)	1.1970*** (0.0369)
4	Rainfall (mm)	0.3040*** (0.029)
5	Area under sugarcane crop (ha)	0.4278 (0.4895)
6	Area under fruit crops (ha)	-2.8938 (2.4698)
7	Area under vegetable crops (ha)	3.6164*** (1.2172)
8	R square	0.83

(1. Figures in parentheses are standard error of respective factors.
2. *, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

of well irrigation, because of highest growth in surface irrigation resources in Marathwada during period of 40 years as compared to other regions. Though the range of rainfall is only 700-900 mm, it has contributed positively and significantly in growth of gross irrigated area. Non-significant and positive contribution of irrigated area under sugarcane was observed. Irrigated area under fruit crops has turned out to be negatively correlated with gross irrigated area, while irrigated area of vegetable crops played significant and positive role in irrigation growth.

5.5.4 Factors responsible for irrigation in Western Maharashtra region

In Western Maharashtra region, it has been observed that significant improvement in gross irrigated area was largely due to high exploitation of water resources as presented in Table 5.30. Rainfall and irrigated area under fruit crops showed non-significant and positive correlation with gross irrigated area. Rainfall in Sahyadri ranges is high and gets diverted toward larger part of Western Maharashtra region etc. Sugarcane indicated negative and non-significant contribution in growth of gross irrigated

Table 5.30. Factors responsible for irrigation growth in Western Maharashtra region.

Sr. No.	Independent factors	Coefficient
1	Intercept	7885.47
2	Surface Irrigation (ha)	0.9926*** (0.2976)
3	Well Irrigation (ha)	1.1716*** (0.0122)
4	Rainfall (mm)	0.4269 (1.1280)
5	Area under sugarcane crop (ha)	-2.7533 (2.4046)
6	Area under fruit crops (ha)	5.6280 (3.4829)
7	Area under vegetable crops (ha)	1.0698** (0.4756)
8	R square	0.84

(1. Figures in parentheses are standard error of respective factors.
2. *, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

area. Vegetables have maintained positive and significant contribution in gross irrigated area during period of 40 years. In the region, large fallow land has brought under irrigation.

Due to an increase in surface and well irrigation, gross irrigated area has increased positively and significantly. Except Western Maharashtra, in all the other regions of Maharashtra State, there was negative correlation between irrigated area under fruits and gross irrigated area. In all the regions, rainfall revealed positive contribution in gross irrigated area except Vidarbha region. Vegetable crops maintained positive correlation with gross irrigated area in all the regions of the State. The factors considered have explained 84 per cent variation in growth of irrigation.

5.5.5 Factors responsible for irrigation growth in Maharashtra State

Multiple regression function has been fitted for the State as a whole and results are presented in Table 5.31. It is observed that surface and well irrigation showed positive and significant share in irrigation growth. Average rainfall in the State is conducive for the growth of gross irrigated area. Major and medium irrigation projects had negatively correlated with gross irrigated area. However, minor irrigation projects have kept positive contribution over 40 years. With increase in area under drip irrigation, gross irrigated area has increased. In case of sugarcane, it has been observed that gross irrigated area has declined with increase in area under sugarcane. Irrigation under fruit and vegetable crops has made positive contribution in irrigation growth.

Table 5.31.Factors responsible for irrigation growth in Maharashtra State

Sr. No.	Independent factors	Coefficient
1	Intercept	2039.74
2	Surface Irrigation (ha)	2.3461*** (0.3629)
3	Well Irrigation (ha)	1.2211*** (0.0248)
4	Rainfall (mm)	1.2112** (0.5920)
5	Major and medium projects (ha)	-0.3265 (3.5793)
6	Minor projects (ha)	2.8296 (11.57)
7	Drip Irrigation (ha)	0.1196*** (0.0150)
8	Sugarcane (ha)	-0.1504** (0.6523)
9	Area under fruits crop (ha)	1.0814 (5.87)
10	Area under Vegetable crops (ha)	1.0967** (0.4834)
11	R square	0.87

(1. Figures in parentheses are standard error of respective factors.
2. *, ** and *** are the levels of significance at 10, 5 and 1%, respectively)

The variables considered have explained 87 per cent variation in growth of irrigation.

