CHANGES IN CROPPING PATTERN, AGRICULTURAL PRODUCTIVITY IN IRRIGATED AND UN-IRRIGARTED TRACTS OF RAJASTHAN (1970-73 to 2000-03)

Dissertation Submitted to Jawaharlal Nehru University
in Partial Fulfilment of the Requirements
for the Award of the Degree of

MASTER OF PHILOSOPHY

NARENDRA KUMAR RAI

CENTRE FOR THE STUDY OF REGIONAL DEVELOPMENT
SCHOOL OF SOCIAL SCIENCES
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI- 110067
INDIA
2007

जवाहरलाल नेहरु विश्वविद्यालय
JAWAHARLAL NEHRU UNIVERSITY
Centre for the Study of Regional Development
School of Social Sciences
New Delhi - 110067

CERTIFICATE

This dissertation titled "**Changes in Cropping Pattern and Agricultural Productivity in Irrigated and Un-irrigated Tracks of Rajasthan (1970-73 to 2000-03)**" submitted in partial fulfillment for the Master of Philosophy degree of Jawaharlal Nehru University has not been previously submitted for any other degree of this or any other university and is my original work.

Narendra Kumar Rai

We recommend that the dissertation be placed before the examiner for evaluation.

Prof. M. H. Qureshi
(Supervisor)

Prof. Saraswati Raju
(Chairperson)

Tel. 26704463, Gram: JAYENU Fax: 91-11-26717586, 26197603

Dedicated to

Mummy

Who shaped her own destiny

ACKNOWLEDGEMENT

During the process of writing this dissertation the first person I should acknowledge is my guide Prof. M.H. Qureshi. It was mainly due to his continuous encouragement and quest for improvement that I could complete this dissertation. With his fatherly attitude, he always helped me during my difficult time in these two years. Without his support, it would have been an impossible task to complete my M. Phil.

I am also thankful to Dr. Sucharita Sen and Dr. Padmini Pani for their useful comments as members of my advisory board. I am also deeply grateful to Prof. R.K. Sharma for his valuable suggestions related to statistical techniques used in this dissertation.

This work would not be complete, without mentioning my sincere gratitude to the faculty of Babu Shobha Ram New Government Arts College, Alwar- Dr. Mohar Singh, Dr. Sneh Saiwal, Dr. Lokesh Bhatt and Dr. Manju Gupta. It is my pleasure that from the very first day of my college life they have been the most influential in charting out my future career path. Without their continuous support and encouragement this work would not have been completed as swiftly as it was done.

I am also deeply indebted to some of my senior-cum friend, especially advocate Praveen Kumar Buroliya for his continuous help and support. I am also thankful to Maheshwari Singh for his valuable guidance and help during my school days.

Friends are the closest and dearest ones when you are away from home and especially in places like JNU. It is my pleasure that I was never devoid of friendship when colourful chaps like, Abhinav, Satya, Ravi, Arindam, Alvite. N., Om Prakesh, Sahab, Chetan, and Abira surrounded me. Naresh and Sameer too lent their valuable support. Their contributions are wholeheartedly acknowledged.

I am also grateful to the UGC for providing me financial assistance during the time when I needed it the most.

Finally, whatever I have achieved in life till now belong to my parents. Without their sacrifice and support this would not have been a reality.

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INTRODUCTION AND LITERATURE REVIEW

Chapter-1

INTRODUCTION AND LITERATURE REVIEW

Dry farming is basically associated with arid and semiarid climatic conditions. Rajasthan's climatic condition supports that kind of cultivation. At first glance the term dry farming sounds like a contradiction because farming is a function of the three physical and biological resources such as land, water and seeds. Without anyone of the three elements, there can be no farming. If dry farming means farming without water, we are in the realm of magic and folk lore and not in the science and art of cultivation. The art of cultivation that is observed in some parts of the country where limited and uncertain rainfall determined the nature and method of cultivation is termed as dry farming[1].

"In 1970, about 70 % of the cropped area in India was cultivated under dry conditions and a large proportion of output of important crops such as coarse cereals, pulses, oilseeds, and cotton came from these areas. These areas produce 42 % of total food grains, almost all the coarse grains and more than ¾ of pulses and oilseeds of the country."[2]

Dry farming is often equated with rain-fed farming. However, it is necessary to distinguish dry land farming from absolutely arid or desert area on the one hand and the areas having a relatively assured rainfall on the other hand. The availability of irrigation facilities has also to be taken into account as a significant factor modifying the intensity of dry-land farming in different rainfall zones. "The dry farming areas, as defined in the Fourth Five Year Plan, are those which receive an annual rainfall from 375mm to 1125mm, and

[1] B.L. Teli (1994), "*Dry farming in India: Constraints and Challenges*", ed J.L. Raina, Pointer publisher, Jaipur (1994).
[2] R.P. Singh,(1994), "*Dry farming in India : Past, Present and Future*", ed, J.L. Raina, Pointer publisher, Jaipur(1994).

very limited irrigation facilities"[3]. "It is known that rain fall determines the cropping potential in arid and semi-arid areas. Arid areas are those which receive rainfall below 500mm. Areas receiving rainfall between 500mm to 750mm are semi-arid and with a rainfall range of 750mm to 1125 is described as sub humid, but the agricultural areas where rainfall ranges between 375mm to 750mm and irrigation level is below 10 % are the ones, which really belong to dry farming area. Areas where annual rainfall is below 375mm are considered as absolutely arid and desert area. It needs special attention and specific techniques in order to improve their production"[4]. It is these dry farming tracts, which are characterized by low yield, and maximum instability in agriculture output, therefore, present a problem of acute economic distress.

Much attention has been devoted in recent years to the sources of agricultural development in such region of India as Punjab and Harayana. Yet other states also merit noticed because of their spatial natural and social characteristics, unique agrarian patterns, and less publicized achievement. Thus we believe it would be useful to investigate the source of variation in agricultural productivity and cropping pattern in Rajasthan's 26 districts. It is clear that Rajasthan has variety of ecological region and that productivity differences in agriculture are likely to be associated with a number of climatic, infrastructure, input, technological and social characteristics that are themselves interrelated.

THE NATURE OF AGRICULTURE IN DRY AREA:-

The agricultural development in dry area is associated with climatic, edaphic and hydrological conditions namely rainfall distribution, rate of evapotranspiration, soil moisture, and ground water potential. The erratic

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[3] P. Ramgaswamy,(1982), "*Dry farming technology in India, A study of its profitability in selected area*", Agricol publishing academy new Delhi (1982)

[4] Y.S.Ramakrishna, B.Venkateswarlu (2006), "*Dry land farming :Issues and strategies*", Yojana vol.50,aug.(2006)

behaviour of the monsoon, frequent occurrence of drought and prolonged dry spell and unsuccessful efforts in the last several years to find permanent solution of drought is the most restrictive feature of agriculture backwardness in the arid and semi-arid area. The irrigation and dry farming technologies have only touched the fringe of the problem and monsoon is still a powerful factor to be reckoned with in all calculation of agriculture planning.

The nature of agriculture in the dry area has been divided into two parts, arid and semi-arid. These areas are often vulnerable to drought and hence agriculturally unstable. The ecological balance in the arid and semi-arid ecosystem is delicate and gets easily disturbed The effect of drought on the total ecosystem, especially on vegetation, soil moisture regime land use, animal life and human habitation is performed and far reaching.

STATEMENT OF THE PROBLEM:-

The major problem of agriculture in Rajasthan is its backwardness and this is due to its climatic conditions and inappropriate infrastructure, though agriculture sector occupies an important place in the economy of Rajasthan. It provides livelihood to 68 percent of labour force (main workers) in the state, out of which 10 percent were agriculture labourers and 58.8 percent were main farmers in 1991[5]. Agriculture provides food grain for the population, raw material for the agro-based industries and employment opportunities in storage, transport, marketing and other activities related to agriculture. The agriculture sector is inter-related with other sectors. If this sector is grows rapidly, the other sectors also grow. The share of Rajasthan in surface water resource in India is hardly 1 percent only, while the population in 5.5 percent and geographical account for 10.4 percent. Due to high growth rate of population to the extent of 33 percent during 1971-81, 28.4 percent during

[5] Nathuramka, Lakshminarayan (2006)' "*Economy Of Rajasthan; Rajasthan Physiography*", Kanihya Offset Printer, Jaipur, pp 28-48

1981-91, and 28.3 percent during 1991-01[6], the growth rate of food grain in the state has lagged far behind the population growth rate. Therefore for feeding this growing population is possible in two ways, either to increase the agricultural productivity or change the cropping pattern, from low value to high value crops. The growth of productivity has only limited option because productivity is directly related to irrigation facilities, fertilizer, pesticide, HYV seed etc, and these facilities are very costly in Rajasthan while the shift in cropping pattern may solve some of the problem. Because better crop mix and crop rotation has produce better result.

THE CONCEPT OF CROPPING PATTERN:-

Cropping pattern represents the spatial crop sequence in a given area at a particular point of time. It indicates the proportion of area under various crops at a point of time. Such an exercise helps to identify the most important crops of the region and their area differentiation.

The pattern of crop farming is complex dynamics and spatially variable. The most striking characteristic of the present day agriculture is its great diversity of practices, products and organization. The spatio-temporal variations in cropping pattern, crop association, and crop production as well operation of farming are apparent because of spatial differences and changes in agro-climatic, socio-economic and techno-organizational conditions.

AREA OF STUDY:-

The state of Rajasthan is located in the north western part of India. Its geographical location is between 23° 3′ to 30° 12' north latitude and 69° 30' to 78° 17'east longitude with the tropic of cancer passing through the southern most tip of the state. It is surrounded by Punjab in north, Gujarat in south,

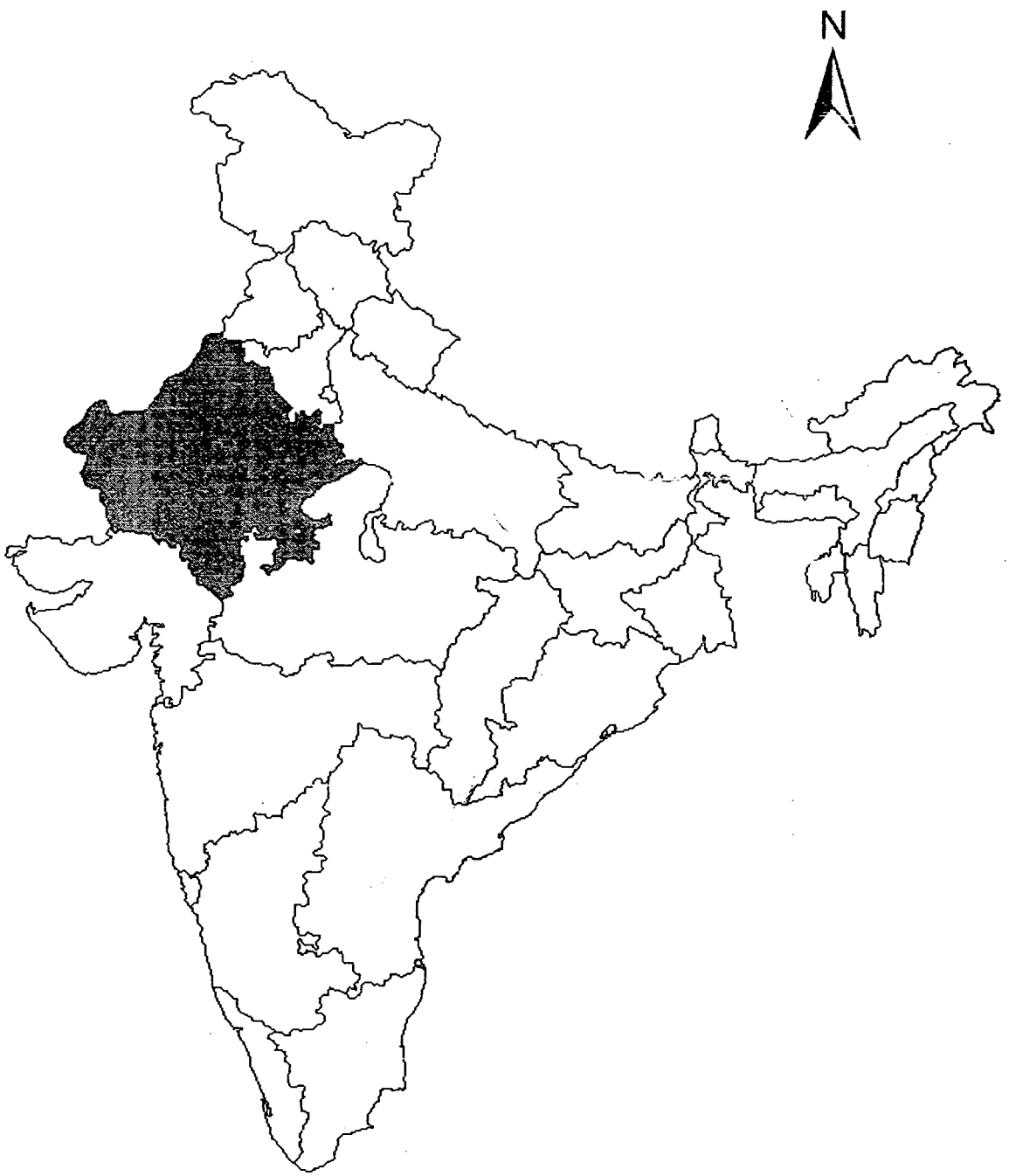
[6] Nathuramka, Lakshminarayan (2006), ibid, pp 29-48.

Pakistan in west and Uttar Pradesh in east. It has Harayana and Delhi in north-east and Madhya Pradesh in south-east. From the geographical point of view, Rajasthan was formally enveloped by the plains of rivers Ganga and Yamuna in the east, plateau of Malwa in south and the plains of Sutlej-Vyas Rivers in north and north-east. It's location in the western fringe of the Indian landmass has placed the state en route to hot western winds during summer and Mediterranean cyclones during the winters.[7] The length of Rajasthan state is 826 km from north to south. The land boundary of Rajasthan is about 5920 km long. It' is the largest state of India from the view point of area. Its total area is 3, 42,239 square kilometer which is equivalent to about 10.74 percent of the area of India. Physiographically, it is difficult to find a region more varied and diverse than Rajasthan. It is a land of hills and shifting sand dunes, of scorching heat and freezing cold, of fertile plain, rugged ravines and dense forest. However, desert remains its dominant peculiarity, besides the Aravalli range that divides the land into two natural divisions. Aravalli is one of the oldest mountain ranges in the world which runs across the Rajasthan from southwest to northeast. This range though not of uniform width, extends for about 692 kms. from Palanpur in Gujarat to Delhi[8].

[7] V.C Misra (1967), "*Geography Of Rajasthan; Rajasthan An Introduction*", pp.1-10,National Book Trust, New Delhi

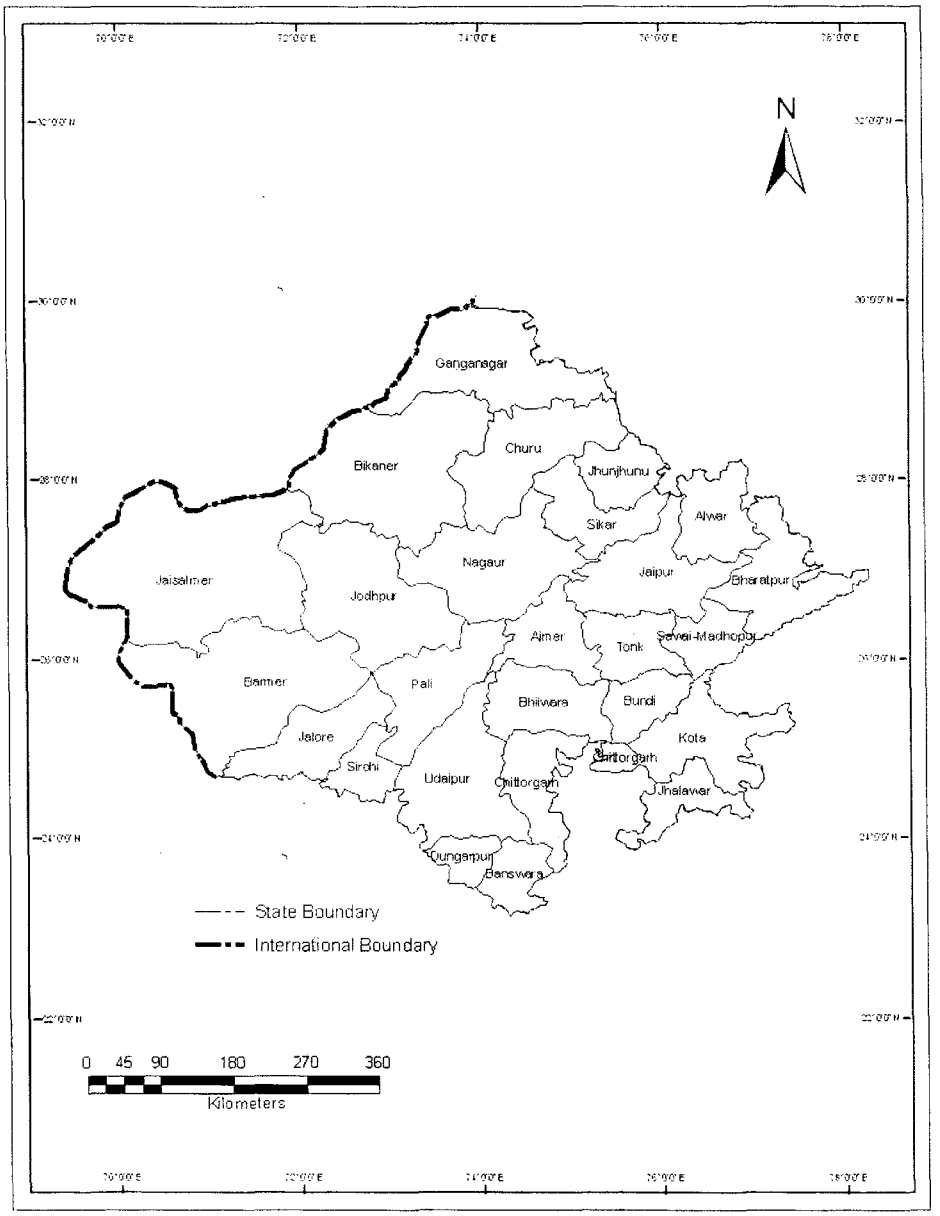
[8] V.C Misra (1967), "*Geography Of Rajasthan; Physiography Of Rajasthan*", PP 11-22, National Book Trust, New Delhi

LOCATION MAP OF RAJASTHAN



Map 1.2

District Map of Rajasthan



CLIMATIC CONDITIONS OF RAJASTHAN:-

The climate of Rajasthan plain west of Aravalli is characterized by great extremes of temperature and long period of severe drought have accompanied by high wind velocity and low relative humidity. It is the hottest region of India (mean June temperature 34.5° Celsius at Jaisalmer and Bikaner) with annual range of temperature between 14° to 17°celsious. The 50 cms. isohyte line, which runs along the western edge of the Aravalli range, divides the state into two parts. The rainfall is very low, erratic and seasonal throughout the Rajasthan plain. The mean annual rainfall is highly erratic in its occurrence and varies from 10 cm on Indo-Pak border to 40 cm. on the eastern edge of the region. The rainfall decreases from east to west and variability increases in the same direction. The variability of rainfall is as high 50 to70 percent variability in the annul rainfall.

OBJECTIVES:-

1. To examine the trend of area under some important crops in arid and semi-arid parts in Rajasthan,
2. To show effect of irrigation facilities on cropping pattern and agricultural productivity.
3. To show the spread of agricultural techniques in irrigated and un-irrigated districts of Rajasthan.
4. To examine the differences in the pattern and productivity irrigated and un-irrigated.

HYPOTHESIS:-

1. There have been changes in cropping pattern after introduction of new technology inputs in the form of (irrigation, HYV seeds,

agriculture machinery and fertilizers etc) in irrigated districts of Rajasthan while the un-irrigated districts have not witnessed significant change.

2. The yield of crops has increased in irrigated districts with the introduction of irrigational facility as compared to the district which practise dry farming.
3. The expansion of irrigation facilities have created a positive and impact on cropping pattern (cropping pattern shifted to coarse cereals from fine cereals and oilseeds).
4. The expansion of irrigation and use of biochemical inputs have positive effect on yield of crops.

COVERAGE OF DISTRICTS:-

This study is based on the analysis of data pertaining to 26 districts of Rajasthan. In 1970-73, there were 26 districts however their number had increased to 32 in 2000-03. Generally speaking, whenever a new district is formed, no attempt is made to generate data series for the new districts for the earlier period.

Table 1.1

Formation of Districts (During the Study Period)

Name of Districts	District Formed during 1970-73	District Formed during 1980-83	District Formed during 1990-93	District Formed during 2000-03
Bharatpur			Dholpur	
Jaipur				Dausa
Kota			Baran	
Udaipur				Rajsamand
Ganganagar				Hanumangarh
Sawai-Madhopur				Karoli
Total No. Of Districts	26	26	28	32

In order to study the changes in cropping pattern and agricultural development at districts level, one has either to generate crop-wise area and output data for the newly created districts for the earlier years, or merge the newly-created districts with their original constituent districts. Since, it has not been possible to generate data for the earlier year it was decided to merge the newly created districts with their original constituent districts.

SELECTED CROPS:-

In the present study the Data on 16 major crops has been obtained from the Directorate of Economics and Statistics Rajasthan (DSE). The data on area and production of crops has been considered only for those crops which cover more than 1 percent area of gross cropped area. However, the area under sugarcane and cotton record more a 1 percent area in some districts but at state level the area under these two crops was less then 1 percent. As a result these crops have not been considered in this study.

DATA LIMITATION:-

The other relevant data for this study has been obtained from the Directorate of Economics and Statistics Rajasthan (DSE) and northern fertilizer statistics of India. Some data were also obtained from G.S Bhalla and Gurmail Singh's book "Indian Agriculture; Four Decade of Development (2001)". The data that related to agricultural machinery was available at one yearly average while other data were available at triennium moving average.

METHODOLOGY:-

In order to examine the changes in cropping pattern in irrigated and un-irrigated districts of Rajasthan, with the help of percent changes in area under various crops, by using triennium averages have been calculated.

The Growth performance of irrigated and un-irrigated districts of Rajasthan has also been calculated in terms of percentage increase and annual compound growth rate with the help of following formula.

$P_n=P_0 [1+ r]^n$

Where;

P_n = Production in current year

P_0 = Production in Previous year

r = Rate of change

n = Number of time periods.

It follows from the above formula that:-

$r = ((\text{Antilog} (\log (P_n/ P_0)/t)) -1)*100$

Productivity levels in terms of money value (for the districts) has been calculated by using the following formula-

$$\text{Productivity Level (Per Hectare)} = \frac{\text{total production of crops x constant price}}{\text{gross cropped area}}$$

(It is to noted that productivity levels have been calculated for only major 12 crops of districts in Rajasthan)

The Karl Pearson's correlation co-efficient has been worked out to find out the relationship between area under crops and rainfall and irrigation facilities.

The regression analysis will be used to determine the overall impact of agricultural determinant on agricultural productivity. Production per acre is the dependent variable and the independent variables are fertilizer consumption per acre, high yielding varieties of seeds, irrigation, rainfall area under all crops and agricultural machinery.

DATABASE:-

The study is based on the secondary data collected from different published sources, namely -

- Agricultural Statistics of India various issues 1970-73, 1980-83, 1990-93, 2000-03.
- Statistical Abstracts of Rajasthan various issues 1970-73, 1980-83, 1990-93, and 2000-03.
- District Statistics of Rajasthan
- Fertilizer Association of India

LITERATURE REVIEW:-

Changes in cropping pattern and crops diversification:-

A cropping pattern is usually referred to as the numbers of crops grown within one agricultural year. Cropping systems of a region are decided by and large, by a number of soil and climate parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crops for cultivation. Indrapal and S.C. Kalwar 1984 found that the cropping characteristic for the period of 1950-51 to 1970-71 in Jaipur district remained the same but in tehsil level few changes occurred. They have found that Bajra and the second ranking crops, gram, barley and Sesamum replaced by other kharif crops and wheat. The first ranking crops become so popular due to HYV seeds. For examining the crop combination, the authors have applied all the formula of crop combination but none of the method tested helped in determining the crop combination regions in the district. Therefore, the authors for the purpose of the present study examined the average data for five year 1971 to 1976 and delineated the crop combination region on the basis of ranking up to the third rank. Thus, the seven crop combination regions were formed and the cropping pattern of these regions was predominantly affected by the soil condition. Irrigation and other factor have only nominal control. The authors have divided crops diversification into three parts low, moderate and high. The low diversification is due to its soil condition and lack of irrigation, while high level of diversification was seen in north eastern part of the district due to developed irrigation facilities and favourable rainfall conditions. Further they examined cropping intensity in the district which remains almost constant as it has been during the last twenty years. However, the area sown more than once is increasing continuously, but as the rate of increase in the net sown area and in the double cropped area had the

same trend, the cropping intensity did not grow[9]. Ram Kumar Gurjar and Lakshmi Shukla 1984 found the introduction of irrigation through Rajasthan canal has changed the agronomic conditions in the arid parts of the state. Significant changes have been recorded in agricultural and cropping pattern in Rajasthan canal project, the cropping intensity has increased and a high positive correlation (0.70) between irrigation and intensity has been found. The diversity of crops found out by using Bhatia's index showed that the crop diversity gradually became low and the farmers started concentrating on two or three crops only which were best suited to the irrigated condition. The first rank crop Bajra has been replaced by Gwar in the most of the area; irrigated crops like wheat, and rabi oilseed are new introduction in the area. The crop associations have also changed very much.[10]. R.B. Singh and Jagdish Prasad 1986 found that in Srimadhopur tehsil, small holding and better well irrigation facilities have increased the agricultural intensity as a whole. The cropping pattern had also undergone a significant change. The area under oil seed and pulses has increased by diverting wheat and barley area. The reason is the price of oil seed and pulses being higher. The market price of gram is almost double to that of wheat similarly mustard and rapeseed are more in demand, fetching good price while other economic factors responsible for less production of these crops. However they require less irrigation and fertilizers in comparison to wheat and barley. Further they stated that the better irrigation facilities improved seeds, fertilizer, mechanization and increased use of input has considerably increased the yield of various crops[11]. Sneh Saiwal 1986 analyze decadal change in integrated characteristics of crop land use as crop diversification of Nathwara tehsil at the village level by using the modified formula of Bhatia's crop diversification index for 1973-74 and 1983-84. Diversification regions could be divided into high, medium and low.