5.6 Strategies for the Growth and Development of Irrigation in Maharashtra State

5.6.1 In Konkan region, percentage of gross irrigated area in gross cropped area is lowest as compared to other regions. Paddy is dominating irrigated crop. No major irrigation projects are constructed in the region. Utilization of irrigation potential created in the region has increased in last decade with advancement of technology.

The use of micro irrigation systems and other modern water saving technologies for paddy can save water

and this water can be diverted towards vegetable crops. Construction of major irrigation projects can increase the irrigated area of the region.

5.6.2 In Vidarbha region, growth in irrigation is less for entire period. Irrigated area under non-food crops is less (3.95 per cent). Paddy is major irrigated crop of the region. Cotton has shown positive contribution in gross irrigated area. Gap between potential created and utilized of irrigation has been increased during last decade.

With the use of modern water saving technologies, water use for paddy can be saved and this surplus water can be diverted towards cotton crop as well as other non-food crops. Gap between potential created and utilized of irrigation can be reduced with the increase in Command Areas Development Programmes, construction of canals and subcanals.

5.6.3 In Marathwada region, growth in irrigation is high as compared to other regions for entire period. Sugarcane has large share in gross irrigated area. Vegetables have shown positive and significant share in gross irrigated area. Gap between potential created and utilized of irrigation has been large.

With the use of micro irrigation systems for sugarcane, water can be saved and this water can be diverted towards vegetable crops. It will increase gross irrigated area of the region. Utilization of irrigation potential created can be increased by constructing canal, subcanals and tail storages.

5.6.4 In Western Maharashtra region, Sugarcane crop has shown highest share in gross irrigated area and negative correlation with gross irrigated area. Gap between potential created and utilized of irrigation has been largest as compared to other regions.

If the water requirement in sugarcane is reduced with the use of micro irrigation systems and diverted it towards other crops, it will increase gross irrigated area of the region. Gap between potential created and utilization of irrigation can be reduced with the increase in Command Areas Development Programmes, construction of canals and subcanals.

SUMMARY AND CONCLUSIONS

6. SUMMARY AND CONCLUSIONS

Irrigation plays an important role in agricultural development. It ensures a secure harvest and acts as insurance against inadequate and inconsistent monsoon. It increases gross cropped area. It diversifies and transforms the cropping pattern with such beneficial effects as substitution of inferior and low value crops by superior and high value ones that prove to be more remunerative to the farmers. The gross irrigated area of India has increased from 17.10 per cent in 1960-61 to 39.22 per cent in 2000-01. In Maharashtra, gross irrigated area was 36.47 lakh hectares, which was 16.39 per cent of gross cropped area in the year 2000-01. The State has 126 lakh hectares of ultimate irrigation potential, out of which only around 60 lakh hectares potential is created and only 61 per cent there of is utilized. The State has therefore tremendous scope in irrigation development. Regions of the State had disparities in irrigation growth and development. Irrigated area under different crops in different regions was also varying over a period of time. However, a very few studies had been undertaken to assess the problem regarding regionwise growth and development of irrigation in the State. Looking to the importance and nature of regionwise disparities in irrigation, present study attempts to examine in detail the "Growth and Development of Irrigation in Maharashtra: A Regionwise Analysis" with a view to understand growth of irrigated area, shift in irrigated area of crops, gap between irrigation potential created and utilization and factors influencing irrigation growth.

The study contemplated a detailed analysis of empirical data on different variates of irrigation

development in different regions of Maharashtra to fulfill the requirements of following objectives:

1. To study the temporal and spatial growth in irrigation in different regions of State,
2. To study the shift in allocation of irrigated area amongst the crops over a period of time in different regions,
3. To study development of irrigation potential and its utilization,
4. To identify the factors responsible for growth and development of irrigation in different regions of the State and
5. To suggest strategies for the development of irrigation in the State.