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[9] Indrapal and S.C. Kalwar (1984), "*Changing cropping Characteristics: A Case Study of Jaipur Districts*", Annals of the Association of Rajasthan Geographer, Vol.4, Annual Number, pp.1-11.

[10] Ram Kumar Gurjar and Lakshmi Shukla (1984), "*Impact of Rajasthan Canal on Cropping Characteristic (A Case Study of Rajasthan Canal Command Area Stage I)*", Annals of the Association of Rajasthan Geographer, Vol.4, Annual Number, pp.33-39.

[11] R.B. Singh and Jagdish Prasad (1986), "*Landuse Pattern Constraints and Consequence*", Annals of the Association of Rajasthan Geographer, Vol.7, Annual Number, pp.1-6.

The low diversification is due to recently extended facilities, moderate due to varied soil fertility, low amount of rainfall, moderately developed irrigation facility, different population density etc. the objective of crop security has also forced cultivators to grow more crops in these areas and high diversification is due to less developed irrigation, undulated terrain and wide variety of soils. This study reveals that the diversification index has varied 10 to 40 with in one decade on the whole the crop diversification has come down slowly. The villages of middle and western region have shown marked change toward specialization due to better and higher intensity of irrigation, high density of population, nearness to urban and religious centre[12].

B.D. Dhawan 1989 suggested two changes in the irrigated agriculture by using the data in respect of eleven major irrigation projects for which information on crop yield and irrigation requirements was available. For inter-crop comparison, he mainly used the average crop price and found that, firstly, a switch over from summer paddy to summer groundnut (both are irrigated crops) was recommended for the southern states of Tamil Nadu, Andhra Pradesh and Karnataka. Due to the high price of groundnut oil, summer groundnut is already being cultivated in the southern states on an increasing scale, but without any corresponding reduction in summer paddy area, secondly increase in area under sugarcane for the northern state of UP, Punjab and Harayana was recommended, partly because irrigated sugarcane, when sold to sugar mills is no less remunerative than paddy-wheat or maize-wheat sequences under irrigated condition, and partly because this crop, in the north Indian conditions needs much less irrigation than paddy-wheat sequence.[13] S.K. Bhat, R.S. Prasher and P. Mehta 1994 examined the trends in crop diversification, its relationship with variability in food grain production and factors affecting the level of diversification in Indian agriculture over the period 1970-71 to 1989-90 by using two measures viz., the Herfindal Index

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[12] Sneh Saiwal (1986), "*Dynamics of crop Diversification in Aravalli Region*", Annals of the Association of Rajasthan Geographer, Vol.6, Annual Number, pp.23-26.

[13] B.D. Dhawan(1989), "*Enhancing Production Through Crop Pattern Change*", Artha Vijnana, vol.31, No.2, pp153-175.

and Entropy Index. The result revealed that in the states like Bihar, Punjab, Harayana, Uttar Pradesh and West Bengal specialization is taking place, while other states are experiencing diversification. The relationship of diversification with food grains yield was negative, whereas, it was positively correlated with coefficient of variation. The Gini's concentration of operational holding, weighted price index, and area under high yielding varieties, rainfall and average size of holding emerged as important variables which significantly reduced the diversification level[14]. R. L. Shiyani and H. R. Pandya 1998 examined the crop diversification in different agro climatic zones of Gujarat, during the period 1960-61 to 1995-96. By using following five measures of crop diversification in the empirical analysis (a) Herfindal Index (HI),(b) Ogive Index (OI), (c) Entropy Index (EI), (d) Modified Entropy Index (MEI), (e) Composite Entropy Index (CEI). They found that there exists wide spatio-temporal disparity in the average allocation under different crops. In general, the farmers have shifted their cropping pattern from the subsistence crops to the commercial crops. On an average, relatively higher growth rates of acreage under tur, cotton, rapeseed, mustard, sugarcane, maize and wheat has been recorded in different agro climatic sub zone of Gujarat, where a negative compound growth rate of acreage under pearl millet, jowar, cotton, was noticed. The entropy index was found to be better suited based on the situation[15]. Ajaz Husain Ansari, Anisur Rehman and Hameed Ahmad 2000 found the Indira Gandhi Canal Project has changed the agrarian structure of the command area. In this region before introduction of irrigation only drought resistant crops were grown. It is only after IGCP, the cropping pattern has changed drastically from traditional dry farming to commercial and food crops. The agricultural production, productivity and intensity are steadily increased[16]. Abdul Shaban and P. L. Katara 2003

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[14] S.K. Bhat, R.S. Prasher and P. Mehta (1994), "Diversification of Indian Agriculture: Issues and Perspectives", *Indian Journal of Economics*, pp. 101-111.

[15] R. L. Shiyani and H. R. Pandya (1998), "*Diversification of Agriculture in Gujarat: A Spatio-Temporal Analysis*", Indian Journal of Agricultural Economics, Vol. 53, No.4, pp.627-639

[16] Ajaz Husain Ansari, Anisur Rehman and Hameed Ahmad (2000), "*Changing Cropping Pattern in Thar Desert: A case Study of Indira Gandhi Canal Command Area*", Asian Profile Vol.28, No.3, pp.215-219.

examined the commercialization of agriculture, food security and determinant of participation of farmers in market in Dungarpur district of Rajasthan for the period of 2002. They used logistic model in his study. It is found that there has been very low level of commercialization of agriculture in the district and most of the farmers are unable to produce the amount of food grain needed to feed them through out the year. About 50 percent of the farmers suffer from food security and 20 percent live in marginal level. The probability of participation of the farmer in the market increase with increase the in the size of landholding and irrigated area in case of cereals while in case of pulses the probability of increase was with the increase in the size of landholdings and distance from the district and tehsil headquarters[17]. B.N. Mishra and Pankaj Mishra 2002 show the relation between seasonality of climate and the cropping in the administrative unit (tehsil) of Handia, which consists of four development blocks, in the middle Ganga Plane of Uttar Pradesh. The variation in the cropping in the territory is mainly climatically determined. The crop calendar has three parts biz, Kharif, Rabi and Jayad, which correspond to the rainy season of the Indian monsoon, the relatively dry winter and the dry summer respectively. The Rabi cropping in the territory is mostly dependant on irrigation. It is observed that the climate does not determine the intra territorial variation of concentration of crops, which rather reflects the variation of the quality of land of soil in the Block[18]. S. N. Goswami, S. Chatterji, T.K. Sen, U. K. Singh and O. Chala 2004 examined the concentration and diversification of crops in India. Using compound growth rate, crop concentration index and various crop diversification index such as Herfindal Index, Ogive Index Entropy Index and modify Entropy Index and composite Entropy Index for two time periods viz., period 1st (1967-68 to 1980-81) and period second (1981-1982 to 1998-99), he found that the compound growth rate of productivity was observed to be higher during

[17] Abdul Shaban and P. L. Katara (2003), "*Food Security and Agricultural Supply Response of Marginal & Small Farmers in Dungarpur, Rajasthan*", Geographical Review of India, Vol.65, No.4, pp.361-370.
[18] B.N. Mishap and Pankaj Mishap(2002), "*Climatic Elements and the Cropping Pattern in Handia Tehsil, Allahabad Districts(U.P.)*", Geographical Review of India, Vol.64, No.4, pp.356-365.

second period, as compared to the first period in most of the crops. It also brings out that concentration of cereals was confined to northern and eastern states whereas concentration of oilseed and pulses were found in southern states. This is mainly due to the diversion of area under coarse cereals to pulses and oilseeds in the southern and western states. It also shows that the nature and extent of crop diversification, which has already taken place (as shown by the negative growth rate in area under total food grain from 1980-81 and significant positive trend in diversification in index four crops), has not witnessed any conflict self sufficiency in food grain. In the crop sector the pattern of diversification is characterized by growth in the share of non-food grain crops as a group. Superior cereals replace coarse cereals among food grains. Among non food grains the share of area under oilseed as well as vegetable in the total has increased over time[19].

Variation in Agricultural productivity and its determinants:-

Agricultural productivity is a measure of the efficiency with which inputs are used in agriculture to produce an output. When a given combination of input produces a maximum output, the productivity is said to be at its maximum. Edison Dayal (1984) used three indices of agricultural productivity- land productivity, labour productivity and aggregate productivity-have been employed to measure and map productivity pattern in India. There are large regional inequalities in the levels of productivity. Regression analysis reveals that the spatial variation of land productivity is positively related to fertilizer use, irrigation, and urban industrial development and is negatively related to population density[20]. Jai Prakash and Noor Mohammad 1997 delineate the pattern of energy consumption in agriculture and explore the relationship between energy consumption and

[19] S. N. Goswami, S. Chatterji, T.K. Sen, U. K. Singh and O. Chala (2004), "*Crop Concentration and Diversification in India- A Spatio-Temporal Analysis*", Geographical Review of India, Vol.66, No.4, pp.50-66.
[20] Edison Dayal(March 1984), "*Agricultural Productivity in India: A Spatial Analysis, Annals of American Geographers*", Vol.74, No.1, pp98-123.

agriculture production in Sonepat district of Harayana. Their hypothesis was that the consumption of energy increases the agriculture productivity and agriculture intensity. They used standard scoring scheme, standard energy unit, areal coverage and yield per unit of land for their analysis. The correlation coefficient is worked out to find out relationship between energy consumption and agriculture productivity. The result shows that fertilizer and manure application is evaluated as the highest energy consuming operation not only at district level but also at tehsil level. The per cent of fertilizer and manure consumption of energy are 48.69, 50.6, and 54.50, respectively in Sonepat, Ganaur, and Gohana. While in all the operation marketing was using lowest energy in tehsil. They showed the variation of energy consumes in all crops, sugarcane on mixed farm consumes maximum energy followed by paddy whiles the Arhar is the least energy consuming crop. Further they showed, under all the mode of farm operations the highest proportion of consumption of energy is observed on small farms. However the energy consumption as tractors was highest in medium farms. And in case of bullock small farms were consuming highest energy followed by medium and large farms. It is inferred that all the crops in the district are energy efficient, producing more energy then they consume. In all the crops, the input-output ratio of wheat crop i.e., 0.33 this shows that this crops is more efficient compare to mustard 0.68. The relationship between energy use and agriculture productivity is very high and significant at 5percent level[21]. Shafiqullah 1999 analysed the level of agriculture development in Gond district of Uttar Pradesh. It is also attempt to identify the spatial variation of agriculture development from 1984-85 to 1992-93 with the help of Z score method. It is observed that even after a gap of eight year change in the spatial pattern was very small. The high level of agriculture development was observed in the central parts due to availability of assured irrigation facilities, fertilizer, HYV seeds etc. while low level of development was observed in

[21] Jai Prakash and Noor Mohammad (1997), "*Impact of Energy Input on Agriculture Productivity of Sonepat District*", Geographical Review of India, Vol.59, No.4, pp.313-320.

Rapti and Gaghra River. This area is flood-prone and the irrigation facilities are almost non-existent. Thus the farmers do not take risk in developing the agriculture of this block[22]. D.D. Vishwakarma 2003 find out that the relationship between agricultural productivity and its determinant like size of land holding, caste, family labour, area under HYV and irrigation per hectors. He found that marginal size land holding shows high productivity in most of the cases while large size holding get higher yield only in commercial crops, the small holding shows high productivity in cereals production. Productivity imbalance is also evident within different formal societies in the region. Scheduled cast community have lower productivity than backward class and other caste of the societies. This study also show positive relationship between agricultural productive, with technology (irrigation, HYV seeds, etc), cash expenditure and density of family labours[23]. Mohammad Taufique 2003 investigated the inter-district variation of selected crops and over all crop productivity in Uttar Pradesh for the period of 1996-1997. The productivity calculated by using Jasbir Singh method and after that the productivity index divided into three categories viz., high, medium and low. He found that in western Uttar-Pradesh, high productivity of wheat and maize are attributed to better irrigation facilities, H Y V seeds and fertilizer helped to happen this. While rice is enjoy high productivity in Tarai areas. Good rainfall and other climatic factors area responsible for this. Pulses noted high productivity in southern district[24]. Vrishali Deosthali 2003 investigates critically the rice-weather relationship. For this purpose he suggested a model for the prediction of rice yield, and suggested mid session corrective strategies for sustainable rice cultivation in the Vidarbha region for the period of the period of 1971-1993. He used exponential growth rate, regression, correlation coefficient for examining the crop- weather model. He found that a very slight

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[22] Shafiqullah (1999), *"Levels of Agricultural Development in Gonda District"*, Geographical Review of Indian, Vol.61, No.4, pp.361-371.

[23] D.D Vishwakarma (2003), *"Relationship Between Structural Determinants and Agricultural Productivity in Betul-chhindwara Plateau"*, (M.P), Geographical Review of India, Vol.65, No.2, pp.151-161.

[24] Mohammad Taufique (2003), *"Regional Variation in Food Crop Production-A Case Study of Uttar Pradesh"*, Geographical Review of India , Vol. 65, No.1, pp.11-22

difference between rice weather adjusted growth rate and unadjusted growth rate in Bhandara and Paoni taluka. Thus we found that there is no significant impact of rain fall on their yield growth while remaining taluka shows a significant impact of rain fall on their yield[25]. Mohammad Taufique 2004 assessed the spatial variation in the level of agriculture productivity in north Bihar plain for the period of 1979-80 to1999-2000. He calculated district-wise agriculture productivity through yang method (1965). The result of this study shows that the central and western parts have high agricultural productivity during the study period. High fertility of soils along with bank of rivers, Ganga and Gandak showed high productivity[26].

Impact of Irrigation on Cropping Pattern and Crop Productivity

Modern agriculture is highly affected by the development of irrigation. Since rainfall is unreliable both in time of incidence and amount, artificial source of watering is necessary for the growth of agricultural in the state. It encourages the farmer to adopt more scientific techniques as well as intensive cultivation. Irrigation plays decisive role in determining cropping pattern, cropping intensity of cropping, crop combination and all over the increase of yield. Richard B. Reidirger 1974 examines the rationing system used with the Bhakra Canal, one of the major new canal systems in north India. Hissar district was taken as study area. He found that the allocation of canal water was done through institutional or administrative decision rules and schedules rather than market forces. His study clearly indicated that there was a high degree of irregularity and uncertainty of water supply both in timing and quantity. Several weeks of no effective supply often followed two consecutive weeks of essentially full supply of water. According to his results yield generally increases with increasing amount of irrigation. Substantial yield

[25] Vrishali Deosthali (2003), "*Assessing the Influence of Weather on Rice Crop in Bhandara District of Maharashtra*", Geographical Review of India , Vol.65, No.4, pp.319-327.

[26] Mohammad Taufique(2004), "*Inter Regional Variation in Agricultural Productivity In North Bihar Plain*", Geographical Review of India, Vol. 66, No.2, pp283-288.

difference was occurred with different timings of the same mode of irrigation. Clearly both timing and quantity of water applied affected yields substantially[27]. B.D. Dhawan 1997 obtain ration estimator of crop production augmentation per canal irrigated for the period of 1980-81 to 1992-93. A major objective this paper is that, find out the irrigated yield for entire canal network in India and compare the crops output of irrigated and Un-irrigated area yield. For achieving this objective he has measured overall crop yield on irrigated as well as un-irrigated land for entire period. He found that value of gross output of crop sector rose between 1980-81 and 1992-93 in current as well as constant prices. The real growth in crop sector come from enhancing crop productivity (combined effect of pure yield increase and improvement in crop in favour of more valued crops), because gross cropped area increased by mere 7 per cent in the above period. The yield differential between irrigated and un-irrigated yield have increased in real term while in relative term it is constant. However, further he mentioned that the benefits of canal irrigation exceeded the cost of canal irrigation but the margin was very low through out the period. However, the margin tended to decline in current price term, this decline may be attributed to the fact that increase in farm product prices tended to lay behind increase in supply cost of canal irrigation[28]. Randhir Singh Hooda 1997 showed the impact of lift irrigation on cultivation of commercial crops in the drought prone area of Juhi Lift Canal Command area in south western Harayana for the period of 1967 to1992 using physiographic division of region into three categories (a) Aeolian plains (b) sandy undulating plains (c) high dunal plain and calculated the intensity of irrigation and correlation method. He found that Juhi Lift Command area witnessed a high degree of change in the harvested area to commercial crops throughout the region after the introduction of lift irrigation. The change in the harvested area of commercial crops is directly correlated with the

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[27] Richard B. Reidirger (1974), "*Institutional Rationing of Canal Water in Northern India: Conflict between Traditional Pattern and Modern Needs*", Economic Development and Cultural Change, Vol.23, No.1, pp.79-104.

[28] B.D.Dhawan(1997), "*Production Benefits From Large-Scale Canal Irrigation*", EPW, Dec1997, pp.A-177-A181

intensity of lift irrigation. There is a high degree of positive correlation between these two. The maximum change has occurred in the area of sandy undulating plains followed by Aeolian plains and high dunal plains[29]. Ashok K Mitra 1998 focused the management, financing and pricing of irrigation water with respect to major, medium irrigation system in Maharashtra during 1960-61 to 1991-92. He found that over the period of time the share of net irrigation by canal and tank had reduced by 19 and 18 percent respectively while the corresponding estimate for well irrigation increased by 63 percent. He mentioned that the organizational and institutional changes through the user intimate involvement and participation in the management of the system, are expected to bring about the control and restriction in the use of water for crops like sugarcane and encourage the use of water for crops likes pulses, oilseed, fruits, and vegetable in addition to basic cereals. Again he noted that major and medium irrigation schemes leads to widening the access to irrigation water among the user as well as across the canal command area. The revenue collected from sale of water was not even sufficient to meet the operation and maintenance expenditure of the major and medium irrigation schemes. Therefore a financial autonomy would create enough incentive for the irrigation agencies to carry out the cost of operation and maintenance and also to increase revenue through collection of water charges[30]. A Janaiah, Manik L Bose and A G Agrawal 2000 examine the structure and inequality of house hold income and analysed rural poverty in rice dominated village of Chhattisgarh in Madhya Pradesh by using Gini's coefficient, F G T index and Probit model. He found that the share of capital input in the gross value of out put was relatively higher in the irrigated ecosystem because of greater use of fertilizer pesticides, machinery and others, while the return on labour was relatively higher in the rain-fed ecosystem. Moreover land productivity was also substantially higher in the irrigated ecosystem, implying that the

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[29] Randhir Singh Hooda (1997), "*Lift Irrigation and Commercial Crop in the Drought-Prone Area of South-Western Harayana*", Geographical Review of India, Vol. 59, No.2, pp.151-158.

[30] Ashok K Mitra(1998), "*Development and Management of Irrigation in Maharashtra: With Special Reference to Major Surface Irrigation Systems*", EPW, June 1998.

technological progress contributed to increase in land productivity. Irrigated ecosystem income estimates was about 40 percent higher then rain-fed ecosystem. Similarly the inequalities in the distribution of agriculture or rice and non agriculture income were either the same or relatively lower in the irrigated ecosystem then in the rain-fed ecosystem. However the depth and the severity of the poverty were much lower in the irrigated ecosystem as compared to rain-fed ecosystem. The adoption of modern technology showed a significant negative effect on poverty. However the basic infrastructure especially assured irrigation is essential to realize the benefit of modern technology. Thus irrigation technology intensification had a direct impact on poverty reduction in the rural area.[31] Anuradha Sengupta 2002 analysed the entire resource management with special physiographic parameter to increase the level of productivity, to reduce the regional imbalance in Malda district of West Bengal. In her study she used caring capacity of land for measuring land productivity and found that Kaliochak I and II were below the district average productivity level, while having low population density and fertile soil. Probably this is mainly due to (i) more emphasis on cash crop production than cereals, (ii) less irrigation facilities and (iii) loss of land by river bank erosion. Further the carrying capacity reveals a wide spatial variation ranging from 1.3 person / hectares / annum in Bamangola to 9.5 person / hectares / annum in Kaliachok[32]

S.N. Goswami, T.K. Sen, N.C. Khandare and M.Velayutham 2002 analysed the structural changes occurring in number of operation, such as operated area, irrigation resources endowment and its impact on land use efficiency as well as allocation of irrigation endowment of various crops in Maharashtra. And they compared to detect change that occurred during 1980-81 to 1990-91. Their hypothesis was that the large sized farmers put more irrigated area under valued crops as compared to smaller sized holding. But

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[31] Janaiah, A., M.L. Bose, and A.G. Agarwal (2000). Poverty and income distribution in rainfed and irrigated ecosystems: village studies in Chhattisgarh., EPW, December 30, 4664-4669.

[32] Anuradha Sengupta(2002), "*Water Resource and Agricultural productivity in Malda District*", Geographical Review of India, Vol.64, No.1, pp.14-20.

the result presents a contrary picture. The result indicated that there was substantial reduction in the allocation of irrigated area under food grain in all size - classes of holing in 1990-91 as compared to 1980-81. Farmers diverted their irrigated area towards cultivation of cash crops like sugarcane and fruits and vegetables with the objective of achieving better financial return[33]. M. S. Sidhu and Kamal Vatta 2004 evaluate the impact of new technology on the Indian agriculture in the 21 century. They found that the growth rate of area production and yield for all food grain and non-food grain had slowed down after the economic reform. Similarly a decline trend in growth rate of fertilizer consumption also seen in post reform period and this can be attributed to merger increases in irrigated area where the use of chemical fertilizer is more. Similarly he had seen a gap between the requirement of certified/quality seeds and its supply especially for oil seed and pulses. Again he noted that irrigation will play vital role in increasing the productivity of various crops. Because higher the irrigated area under particular crop higher is the level of yield[34].

Impact of consumption of fertilizer, pesticide and HYV Seed:-

Along with the high yield-rising technology, certain protective measures have been propagated. Bio-technology is the real core of green revolution because of its high yielding potential. Therefore, the earlier, use of improved seeds is popular among all farmers. Improved seeds occupy most important place in the package of new technology. These protective practices include land and seed treatment, use of chemicals and fertilizers with sowing, weed control, rat control etc. The use of modern practices and plant protection measures is also positively related with other determinants. Barbara Harriss 1972 investigated IADP in technical rather than social term, exemplified by

[33] S.N. Goswami, T.K. Sen, N.C. Khandare and M.Velayutham(2002), "*Impact of Irrigation on Land use Efficiency and Area Allocation in Different Size-Classes of land Holding in Maharashtra*", Vol.64.No.4, pp.323-330.
[34] M. S. Sidhu and Kamal Vatta (2004), "*New Technologies and Indian Agriculture in The 21st Century*", Man and Development, pp.47-65.

the increasing use in planning of techniques such as cost benefit analysis and linear program. He showed that the HYV had increased the regional disparity among the district and decreased the yield of straw and stalk utilized as fodder fuel and organic fertilizer which has disrupted the pastoral side of the agricultural economy in a way that had not been foreseen. He studied the innovative center of the HYV by using logistic curve method in 1961 to 1966. He found that there is no significant difference in yield between area chosen for HYV and other one, while wheat in Ludhiana and maize in Aligarh had more effective in widening regional disparities. Finally, use of HYV seed has resulted in a 50% decrease in the yield of straw and stalk utilized as fodder, fuel and organic fertilizer[35]. A.K. Chakravarti 1973 found that in green revolution the high yielding variety seed program (HYV) has widening regional disparities among the different region. Similarly the adoption rate of HYV seeds was very weak in kharif and coarse cereals. The successful adoption of the HYV depended on judicious combination and use of chemical, fertilizers, supply of irrigation water. Farmer must produce a surplus in order to repay the capital he has borrowed, which requires him to adopt commercial farming. As a result of the HYV is not successful in the agriculturally backward area of India. Many farmers in agriculturally backward area cannot afford to purchase chemical fertilizer, pesticide and distribution centres and credit facilities also inadequate in most of these areas. The HYV has been adopted mainly in area with well developed irrigation facilities area where credit, fertilizer and pesticide are available. The wheat growing areas have benefited more than the rice growing areas under this program. The north western region is well irrigated and most agriculturally developed part of the India benefited more from this programme more in comparison to rice and other crops because of their unattractive price and vulnerable to pests and diseases etc. Surplus production of food grain is not true because remain unaffected by green revolution program and are still

[35] Barbara Harriss (1972), *"Innovation in Indian Agriculture—The High Yielding Varieties Programme"*, Modern Asian Studies, Vol.1, No.1, pp.71-98.

vulnerable to famines[36]. Gunvant M. Desai and N. V. Namboodiri 1986 studied use of fertilizer. Indian soil is deficient in nitrogen, phosphorus and potash. However, the growth of our agriculture sector is highly dependent on soil fertility. He mentions that fertilizer use firstly started in plantation sector, but when we faced the food crises and famines during 1960s, government has changed their policy and it started using in agriculture sector. And also the nation wide development of irrigation facilities, credit and introduction of HYV seed, cooperative movement and price factor substantially raised the potential use of fertilizer. This extensive use of fertilizer was totally biased towards irrigated areas, and especially large farmers, while the un-irrigated part of the country and small and medium farmers have adopted these innovations very slowly[37].A Narayanamorthy 1995 showed that impact of fertilizer decontrol is not uniform across the state and different zones. Majority of the agriculturally advanced states have crossed the national average reduction of P and K fertilizer. Among the four zones, heavy reduction in P and K consumption is noticed in north zone. However, per hectare consumption of NPK consumption has reduced more in south zone. Among Kharif and Rabi season the reduction is noticed once in Rabi, both in total as well as P and K consumption. In the NPK ratio, the worst affected zone because of decontrol is north and least is south. The state which have above national average in term of gross irrigated area, ground water area, and canal irrigated area, food crops and cropping intensity are the worst affected both in P and K consumption and NPK ratio. He further stated that the existing situation is allowed to continue for some more years the soil health will be deteriorated and subsequently productivity of food grain will come down sharply[38]. Bharat Ramaswami, Carl e. Pray and Timothy Kally 2000 taking three states which are situated in semi-arid tropics - Andhra Pradesh,

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[36] A.K. Chakravarti (1973), "*Green Revolution in India*", Annals of the Association of American Geographers, Vol.63, No.3, pp.319-330

[37] Gunvant M. Desai and N. V. Namboodiri (1986), "*The Deceleration Hypothesis and Yield-Increasing Input in Indian Agriculture*", Indian Journal of Agriculture Economics, pp.495-506.

[38] A Narayanamorthy 1995, "*Fertilizer Consumption after Decontrol : Myths and Realities*", Artha Vijnana, Vol.37, No.4, pp-359-379.