The study is based on time series data on different aspects of irrigation for the period 1960-61 to 1999-2000. The entire period of 40 years has been divided into four decadal sub-periods for growth rates of irrigation. Five triennial averages *viz.*, 1960-63, 1970-73, 1980-83, 1990-93 and 1995-98 are considered for studying shift in area of irrigated crops for all the four regions of the State.

Four revenue divisions of the State *viz.*, Konkan, Vidarbha, Marathwada and Western Maharashtra are considered as regions. Regionwise time series data in respect of the variates such as gross irrigated area, gross cropped area, net irrigated area, net cropped area, sourcewise irrigated area, irrigated area under different crops, potential and utilized irrigated area, rainfall, area under drip and sprinkler irrigation systems etc. were collected from Season and Crop Reports, Epitomes of Agriculture, Statistics wing of the Department of Agriculture Commission, Department of Irrigation, Government of Maharashtra.

Data so obtained have been analysed to obtain estimates of different variates relating to the irrigation development in four regions of the State during different time periods. The analytical framework included Compound Growth Rates of gross and net irrigated area, gross and net cropped area, shift in triennial averages estimates for surface and well irrigation, potential and utilization of irrigation, cropwise irrigated area. Correlations, Multiple Regression Analysis and Compound Growth Rates are used combinely for studying shifts in area of irrigated crops in different regions of the State. The multiple regression analysis technique is used to find out factors influencing irrigation growth in the State. Different Indices *viz.*, Herfendahl Index, Entropy Index, Modified Entropy Index, Composite Entropy Index and Ogive Index are used to find out diversification amongst irrigated crops both in regions as well as for the State as a whole.

6.1 Summary of findings

The findings of the study are briefly summarized as below:

6.1.1 In Maharashtra, percentage share of gross irrigated area in gross cropped area had increased from 6.38 in 1960-63 to 16.46 in 1997-2000. Western Maharashtra ranked the first for percentage share of gross irrigated area in gross cropped area (21.12 per cent) followed by Marathwada (14.41 per cent), Vidarbha (13.10 per cent) and lowest in Konkan region (6.96 per cent). The annual rate of compound growth in gross irrigated area was 3.15 per cent during the period from 1960-61 to 1999-2000 in the State. Among regions, annual rate of compound growth in gross irrigated area of Marathwada was the highest (4.76 per cent) followed by Konkan (3.31 per cent) and was the lowest (2.67 per cent) in Western Maharashtra region.

6.1.2 In the State, growth of well irrigation was observed to be higher than surface irrigation. Among the regions, the growth of surface irrigation was the highest in Marathwada and the lowest in Vidarbha region as compared to other regions, whereas the growth of well irrigation was the highest in Vidarbha and the lowest in Konkan region during the period from 1970-73 to 1997-2000. In Western Maharashtra region, growth of well irrigation was higher than the growth of surface irrigation during the period from 1970-73 to 1997-2000. The proportion of well irrigation was high (65.30 per cent) in gross irrigated area of the State. The share of well irrigation in their respective gross irrigated area was higher in Marathwada and Western Maharashtra regions. While the share of surface irrigation in their respective gross irrigated areas was observed to be higher in Konkan and Vidarbha regions during the period from 1970-73 to 1997-2000.

6.1.3 In Konkan region, irrigated area under paddy, chilli and coconut has been shifted to gram, chikoo and mango crops during the study period from 1960-63 to 1995-98. The significant shift of percentage of irrigated area have been noted from paddy and chilli to gram and groundnut. In this region, share of non-food crops in gross irrigated area showed a decline from 34.16 to 28.74 per cent during the period of last 38 years i.e. from 1960-61 to 1997-98.