Karnataka and Maharashtra. They examined whether variation in the area under private hybrid seeded crops is a significant determinant of the variation in average district yields. For examining this objective they used regression analysis and correlation matrix. They found that in six of the nine cases considered here, average district yields are significantly higher in districts with higher spread of private hybrids after controlling for the effects of weather, infrastructure variable and HYV. Private hybrids seem to have had little impact on yield of pearl millet in Andhra Pradesh and Karnataka as also on maize yield in Karnataka. These estimates had provided the first econometric evidence of the contribution of private hybrids to agriculture productivity in developing countries. The significance of this finding is that it means that the priority sectors have been successful in finishing and distributing improved varieties. The seal of this effort has been large enough to effect aggregate productivity measures[39]. Sukhjit K. Saran and Kiran Sethi 2000 found a positive trend in fertilizer consumption in India during 1965-66 to 1994-95 and it is worth noting that nitrogenous fertilizer continued to be the major component of the fertilizer use while the consumption of fertilizer among the state was highly uneven. Five states viz., Punjab, Harayana, Andhra Pradesh, Tamil Nadu and Uttar Pradesh occupying about one third of the country gross cropped area accounted for a half of total fertilizer consumption in 1994-95 on the other hand M.P. Maharashtra and Rajasthan covering the same area accounted for only 21% of the total fertilizer consumption in the country. Season wise consumption of fertilizer almost doubled in Kharif season. Farm wise consumption of fertilizer was inversely related with farm size. Marginal and small farmers use fertilizer more intensive then their counterpart larger farmers. Further they stated that there was a significant upward trend in the consumption of fertilizer. Production of food grain has also increased. But there was opposite trend, because growth rate of fertilizer much higher than the food grain production. The

[39]Bharat Ramaswami, Carl e. Pray and Timothy Kally (2000), "*Dissemination of Private Hybrids and Crops Yields in the Semi-Arid Tropics of India*", Indian Journal of Agricultural Economics, Vol.57, No.1, pp.38-51.

consumption of fertilizer is effected by two significant variables; they are percentage of gross cropped area irrigated and the supply of short term credit[40].

Agriculture technology and its impact on agriculture productivity

Machine and improved implements are integral part of modern farming. They help in proper utilization of agricultural resource, increase efficiency and save human energy. S. K. Sharma 1999 investigated the causal relationship between social structure and level of adoption of agriculture innovation by examining Chhattisgarh and Chhindwara-betul region. He used composite index for examining this relationship and he found that there is direct relationship between the use of innovation on the one hand and size of land holding and social status of the community on the other hand. Marginal and small farmers as well as schedule tribe and schedule castes are lagging far behind in respect of agriculture innovation under consideration. The variation is showed by computing composite Index of adoption modern technology of each class. It found to be range from 29508 for marginal to7652.8 for large holding and 660.9for schedule cast to 1650.8 for backward community in the Chhattisgarh region and from 1118.5for marginal to 208.3 for large holding and from 531.5 for scheduled tribes to 2431.5 for upper cast in Chhindrara-betul plateau, leading to the conclusion that low level of adoption among these classes of farmers is also due to the socio economic structure of the society[41]. B. N. Mishra and Pankaj Mishra 2004 showed the process of agriculture development of the middle Ganga Plain. The aim at assessing the condition of agriculture sector in terms of different variable like net sown area, irrigated area, cropping intensity, use of fertilizers and use of tractors and finally measuring and determining the special pattern of Jumper

[40] Sukhjit K. Saran and kiran Sethi (2000), "*Fertilizer use in Indian Agriculture*", Indian Journal of Regional Science, Vol.32, No.2, pp77-81.
[41] S. K. Sharma (1999), "*Social Structure and Adoption of Agricultural Innovations in Madhya Pradesh*", Geographical Review of India, Vol.61, No.2, pp.156-164.

District by using Z score technique and development block were classified into three development levels viz. low, medium and high on the basis of their composite score. He found that the composite score range from "-5.63(lowest) in Barasathi block to +9.29(highest) in Machhalishahar block leading to the conclusion that the farmer is the least development block of Jaunpur district in terms of five variable considered together. On the basis of composite score Machhalishahar and Sujanganj are highly developed block, while nine viz., Barashathi, Suthiakala, Khutahan, Rampur, Badlapur, Suhasganj, Mariahu, Ramnagar and Muftiganj blocks are less developed of Jaunpur district[42].

Agricultural problem in arid and semi-arid region

The arid and semi-arid parts of India are facing various type of problem like shortage of water, wind erosion, salinity and alkalinity etc. All these problems obstruct the development of agriculture. K. K. Datta and Bhu Dayal 2000 estimated the direct economics losses from the use of poor quality irrigation water and to evolve technique for the safe utilization saline water in order to reduce the economic losses in Karanpura village of Muthera district, Uttar Pradesh since 1993. They used water sample and least square as methodical terms and they found that poor quality of water (alkaline, Saline) has adversely affect the crop yields. He noticed that irrigation water is used less efficient in the case of wheat and mustard under both saline and alkaline water condition. Therefore a considerable scope for applying more water to these crops and increasing thereby crop output. The damage due to poor quality irrigation water and soil salinity and alkalinity counterbalance even the positive effect of the yield increasing factors like water quantity. Further they explained that for mitigating the adverse effect of salinity and alkalinity most of the farmers used rainwater conservation in saline and alkaline water irrigated farm. They also used organic manure for improving the physical soil

[42] B. N. Mishra and Pankaj Mishra (2004), "*Spatial Pattern and Level of Agricultural Development in Jaunpur District U.P*", Geographical Review of India, Vol.66, No.2, pp.163-170.

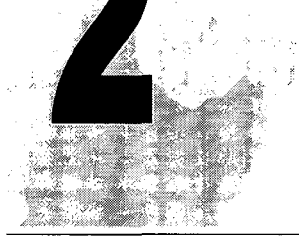
condition to mitigate adverse effect of poor quality water[43]. K. R. Shanmugam (2003) estimated the technical efficiency of raising rice crops in different region of Karnataka, using unbalanced penal data for the period of 1991-92 to 1994-95. The maximum likelihood estimation method was used to estimate the frontier (per hectare) production function. Labour fertilizer and other cost variables are found to be significant determinant of the rice output. The input elasticity value of labour, chemical fertilizer, bullock, other cost and land are 0.32, 0.29, 0.13, 0.18 and 0.17 respectively. He find that technical efficiency varies widely (ranging 60-94 percent) across sample region and is time invariant. The mean technical efficiency is 86 percent, indicating that, on an average, the actual rice output can be increase by 14 percent without any addition a resource[44]. Abaha Lakshmi Singh and Md. Sarfaraz Asgher 2004 located the bricks kilns, examined the process of manufacturing of bricks and to analyze the impact of bricks making on soil fertility and agriculture productivity in Aligarh for the year of 1995, 1996, 1997, 2000, 2001, and 2002using soil testing for PH value organic components, phosphorous and potash content and questionnaires based interview and demarcate the brick kilns area with the radius of 20 Km was drawn from city head quarter. The result shows that bricks manufacturing has negative impact on the land capability and led to loss of soil fertility and declining agriculture productivity[45]. K. M. Mohapatra 2003 analysed and interpreted both positive and negative aspect of new technology in the context of Indian agriculture and environment. He revealed that increase use of fertilizer and HYV seeds enhanced the rice production by 31.9 and 22.8 percent respectively in India. Similarly pesticides uses reduce the food grain production losses, because 40 to 50 percent of the world potential food supply is lost dye to pest. Further he mentions that negative impact of new technology. Modern technology

[43] K. K. Datta and Bhu Dayal(2000), "*Irrigation With Poor Quality Water: An Empirical Study of Input Use, Economic Loss and Cropping Strategies*", Indian Agricultural Economics, Vol.55, No.1, pp.26-27.
[44] K. R. Shanmugam (2003), "*Technical Efficiency of Rice, Groundnut and Cotton Farms in Tamil Nadu*", Indian Journal of Agriculture Economics, Vol.58, No.1, Jan-March.2003, pp.101-113.
[45] . Abaha Lakshmi Singh and Md. Sarfaraz Asgher (2004), "*Impact of Brick Making on Soil Fertility and Agricultural Productivity: A Case Study of Aligarh*", Geographical Review of India, Vol.66, No.4, pp.331-340.

increases the air and water pollution because of excessive use of fertilizer and pesticide in agriculture. Agriculture sector use hug amount of fossil fuel in tractors and manufacturing fertilizer, pesticides etc in industries and this thing create air pollution while use of fertilizer and pesticides deteriorate the soil health. Similarly land biodiversity and ground water quality also degraded due to excessive use of ground and canal water. Finally all these factors create a negative cumulative impact on human health[46].

[46] K. M. Mohapatra 2003, "*Green Revolution technology and Some Environmental Issues: A Note from Indian Experience*", Artha Vijnana, Vol.55, No.2, pp.89-99.

CHAPTER



PATTERN OF AGRICULTURE TECHNOLOGY IN RAJASTHAN

Chapter-2

PATTERN OF AGRICULTURE TECHNOLOGY IN RAJASTHAN

To understand agricultural development there is a need to clarify the process of intended for the change that involves technical experts amongst others. It also consists of research, technology and it transfers, concerned policy and diffusion of techniques. The technological change seemed to be one of the most crucial factors in the agricultural development which consists of adoption of farming techniques and new inputs which are developed through research and is calculate to bring about diversification and increase of production and greater economic return.[1] Agricultural techniques are concerned with all the new input, viz. improved seeds, fertilizers and manures, plant protection, agricultural implements, effective water use and management (irrigation) as well as inter-cultural practices. A suitable package of technology such as utilization of improved seeds, timely sowing, judicious use of fertilizers, plant protection measures, etc will also help in achieving a high yield[2].

After the spread of Green Revolution the HYV seeds and improved seeds have been adopted on a sluggish rate in Rajasthan. The consumption of fertilizer is also increased as well as the use of insecticides, irrigation facilities and other techniques in the state. Therefore Rajasthan has a very rich potential for the production of food grain. Despite its great potential for agricultural development, the situation has to be grim. The only way which the state was trying to increase their food production by bringing more and more area under plough, there was no scope for it in Rajasthan because of its adverse climatic condition and its desert area. The only possibility was to

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[1]Frederick C. Fliegel, Prodipto Roy, Lalit K. Sen, Joseph E. Kivlin, *Agricultural innovation in Indian village*, National Institute of Community Development, Hydrerabad:1968

[2] Gobinda C Mandal, *Technology growth and welfare in Indian village* ,Agricole Publishing Academy, New Delhi:1989

increase the yield which could ensure a higher production by means of adopting new agricultural technologies.

The starting was made with the development of minor irrigation work followed by high use of a chemical fertilizer, high yielding verities of seeds and other agricultural technologies. Since this was done in irrigated areas, their uses were confined to certain districts. Since this initiative proved to be successful their application spread to other districts also. But the adoption levels of these technologies were different in various districts of Rajasthan as the rate of diffusion was not even because of the variegated nature of the factors governing this process. It is in this perspective that in this chapter an attempt has been made to analyse the pattern of diffusion of the agricultural innovation in the districts of Rajasthan.

The present study is confined to five agricultural technologies viz. irrigation, fertilizer, HYV seeds, tractors, and pumpsets. The process of diffusion has been studied by analyzing their percentage increase over the base year[3]. The increase over base year is indicative of variations in the rate of spread of technology over time. While the increase of a technology over time in a district reflects its behaviours during that span of time, the variation over space indicates the relative capacity of the district to record an increase or a decrease in that particular year. However, both the variations, i.e. over time and space reflect the process of diffusion.

SPREAD OF IRRIGATION:-

Irrigation implies maintaining adequate soil moisture required for plant growth at the time and places of deficit water supply. Water requirement depends mainly on climate and soil factors. Due to erratic

[3] Base year 1970-73, when this study started

rainfall, the water requirement is too high in Rajasthan as compared to other Indian states.

Table 2.1

Percent Change in Area under Irrigation
1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	1970-73	1980-83	1990-93	2000-03	A	B	C	D
Ajmer	21.32	12.41	21.29	22.23	-5.27	5.55	0.43	0.1
Alwar	15.55	33.20	43.11	59.57	7.88	2.65	3.29	3.41
Banswara	5.22	8.96	23.32	20.21	5.55	10.04	-1.42	3.44
Barmer	1.09	2.50	2.44	9.86	8.66	-0.24	14.99	5.66
Bharatpur	23.18	27.55	35.95	45.77	1.74	2.7	2.44	1.72
Bhilwara	39.57	43.72	40.82	30.81	1	-0.68	-2.77	-0.62
Bikaner	0.59	4.53	13.40	17.67	22.61	11.46	2.8	8.87
Bundi	43.43	46.96	57.26	57.09	0.78	2	-0.03	0.69
Chittor	25.78	25.52	36.55	25.11	-0.1	3.66	-3.68	-0.07
Chru	0.04	0.09	0.51	5.21	8.45	18.94	26.16	12.95
Dungarpur	8.71	10.29	30.83	14.01	1.68	11.6	-7.58	1.2
Ganganagar	45.69	50.53	64.44	70.54	1.01	2.46	0.91	1.09
Jaipur	26.69	43.92	41.92	49.11	5.11	-0.46	1.6	1.54
Jaisalmer	0.17	0.05	1.37	21.78	-11.52	39.24	31.87	12.9
Jalore	10.15	29.83	30.84	29.04	11.38	0.33	-0.6	2.66
Jhalawar	10.83	12.32	24.97	31.92	1.3	7.32	2.49	2.74
Jhunjhunu	3.73	13.69	18.38	38.12	13.89	2.99	7.57	5.98
Jodhpur	2.82	6.03	8.07	15.82	7.9	2.96	6.96	4.41
Kota	24.34	29.41	46.35	54.36	1.91	4.65	1.61	2.03
Nagaur	2.39	6.34	2.96	22.19	10.25	-7.33	22.32	5.73
Pali	17.76	28.09	26.87	22.11	4.69	-0.44	-1.93	0.55
Sawai-madhopur	17.83	24.73	28.44	42.91	3.33	1.41	4.2	2.22
Sikar	7.41	21.65	25.10	39.70	11.32	1.49	4.69	4.29
Sirohi	25.12	34.89	40.98	32.95	3.34	1.62	-2.16	0.68
Tonk	15.84	20.14	24.43	32.86	2.43	1.95	3.01	1.84
Udaipur	27.58	28.50	34.01	15.05	0.33	1.78	-7.83	-1.5
Rajasthan	16.26	21.76	27.87	31.77	2.96	2.51	1.32	1.69
C.V[4]					1.42	1.76	2.28	1.13

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

[4] Coefficient of variation

The unevenly distributed rainfall necessitates proper irrigation. It has to be different for different crops in different seasons and region. So the modern agriculture is highly affected by the development of irrigation since rainfall is unreliable both in time of incidences and amount and therefore, artificial source of watering is necessary for the growth of agriculture in the state. It encourages the farmers to adopt more scientific techniques as well as intensive cultivation. Moreover, the new seeds respond to fertilizer better if timely and adequate water is available. Irrigation plays a very decisive role in determining cropping pattern, intensity of cropping, crop combination and over all the increase of yield. In Rajasthan, mainly two types of irrigation facilities are available viz. well and canal. However, in southern parts of Rajasthan, tank irrigation is also found, but the area under tank irrigation is not so remarkable. Therefore, well and canal irrigation is the main sources of irrigation in Rajasthan. The gross irrigated area in Rajasthan is continually increasing. It increased from 16.3 percent in 1970-73 to 31.8 percent in 2000-03. The regional variations in gross irrigated area have continually declined among districts. The coefficient of variation has decreased from 83.0 in 1970-73 to 52.5 in 2000-03. The gross irrigated area varied from 0.0 percent in Churu to 45.7 percent in Ganganagar in 1970-73. The expansion of irrigation facilities has been presented in Table 2.1 and it shows that no single district entered into very high class during 70s. However, in later period, Ganganagar is the only district, which attains this category. The gross irrigated areas in Ganganagar, Bundi, and Bhilwara vary from 39.6 percent to 45.7 percent during 70s. All these districts have been classified as those which receive medium level irrigation facilities. The gross irrigated area in Ganganagar increased from 45.7 percent in 70s to 50.5 percent in 80s, 64.4 percent in 90s and 70.5 in 2000 respectively, while gross irrigated area in Bhilwara decreased from 43.4 percent in 70s to 30.8 percent in 2000. The three consecutive years i.e. 2000-03 had been declared as drought affected years. Owing to it, Bhilwara where tank is the major source of irrigation and because of the deficit rainfall, the gross irrigated area registered a significant decline.

Moreover, in Bundi it increased from 43.4 percent in 70s to 57.1 percent in 2000. It is indeed interesting to know that in Rajasthan, Ganganagar is the only district, where irrigated area is more than 60 percent. In Ganganagar, canal is the major source of irrigation. Consequently the area under canal irrigation has increased and as a result the gross irrigated areas also increased.

Table 2.2

Districts Classified by Different Categories of percentage Irrigation in Different Year Over 1970-73

	Classes	1970-73	1980-83	1990-93	2000-03
Very-High	60 and above			Ganganagar,	Ganganagar.
High	45-60		Ganganagar.	Bundi, Kota,	Alwar, Bharatpur, Bundi, Jaipur, Kota.
Medium	30-45	Bhilwara, Bundi, Ganganagar.	Alwar, Bhilwara, Bundi, Jaipur, Sirohi.	Alwar, Bharatpur, Bhilwara, Chittor, Dungarpur, Jaipur, Jalore, Sirohi, Udaipur.	Bhilwara, Jhalawar, Jhunjhunu, Sawai-Madhopur, Sikar, Sirohi, Tonk.
Low	15-30	Ajmer, Alwar, Bharatpur, Chittor, Jaipur, Kota, Pali, Sawai-Madhopur, Sirohi, Tonk, Udaipur.	Bharatpur, Chittor, Jalore, Kota, Pali, Sawai-Madhopur, Sikar, Tonk, Udaipur.	Ajmer, Banswara, Jhalawar, Jhunjhunu, Pali, Sawai-Madhopur, Sikar, Tonk.	Ajmer, Banswara, Bikaner, Chittor, Jaisalmer, Jalore, Nagaur, Pali.
Very-low	0-15	Banswara, Barmer, Bikaner, Churu, Dungarpur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Nagaur, Sikar.	Ajmer, Banswara, Barmer, Bikaner, Churu, Dungarpur, Jaisalmer, Jhalawar, Jhunjhunu, Jodhpur, Nagaur.	Barmer, Bikaner, Churu, Jaisalmer, Jodhpur, Nagaur,	Barmer ,Churu, Dungarpur, Jodhpur, Udaipur.

Therefore, it registered a negative growth -2.7 percent in 2000-03 over 1970-70. The gross irrigated areas in Udaipur, Jaipur, Chittor, Sirohi, Kota, Bharatpur and Ajmer varied from 21.3 percent to 27.6 percent in 70s. In

Udaipur, the gross irrigated area increased from 27.6 percent in 1970-73 to 34.0 percent in 1990-93 and afterwards it registered negative growth -7.6 percent in 2000-03[5]. On the other hand, the gross irrigated areas in Kota, Bharatpur and Ajmer have showed continuous increasing trend and they fall in as 40 to 50 percent irrigation class. In the same way, the gross irrigated area in Kota, that earlier had not more than 24.3 percent in 1970-73 had increased and stretched to 54.4 percent of area in 2000-03. Table 2.2 reveals that the gross irrigated areas in Sawai-Madhopur, Pali, Tonk, Alwar, Jhalawar, and Jalore was in low category during 1970-73. Nevertheless, it recorded a higher growth rate. Gross irrigated area was only 15.6 percent in Alwar during 1970-73 but in due course of time, it increased and recorded a positive growth rate 3.41 percent, in 2000-03. It is the only districts in this category, which record into 50 to 60 percent irrigated areas in 2000-03 (59.6 percent area irrigated in Alwar during 2000-03). The area under well irrigation has increased in these districts and as a result, the gross irrigated area has also increased during the whole period. Sawai-Madhopur is another district that showed a sharp increase in gross irrigated area. Its gross irrigated area increased from 17.8 percent in 1970-73 to 45.8 percent in 2000-03. An analogous trend was also witnessed in Jalore district. The gross irrigated area in Jalore was continually increased up to 1990-90. Nevertheless, in 2000-03 it recorded a marginal decline from 38.8 percent in 1990-93 to 29.0 percent in 2000-03.

The gross irrigated area in Dungarpur, Sikar, Banswara, Jhunjhunun, Jodhpur, Nagaur, Barmer, Jaisalmer, and Churu was very low class 1970-73. In this group, most of the districts lie in the western part of Rajasthan. It is well known that this area is too arid and the ground water availability is extremely low. In these western parts of the State, the gross irrigated area has recorded a significant increase. In Jhunjhunun, Jodhpur, Nagaur and Sikar, the gross irrigated area has recorded increase of more than 4 percent during the whole period. It is notable that the gross irrigated area in Jaisalmer was

[5] Under tank irrigated area was decreased due to deficient rainfall

only 0.2 percent in 1970-73. However, in 2000-03, has recorded growth to be 21.8 percent. In the same way, the gross irrigated area of Nagaur has evidenced the same increasing pattern. In contrast, the gross irrigated areas in Dungarpur and Banswara kept increasing up to 1990-93; thereafter it started to show a negative growth.

SPREAD OF HYV SEEDS -

Modern crop technology was founded upon the improved seeds. These seeds have certain physical attributes which ensure high yield but it requires chemical fertilizer and adequate water supply. It also calls for better agricultural practices such as effective weeding, effective water control and plant protection measures. They are early maturing and non-photosensitive. As far as substantial higher yield is concerned, it has been found that new varieties perform 2 to 30 times better than the traditional varieties[6]. The HYV yielded 74 percent more grains as compare to local variety. In Rajasthan, the area under high yielding variety seeds has continued to increase from the beginning of the green revolution. Table 2.3 shows the area under HYV seeds fluctuated for the entire period. As far as the changes in use of HYV seeds is concerned its growth in the State has remained constant for the entire period. However, the consumption of HYV recorded a significant growth in 1990-93 from 24.72 percent to 29.47 percent. It is evident that the use of HYV seeds in irrigated districts in Rajasthan had been declining from 46.48 kg/00hectare in (1970-73) to 33.80 kg /00 hectare in 1990-93. However, in 2000 it has significantly increased.

[6] Desai, D.K and N.T. Patel, "*Improving Growth of Foodgrains Productivity in Western Region of India*", Indian Journal of Agricultural Economics.

Table 2.3

Percent Change in Use of HYV Seeds in Irrigated Districts 1970-73, 198083, 1990-93, 2000-03

	(Kg/00hectare)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
Ganganagar	156.37	46.75	20.26	111.89	-18.23	-8.87	40.74	-1.66
Jaipur	92.09	75.15	117.50	63.78	-3.33	5.09	-11.50	-1.82
Sawai-madhopur	54.75	91.13	98.00	65.71	8.86	0.81	-7.68	0.92
Jalore	51.61	12.61	7.93	43.74	-20.93	-5.02	40.71	-0.82
Udaipur	50.77	18.55	36.21	10.87	-15.45	7.71	-21.39	-7.42
Kota	36.09	46.70	19.05	25.26	4.39	-9.48	5.81	-1.77
Chittor	29.94	16.57	11.76	42.56	-9.39	-3.74	29.34	1.77
Bhilwara	25.72	7.38	4.57	7.94	-18.79	-5.19	11.68	-5.71
Bundi	21.43	5.00	5.56	8.69	-21.54	1.19	9.34	-4.41
Bharatpur	13.75	56.63	17.18	33.04	26.61	-12.41	13.97	4.48
Sirohi	13.53	14.59	39.56	28.40	1.27	11.72	-6.41	3.78
Alwar	11.67	26.45	28.02	33.61	14.61	0.64	3.71	5.43
Irrigated Districts	46.48	34.79	33.80	39.62	-4.71	-0.32	3.23	-0.79
Rajasthan	24.72	20.66	29.47	24.70	-2.95	4.03	-3.47	0
C.V					85.79	77.70	103.49	71.79

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

Table 2.3 and 2.5 reveal the wide variation in the use of HYV in irrigated and un-irrigated districts. During 1970-73, most of the irrigated districts were in low and a few in high groups. Only two districts namely Ganganagar and Jaipur were classified as very high category and they recorded HYV use of 156.37 and 92.09 kg /00 hectare respectively in 70s. In 70s Ganganagar was categorised as very high but in 80s and 90s the area under HYV was reduced and was classified as medium and low class respectively. The use of HYV seeds was too low in Alwar, Sirohi and Bharatpur during 1970-73 (11.67, 13.53, and 13.75 kg/00 hectare respectively). At the same time, the use of HYV seeds in Udaipur, Jalore and Sawai-Madhopur was classified as medium group. The remaining irrigated districts viz. Chittor, Bundi and Bhilwara were put in low category.

Table 2.4

Districts Classified by Different Categories of percentage HYV Seeds in Different Year Over 1970-73

	Classes	1970-73	1980-83	1990-93	2000-03
Very-High	60 and above	Ganganagar. Jaipur	Sawai-Madhopur, Jaipur,	Dungarpur, Sawai-Madhopur, Jaipur,	Ganganagar. Jaipur, Sawai-Madhopur,
High	45-60	Udaipur.	Bharatpur, Ganganagar.		Jaipur, Nagaur,
Medium	30-45	Kota	Kota, Sirohi.	Jaipur, Jaisalmer, Sikar Sirohi,	Alwar, Bharatpur Chittor, Jalore, ,
Low	15-30	Ajmer, Bhilwara, Bundi Chittor, Jalore, Pali, Sawai-Madhopur, , Tonk,	Alwar, Chittor, Pali, Sikar, Tonk, Udaipur.	Ajmer, Alwar, Banswara, Bikaner Ganganagar Jhalawar, Jhunjhunu, Jodhpur, Kota, Nagaur, Pali, Tonk.	Banswara, Dungarpur, Kota, Sikar Sirohi
Very-low	0-15	Banswara, Alwar Sirohi Barmer, Bharatpur Bikaner, Churu, Dungarpur, Jaisalmer, Jhalawar, Jhunjhunu, Jodhpur, Nagaur, Sikar.	Ajmer, Banswara, Barmer, Bhilwara, Bikaner, Bundi, Churu, Dungarpur, Jaisalmer, Jhalawar, Jhunjhunu, Jalore, Jodhpur, Nagaur.	Bharatpur, Bhilwara, Barmer, Bundi, Chittor, Churu, Jalore, Udaipur.	Ajmer, Barmer, Bhilwara, Bikaner, Bundi, Churu, Jhalawar, Jaisalmer, Jhunjhunu, Jodhpur, Pali Tonk. Udaipur.