6.1.4 In Vidarbha region, paddy was observed to be a major dominating irrigated crop, constitutes around half of the share in gross irrigated area. Importantly, a shift in irrigated area from paddy to wheat and gram crops was noted during the period of last 38 years. The proportionate share of irrigated area under paddy, jowar and chilli has been significantly shifted to wheat, gram, groundnut, cotton and red gram in this region during the study period. Quite a

low percentage share of irrigated area under food crops has been diverted towards non-food crops in this region. The share of non-food crops in gross irrigated area was very mearge i.e. 3.95 per cent in 1995-98. The crops such as sunflower and soybean were newly introduced irrigated crops in the region since 1990-93.

6.1.5 In Marathwada region, jowar had the highest share(20.15 per cent) in gross irrigated area followed by wheat(18.88 per cent) and sugarcane(14.34 per cent) during the period 1995-98. Interestingly, the share of irrigated area under jowar in gross irrigated area has been diverted towards the crops of wheat, sugarcane, gram, groundnut and sunflower in this region. The proportion of irrigated area under non-food crops showed a significant increase from 4.71 to 22.59 per cent. Sunflower was introduced as an irrigated crop in this region since 1990-93.

6.1.6 In Western Maharashtra region, share of jowar in gross irrigated area has been diverted to sugarcane over a period of last 38 years i. e. from 1960-61 to 1997-98. The large number of crops such as wheat, paddy, bajara, sugarcane, cotton, groundnut and onion had considerable share in the gross irrigated area in 1995-98 as compared to 1960-63 in Western Maharashtra. The share of non-food crops in gross irrigated area showed a decline from 13.24 to 11.07 per cent over a period of last 38 years i.e. from 1960-61 to 1997-98.

6.1.7 In Maharashtra State as a whole, the percentage share of irrigated area has been shifted from paddy to wheat, sugarcane, gram and groundnut during the period under consideration. Importantly, during 1995-98, wheat had the highest share in gross irrigated area (17.18 per cent) followed by sugarcane (16.23 per cent) in the State. Sunflower has been introduced as a new irrigated crop since the last decade in the State. The share of non-food crops

group in the gross irrigated area showed an increase from 9.63 to 12.66 per cent in Maharashtra State during the period from 1960-63 to 1995-98.

6.1.8 During 1995-98, the highest diversification in irrigated crops has been observed in Western Maharashtra region followed by Marathwada. However, the lower diversification of irrigated crops was seen in Vidarbha region. But the growth in diversification of irrigated area was observed more in Vidarbha region.

6.1.9 In the Maharashtra, the growth in potential created of major and medium irrigation projects was higher as compared to the minor irrigation projects. However, the utilisation of irrigation potential created was more in minor irrigation projects followed by medium and major irrigation projects. In the State, the share of potential created by minor projects in total irrigation potential and its utilization was found higher during the last 40 years of study. However, this showed declining trend in the State during the period from 1960-63 to 1997-2000. The utilization of potential created by major and medium irrigation projects showed a decline from 75.16 per cent to 40.16 per cent in Maharashtra. Similarly, utilisation of the potential created by minor irrigation projects has also been decreased from 93.41 per cent to 81.21 per cent in the State.

6.1.10 The growth in irrigation potential created has been observed to be the highest in Konkan region followed by Marathwada during the period from 1960 to 2000. The utilization of irrigation potential created was the highest in Konkan region (68.92 per cent) followed by Vidarbha region (66.55 per cent) in the State.

6.1.11 In all the regions, the factors such as sources of surface irrigation, well irrigation and irrigated area under vegetable crops have significant positive influence

in increasing irrigation. The amount of rainfall showed positive association in influencing the irrigation only in Marathwada region and Maharashtra State as a whole. The area under sugarcane had negative influence on the gross irrigated area in Western Maharashtra region and also for Maharashtra State. Importantly, the area under drip irrigation showed a significant positive contribution in irrigation growth in the State.