The important changes in use of HYV seeds have been registered during 1980-83 and 2000-03. During this period, the HYV seeds use in highly irrigated districts have registered significant decline. The HYV seeds consumption in Chittor, Jalore and Ganganagar had been declining up to 90 and then they recorded significant growth. For example in Chittor, it declined from 29.94 kg/00 hectare in 1970-73 to 11.76 kg/00hectare in 1990-93 while in 2000 it recorded very steep growth over 90s level (11.76 kg/00hectare in 1990-

93 to 42.56 kg/00hectare in 2000-03). Similarly, in Ganganagar it declined from 156.37 kg/00 hectare in1970-73 to 20.26 kg/00 hectare in 1990-93 and later it increased significantly. Among irrigated districts, Alwar is the only district that shows positive growth in use of HYV for the entire period but in 2000 it was put as medium category. Bharatpur, Sirohi, Sawai-Madhopur and Kota, the use of HYV fluctuated during the whole period but it recorded positive significant growth in 2000. It is quite interesting that the southern districts of Rajasthan namely Bundi, Bhilwara and Udaipur have recorded steep decrease in use of HYV seeds for the entire period.

The use of HYV seeds in un-irrigated districts has been shown in Table 2.5. The un-irrigated districts present a completely different pattern from irrigated districts. The use of HYV in these districts was far below from the irrigated districts in 1970-73. The use of HYV seeds increased in 90s in un-irrigated districts from 24.72 kg/00 hectare in 1970-73 to 29.47 kg/00 hectare in 2000-03. The use level of HYV seeds fluctuated over the period but it had been constant for the whole period (24.72 in 1970-73 and 24.70 in 2000-03).

The use of HYV seeds was too low in 70s. Most of the districts were put as very low category and its use level was less then 10 kg/00hectare in 70s. Only in two districts, namely Tonk and Ajmer, use was more then 10 kg/00 hectare. The use of HYV in these districts had totally attributed to their irrigation facilities because both of them satisfactory irrigation facility during70s. A sharp declining trend was witnessed in use of HYV seeds in both the districts in 2000-03 over 1970-73. The use of HYV seeds in remaining districts had been put in as very low category in 1970-73. In 80s, 90s and 2000, the use of HYV seeds has recorded some change. Although during 80s, all un-irrigated districts recorded significant growth in use of HYV seeds it was highest in Nagaur, Jodhpur, Sikar, and Bikaner but they still were classified in low class.

Table 2.5

Percent Change in Use of HYV Seeds in Un-Irrigated Districts 1970-73, 198083, 1990-93, 2000-03

	(Kg/00hectare)				Growth Rate			
Districts	1970-73	1980-83	1990-93	2000-03	A	B	C	D
Tonk	29.78	19.58	48.88	4.87	-6.75	10.70	-36.95	-8.66
Ajmer	10.14	6.32	6.55	0.94	-7.58	0.40	-32.18	-11.21
Sikar	9.09	13.92	34.00	30.88	7.36	10.43	-1.91	6.31
Pali	8.50	8.73	10.36	2.89	0.45	1.92	-22.53	-5.25
Jhalawar	6.34	6.62	17.34	3.42	0.72	11.29	-27.72	-3.04
Nagaur	4.62	17.45	28.14	53.06	24.79	5.45	13.52	12.98
Barmer	3.34	5.59	6.43	0.00	8.96	1.57	0.00	0.00
Jodhpur	3.22	12.13	15.34	5.41	24.74	2.64	-18.82	2.63
Banswara	2.87	2.30	7.90	20.06	-3.62	14.69	20.49	10.21
Dungarpur	2.61	3.76	114.35	28.93	6.27	46.14	-24.03	12.78
Bikaner	2.42	16.76	22.43	1.37	38.06	3.29	-42.83	-2.80
Jhunjhunu	1.86	3.79	5.08	5.50	12.60	3.31	1.60	5.57
Churu	0.14	2.82	5.38	9.45	64.95	7.44	11.93	23.44
Jaisalmer	0.06	0.00	38.36	0.00	0.00	0.00	0.00	0.00
Un-irrigated Districts	6.07	8.56	25.75	11.91	5.88	13.03	-14.29	3.43
C.V.					123.95	73.79	112.68	132.05

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

During 90s, similar increasing trend was also witnessed in Dungarpur, it reached its highest level (114.35kg/00/hectare) and it was put in very high category. The remaining districts namely Bikaner, Sikar, Jaisalmer, and Nagaur shifted to medium class in 90s. In 2000, only three districts viz. Nagaur, Banswara, and Churu registered a significant growth.

Thus, we say that the spread of agricultural technology over time and space has taken place at a varying level but the general trend has been of the increase, particularly in those districts where the base was very weak in the initial phase of adoption. This may be attributed to the fact that these irrigated

districts were trying to keep pace with the adoption level of their neighbourhood[7].

SPREAD OF CONSUMPTION OF CHEMICAL FERTILIZERS:-

The use of fertilizer is not a new phenomenon in Indian agriculture. Traditionally, the farmers have been using farmyard manure which had been considered as the most suitable strategy to improve the soil fertility. But with the advancement of technology and shortage of farm yard manure to provide full nutritional requirements of the plants the use of fertilizer took care of macro-nutrients. The chemical fertilizers are capable of meeting the three-macro nutrients viz. nitrogen, phosphorous and potash (NPK). The use of any type of fertilizer depends upon the requirement of the soil. Even the quantity of fertilizer to be used depends upon the requirement of the soil and a particular crop. These two characteristics introduce variation in the consumption of fertilizers- both temporally and spatially.

Table 2.6 showed the fertilizer consumption in Rajasthan is far below from the national average as compared to other agriculturally developed states like Harayana, Punjab, Gujarat and western Uttar Pradesh etc. Table 2.6 shows the consumption of fertilizer in the state was only 1.34 kg/00hectare in 1977. Yet in course of time, it increased significantly. It increased from its 1977 level to 9.93 kg/00hectare in 1982, 23.37 kg/00hectare in 1992 and 36.65 kg/00hectare in 1997 respectively. Therefore, this growth is quite significant in arid and semi-arid climate. Since HYV seeds and fertilizer are more sensitive to irrigation facilities, the opportunity to use fertilizer is limited in Rajasthan. Table 2.6 also shows that the consumption of fertilizer in irrigated districts was only 2.47 kg/00hectare in 1977 and it increased from this level and registered 44.83 kg/00hectare in 1997. Among irrigated districts, the

[7] Satish C. Sharma (1982), *Technological Response in Developing Agriculture (Rajasthan: A Case Study)*, National Publishing House, New Delhi.

consumption of fertilizer varies from 0.01 to 9.96 kg/00hectare in 1977. Thus, all irrigated districts were classified in very low category during this period.

Table 2.6

Percent Change in Consumption of Fertilizer in Irrigated Districts 1970-73, 198083, 1990-93, 2000-03

	(Consumption kg/00hectare)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
Ganganagar	9.96	61.16	73.21	137.19	35.32	2.02	13.38	14.01
Chittor	5.21	27.08	36.47	64.61	31.61	3.36	12.12	13.42
Kota	3.30	11.92	31.91	61.85	23.87	11.56	14.15	15.78
Jaipur	2.29	14.14	18.86	29.14	35.45	3.25	9.09	13.56
Bundi	2.27	2.86	9.43	12.60	3.93	14.18	5.97	8.95
Bhilwara	1.65	7.43	7.89	44.36	28.50	0.67	41.25	17.89
Sawai-madhopur	1.63	7.97	25.27	29.76	30.28	13.68	3.33	15.63
Bharatpur	1.18	2.45	25.10	87.37	12.95	29.50	28.33	24.01
Alwar	1.02	10.93	15.08	25.55	48.48	3.64	11.12	17.47
Sirohi	0.73	1.02	9.34	18.07	5.73	27.90	14.11	17.40
Udaipur	0.40	4.53	9.67	14.58	49.86	8.79	8.56	19.70
Jalore	0.01	0.02	0.32	12.93	12.25	36.08	109.55	43.08
Irrigated Districts	2.47	12.63	21.88	44.83	31.24	6.30	15.43	15.59
Rajasthan	1.34	9.93	23.37	36.65	39.63	9.98	9.42	17.99
C.V					106.36	128.87	84.97	80.30

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

In 1982, all irrigated districts recorded positive growth but they were placed in very low category, while Ganganagar was the only district that was classified as medium during this period. Consumption of fertilizer in Bharatpur, Sirohi, and Bundi did not show any remarkable change up to 1982 while in Jalore it was still constant up to 1992. The similar increasing trend was also witnessed in 1992. The most important changes took place in Kota and Chittor. During this period, they both changed their category from very low to low while Ganganagar still stuck to its previous position. However the fertilizer consumption increased from 61.16 kg/00hectare to 73.21 kg/00hectare during 1992 in Ganganagar. The major changes in consumption

of fertilizer have occurred during 2000-03. In this period all irrigated districts have registered significant increase in fertilizer consumption especially Jalore, Bharatpur, Bhilwara, Sirohi, Kota, Ganganagar and Bundi. During 2000 Bharatpur, Kota and Chittor were put in medium category but which were earlier classified in low to very low category. Ganganagar is the only district which was put in very high category in 2000 with fertilizer consumption of 137.19 kg/00/hectare.

Table 2.7

Districts Classified by Different Categories of percentage Consumption of fertilizer in Different Year Over 1970-73

	Classes	1970-73	1980-83	1990-93	2000-03
Very-High	90 and above	Ganganagar. Jaipur	Sawai-Madhopur, Jaipur,	Dungarpur, Sawai-Madhopur, Jaipur,	Ganganagar. Jaipur, Sawai-Madhopur,
High	90-120	Udaipur.	Bharatpur, Ganganagar.		Jaipur, Nagaur,
Medium	60-90	Kota	Kota, Sirohi.	Jaipur, Jaisalmer, Sikar Sirohi,	Alwar, Bharatpur Chittor, Jalore, ,
Low	30-60	Ajmer, Bhilwara, Bundi Chittor, Jalore, Pali, Sawai-Madhopur, , Tonk,	Alwar, Chittor, Pali, Sikar, Tonk, Udaipur.	Ajmer, Alwar, Banswara, Bikaner Ganganagar Jhalawar, Jhunjhunu, Jodhpur, Kota, Nagaur, Pali, Tonk.	Banswara, Dungarpur, Kota, Sikar Sirohi
Very-low	0-30	Banswara, Alwar Sirohi Barmer, Bharatpur Bikaner, Churu, Dungarpur, Jaisalmer, Jhalawar, Jhunjhunu, Jodhpur, Nagaur, Sikar.	Ajmer, Banswara, Barmer, Bhilwara, Bikaner, Bundi, Churu, Dungarpur, Jaisalmer, Jhalawar, Jhunjhunu, Jalore, Jodhpur, Nagaur.	Bharatpur, Bhilwara, Barmer, Bundi, Chittor, Churu, Jalore, Udaipur.	Ajmer, Barmer, Bhilwara, Bikaner, Bundi, Churu, Jhalawar, Jaisalmer, Jhunjhunu, Jodhpur, Pali Tonk. Udaipur.

Table 2.8 shows that the consumption of fertilizer was far below from the irrigated districts but these districts did not show very wide variation in its consumption level in 1977. During this period the consumption varied from 0.00 kg/00hectare to 1.81 kg/00/hectare. Till 1982 all un-irrigated districts were classified with very low level consumption of fertilizer. However, later period they recorded significant increase. In 1992 the consumption of fertilizer in Dungarpur and Nagaur was increased from 16.27 kg/00hectare and 21.75 kg/00hectare in 1982 to 32.66 kg /hectare and 34.55 kg/00hectare in 1992 respectively. In Churu and Tonk it was 0.41 kg/00hectare and 15.50 kg/00hectare in 1983 to 66.95 kg/00hectare and 68.69 kg/00hectare in 1992. Thus, they changed improve their position from very low to medium category.

Table 2.8

Percent Change in Consumption of Fertilizer in Un-Irrigated Districts 1970-73, 1980-83, 1990-93, 2000-03

	(Consumption kg/00/hectare)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
Pali	1.87	19.96	26.41	38.80	48.38	3.16	8.00	16.37
Tonk	1.42	15.50	68.69	13.01	48.94	17.99	-28.31	11.71
Jodhpur	0.57	5.47	9.36	13.44	45.78	6.15	7.50	17.12
Banswara	0.42	3.04	6.22	21.16	39.08	8.28	27.75	21.65
Ajmer	0.34	3.06	8.34	23.83	44.22	11.78	23.36	23.68
Jhalawar	0.31	4.68	8.39	26.75	57.21	6.70	26.10	24.97
Jhunjhunu	0.16	0.69	0.72	2.73	27.58	0.47	30.55	15.24
Sikar	0.12	1.05	4.09	23.13	43.55	16.31	41.41	30.09
Nagaur	0.00	21.75	34.55	27.75	-	5.28	-4.29	-
Dungarpur	0.00	16.27	32.66	41.04	-	8.05	4.67	-
Jaisalmer	0.00	8.73	61.93	51.31	-	24.32	-3.69	-
Barmer	0.00	5.61	15.20	29.21	-	11.71	13.96	-
Bikaner	0.00	0.61	1.64	5.51	-	11.62	27.43	-
Chru	0.00	0.14	66.95	97.10	-	98.49	7.72	-
Un-irrigated Districts	0.43	8.88	28.76	34.56	65.37	13.95	3.74	24.47
C.V					155.04	99.49	100.63	79.66

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

During 1997 the consumption of fertilizer has recorded significant increase especially in the western districts, except Nagaur and Jaisalmer. In these two districts, it decreased from 66.95 kg/00hectare and 34.55 kg/00hectare to 51.31 kg/00hectare and 27.75 kg/00hectare in 1997. The consumption of fertilizer increased though both were classified as low category (26.41 kg/00hectare in 1992 to 38.80 kg/00hectare in 1997). Among un-irrigated districts, Churu is the only district that is classified as high category in 1997(97.10 kg/00hectare)

Therefore, the above analysis reveals that, over the period, consumption of fertilizer has increased significantly in both sets of districts, irrigated as well as un-irrigated. But if we compare the consumption of fertilizer with irrigation and HYV seeds, we have found a causal relation among these three. The increased irrigation facilities helped the intensive use of HYV seeds, and HYV seeds require comparatively more fertilizer when compared to traditional varieties.