6.2 Conclusions

6.2.1 In Konkan region, the proportion of gross irrigated area in gross cropped area was observed to be 6.96 per cent in the year 1997-2000, which was quite low as compared to State average of 16.46 per cent. It is because of geographical features of the region. The steep slope and lateritic soils in the region do not permit to have water reservoirs needed for advancing irrigation. Importantly, the rate of compound growth in irrigation was observed to be 3.31 percent per annum during the period of last 40 years in Konkan region. In Vidarbha region, the annual rate of compound growth in gross irrigated area was 2.88 per cent per annum during the period from 1960-61 to 1999-2000. Use of large number of historical series of Malgujari tanks is still observed in this region. However, emphasis is being given on development of irrigation since the last decade. Growth in gross irrigated area in Marathwada region was the highest as compared to other regions in the State. Irrigation projects and other irrigation works were not taken up before independence and meagre area was under irrigation during 1960-63. However, subsequent developments in irrigation potential led to high growth rate in this region. The region of Western Maharashtra ranked the first in irrigated area as compared to other regions in the State. The construction of large number of dams on Krishna,

Bhima and Mula basins and sub-basins helped to increase area under irrigation. Luckily, the Western Maharashtra has large number of rivers. Groundwater exploitation in this region was also high.

6.2.2 Sugarcane contributed a large share in gross irrigated area in Western Maharashtra and Marathwada regions. It consumes large quantity of water and depicted negative correlation with an increase in gross irrigated area.

6.2.3 In the State, area under paddy, jowar, chilli, potato and turmeric lost their share of irrigated area in gross irrigated area and significantly diverted it towards gram, groundnut and sugarcane during the period of last 40 years i.e. from 1960-61 to 1999-2000.

6.2.4 In all the regions of the State, irrigated cropping system has been diversified towards non-food grain crops. The share of irrigated area under paddy and jowar was reduced. The region having more irrigated area i.e. Western Maharashtra had the highest diversification amongst irrigated crops as compared to other regions. With an increase in irrigated area, diversification amongst irrigated crops showed an increase.

6.2.5 The gap between irrigation potential created and utilized had increased during the last 40 years from 13.01 to 37.24 per cent of the total potential created in the State during the period under study.

6.2.6 The gap between irrigation potential created and utilized was higher in Marathwada and Western Maharashtra regions because of inadequate command Area Development works in Godavari and Krishna basins.

6.2.7 In all regions except Marathwada region, gross irrigated area has been increased more by surface irrigation sources than well irrigation sources.

Utilization of minor irrigation projects has been higher as compared to major irrigation projects.

6.3 Policy Implication

6.3.1 In Konkan region, percentage of gross irrigated area to gross cropped area was lowest as compared to other regions in the State. No major irrigation projects were constructed in this region. There is need to increase the use of modern water saving technologies for crop production in this region. Besides, conservation of rainwater and its subsequent use for irrigation through appropriate technologies of soil and water conservation may be the main focus of the region. Government can plan for water-saving cropping patterns and cropping systems.

6.3.2 Paddy has been observed as a major irrigated crop in Konkan and Vidarbha regions during the forty years period of the study. Whereas sugarcane has been major irrigated crop in Marathwada and Western Maharashtra regions. These crops consume high quantity of water. Use of micro irrigation for these crops can reduce wastage of water and this saved water can be diverted to other crops. Concentrated efforts are required to increase the use of micro irrigation viz; drip and sprinkler systems as well as other water saving technologies for these crops.

6.3.3 Gap between irrigation potential created and utilisation has been increased in the Vidarbha, Marathwada and Western Maharashtra regions during the period under study. The State Government can divert its efforts towards the increase in utilization of irrigation through framing irrigation planning as well as by construction of canals and subcanals.

6.3.4 The utilisation of minor irrigation projects that include ground water resources was observed to be higher as compared to major irrigation projects. The well irrigation

resources have shown higher contribution as compared to surface irrigation resources. Main efforts are needed to increase the utilization of surface irrigation resources and the planning for minor irrigation projects.

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VITA

8. VITA

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