SPREAD OF PLOUGHING IMPLEMENTS:-

a) Ploughs:-

Plough is traditional implement of agriculture sector. Traditionally it was made of wood with iron sheer but now improved ploughs are made of iron. However the spread of tractor has limited the use of traditional plough. But in Rajasthan it is still used particularly by small farmers.

The number of ploughs in Rajasthan is more or less constant for the entire period. A minor increase had been recorded in 1983 (20.14 /00 hectare in 1977 to 22.10 00/hectare in 1983). Table 2.9 shows the number of ploughs in irrigated districts during 1977 which varied from 15.52 /00 hectare in Kota

to 63.28 /00 hectare in Udaipur. During this period Udaipur was the only district which used more than 60 plough /00 hectare and was put in very high category. Similarly, Chittor was the only district which was put in a medium category. Otherwise, most of the districts were classified in low category. It is also a notable fact that among all the irrigated districts, none of them was categorised as very low category (0-15). It is notable that the use of higher number of ploughs is not a positive sign of technological development. But it presents a clear picture whether the total area under crop or the area sown more than once increase with the increase of ploughs. If the number of ploughs decreased, it would mean either the farmers used more advanced technique (tractor) or the agriculture land was affected by drought or flood (in Rajasthan drought is the most common feature).

Table 2.9

Percent Change in Numbers of Plough in Irrigated Districts 1977, 1983, 1992, 1997

	(Number of plough/00hectare)				Growth rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Udaipur	63.28	32.80	14.45	79.17	-10.37	-8.71	40.52	1.13
Chittor	31.73	31.41	33.98	29.83	-0.17	0.88	-2.57	-0.31
Bhilwara	26.54	33.08	4.53	23.38	3.74	-19.82	38.85	-0.63
Bharatpur	24.86	21.54	49.35	4.70	-2.36	9.65	-37.52	-7.99
Ganganagar	23.23	19.34	6.96	12.54	-3.01	-10.73	12.50	-3.04
Bundi	20.30	24.85	24.45	18.12	3.43	-0.18	-5.82	-0.57
Sawai-madhopur	18.58	20.54	9.19	14.00	1.69	-8.55	8.78	-1.41
Alwar	18.51	21.10	13.12	3.65	2.21	-5.14	-22.58	-7.80
Jalore	18.19	24.57	13.44	19.93	5.14	-6.48	8.20	0.46
Sirohi	17.74	24.95	41.35	19.35	5.85	5.77	-14.09	0.44
Kota	15.52	20.75	13.10	16.16	4.96	-4.98	4.29	0.20
Jaipur	13.63	22.53	112.00	5.70	8.74	19.50	-44.88	-4.27
Irrigated Districts	24.34	24.79	27.99	20.54	0.30	1.36	-6.00	-0.84
Rajasthan	20.14	22.10	21.81	21.80	1.56	-0.15	-0.01	0.40
C.V					49.77	19.24	65.47	85.71

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1983 over 1977
B. 1992 over 1983
C. 1997 over 1992
D. 1997 over 1977

During 1983, the number of ploughs /00 hectare in Irrigated districts varied from 32.80 /00 hectare in Udaipur to 20.54 /00 hectare in Sawai-Madhopur. During this period, none of the irrigated districts was put as very high, high and very low category. In contrast all were put in low to medium category. Bharatpur, Chittor, Ganganagar, and Udaipur were the only districts which recorded significant decline in the number of ploughs. The decline was the highest in Chittor (-10.37/00 hectare) followed by Ganganagar (-3.01/00 hectare), Bharatpur (2.36/00 hectare) respectively. It means the number of tractors in these districts had increased during this period. On the contrary, remaining irrigated districts recorded positive growth in the number of ploughs. But they still were in low to medium category. On the other hand, the number of ploughs in 1992 had significantly declined in most of the districts. Udaipur, Jalore, Kota, Bhilwara, Sawai-Madhopur, Ganganagar, and Alwar are the districts which registered the declining trend. The number of ploughs had recorded a very sharp negative growth in Bhilwara (-19.82), Ganganagar (-10.73) Udaipur (-8.71) and Sawai-Modhpur (-8.55) respectively. Jalore, Jaipur and Bharatpur are the only districts which showed positive growth during 1992.

In 1997, all these districts presented a totally opposite trend to that of 1992. During this period, twelve out of six districts recorded a positive growth while the remaining had registered a negative growth. The number of ploughs in Udaipur, Bhilwara, Ganganagar and Jalore had registered a very sharp positive growth (40.52 percent) (38.85 percent) (12.50 percent) (8.78 percent) respectively while Jaipur, Bharatpur, Alwar, and Sirohi have recorded a very sharp negative growth (-44.88 percent), (-37.52 percent), (-22.58 percent) and (-14.09 percent) respectively. But the over all growth (1997 over 1977) for all the irrigated districts been negative. Only four districts namely Udaipur, Jalore Sirohi, Kota recorded positive growth but this was insignificant in most of the case.

Table 2.10

Districts Classified by Different Categories of percentage Of Number of Plough in Different Year Over 1977

	Classes	1977	1983	1992	1997
Very-High	60 and above	Udaipur.		Jaipur,	Banswara, Dungarpur, Tonk Udaipur
High	45-60		Dungarpur,	Banswara,	
Medium	30-45	Banswara, Chittor, Dungarpur,	Banswara, Bhilwara, Chittor, Udaipur	Bharatpur, Chittor, Sirohi,	
Low	15-30	Ajmer, Alwar Bharatpur Bhilwara, Bundi Ganganagar Jalore, Jhalawar, Kota Pali, Sawai-Madhopur, Sikar, Sirohi , Tonk,	Ajmer, Alwar, Barmer, Bharatpur Bundi, Ganganagar, Jhalawar, Jaipur, Jalore, Kota, Pali Sawai-Madhopur, Sikar, Sirohi. Tonk	Bundi, Dungarpur, Jhalawar, Jhunjhunu, Sikar	Bhilwara, Bundi, Chittor, Jalore, Kota, Sirohi
Very-low	0-15	Barmer, Bikaner, Churu, Jaisalmer Jaipur Jhunjhunu, Jodhpur, Nagaur,	Bikaner, Churu, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur.	Ajmer, Alwar, Bhilwara, Barmer, Bikaner Churu, Ganganagar Jaisalmer, Jalore, Jodhpur, Nagaur, Kota, Pali, Sawai-Madhopur, Tonk. Udaipur.	Ajmer, Alwar, Barmer, Bharatpur, Bikaner, Churu, Ganganagar. Jhalawar, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Pali Nagaur, Sawai-Madhopur, Sikar

Table 2.11 shows that the number of ploughs in un-irrigated districts was not as low as for the irrigated districts. In 1977, the number of ploughs in un-irrigated districts was only 16.54 /00 hectare but over the time it increased significantly and registered 22.88 /00 hectare in 1997. The number of ploughs

in un-irrigated districts varied from 8.23/00 hectare in Jodhpur to 38.56 /00 hectare in Dungarpur during 1977. During this period most of the districts were categorised as very low to low. In 1983 the important change had registered in Jaisalmer. The number of plough increased from 12.89 /00 hectare in1977 to 25.69 /00 hectare in 1983. On the other hand, the number of plough in Tonk, Pali, Jhalawar and Nagaur recorded negative growth. But in 1992 the number of ploughs in most of the un-irrigated districts had recorded negative growth especially in Jaisalmer (-12.97 percent), Dungarpur (-8.37percent) and Tonk (-8.05).

Table 2.11

Percent Change in Number of Plough in Un-Irrigated Districts 1977, 1983, 1992, 1997

	(Number of plough/00hectare)				Growth Rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Dungarpur	38.56	53.65	24.44	89.53	5.66	-8.37	29.65	4.30
Banswara	36.26	42,05	46.83	60.66	2.50	1.20	5.31	2.61
Jhalawar	19.38	19.35	29.67	6.08	-0.03	4.86	-27.17	-5.63
Pali	17.55	16.25	11.71	6.41	-1.27	-3.58	-11.35	-4.91
Tonk	17.09	16.04	7.54	94.68	-1.05	-8.05	65.87	8.94
Ajmer	16.77	18.48	13.94	10.74	1.63	-3.08	-5.08	-2.20
Sikar	15.08	16.53	23.42	7.17	1.54	3.95	-21.08	-3.65
Jaisalmer	12.89	25.69	7.36	6.22	12.18	-12.97	-3.31	-3.58
Barmer	11.55	15.17	7.97	9.62	4.65	-6.90	3.83	-0.91
Nagaur	10.60	9.55	9.32	2.24	-1.72	-0.27	-24.81	-7.48
Chru	9.77	10.20	13.21	9.47	0.72	2.91	-6.44	-0.16
Jhunjhunu	9.02	12.69	18.70	9.63	5.85	4.40	-12.43	0.33
Bikaner	8.74	10.79	10.14	5.43	3.57	-0.69	-11.74	-2.35
Jodhpur	8.23	10.61	6.79	2.49	4.32	-4.84	-18.18	-5.80
Un-irrigated	16.54	19.79	16.50	22.88	3.04	-2.00	6.76	1.64
C.V					57.89	64.98	68.73	143.03

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1983 over 1977
B. 1992 over 1983
C. 1997 over 1992
D. 1997 over 1977

During 1997 the number of plough varied from 2.44 /00 hectare in Nagaur to 94.68 /00 hectare in Tonk. In this period, the number of plough in most of the districts recorded steep negative growth especially in Jhalawar (-27.17 percent), Nagaur (-24.81 percent), Sikar (-21.08 percent), Jodhpur (-18.18 percent), Jhunjhunun (-12.43 percent), and Bikaner (-11.74 percent) respectively while a totally opposite trend was witnessed in Tonk (65.87 percent) and Dungarpur (29.65 percent).

b) **Spread of Tractors**:-

Mechanization of agricultural is not a new phenomenon in India. It can be traced back to the inter-war period when wealthy farmers purchased tractors of the foreign origin for the agricultural practices. Mechanization of agricultural aroused the fear of the substitution of manual and animal labour by the powered implements. It is a part of package technology in order to sustain agricultural development. Tractor is an alternative mode of plough. Even the cultivation with tractor is more profitable as compared to man operated plough. Tractor may be helpful for the increasing cropping intensity.

Table 2.12 shows that the number of tractors in Rajasthan was only .07 /00 hectares. During 80, 90, and 2000, it increased continuously by 0.40, 1.02 and 1.90 /00hectares respectively. This identical pattern was also registered in irrigated as well as un-irrigated districts. In irrigated districts the number of tractors was only 0.09/00hectare in 1977. It made a remarkable increase to 2.69/00hectares in 1997. During 1977, all irrigated districts were put in very low category. Ganganagar, Bharatpur, Alwar, Kota, and Jaipur recorded the highest number of tractors in 1977. During 1983, all these districts recorded a very sharp positive growth with more than 25 percent. At the same time, Ganganagar was the only districts that fell in high category while remaining irrigated districts still were in very low category. A major change in the

number of tractors was noticed during 1992 in all the irrigated districts. During this period, Bharatpur, Kota, Jaipur and Alwar shifted from very low to low category

Table 2.12

Percent Change in Number of Tractors in Irrigated Districts 1977, 1983, 1992, 1997

	(Number of Tractor/00hectare)				Growth Rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Ganganagar	0.49	3.09	4.04	9.41	35.92	3.02	18.42	15.92
Bharatpur	0.15	0.71	1.94	5.29	29.58	11.82	22.22	19.50
Alwar	0.11	0.62	1.66	1.56	33.40	11.56	-1.23	14.18
Kota	0.09	0.44	1.97	2.80	30.28	18.12	7.28	18.75
Jaipur	0.07	0.30	1.80	1.18	27.45	22.03	-8.10	15.17
Jalore	0.06	0.84	2.07	9.30	55.25	10.54	35.05	28.68
Bundi	0.02	0.25	0.82	1.02	52.34	14.11	4.46	21.72
Chittor	0.01	0.12	0.43	0.66	51.31	15.24	8.95	23.30
Sawai-madhopur	0.01	0.07	0.42	0.38	38.31	22.03	-1.98	19.95
Udaipur	0.01	0.06	0.33	0.31	34.80	20.85	-1.24	18.73
Bhilwara	0.01	0.05	0.14	0.23	30.77	12.12	10.44	16.97
Sirohi	0.00	0.03	0.10	0.16	-	14.31	9.86	-
Irrigated	0.09	0.55	1.31	2.69	36.22	10.16	15.49	18.80
Rajasthan	0.07	0.40	1.02	1.90	33.71	10.96	13.25	17.95
C.V					151.79	148.03	84.85	122.07

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

The number of tractor in Ganganagar continuously increased from 3.09 /00 hectares in 1983 to 4.04 /00 hectares in1992 and 9.41 /00 hectare in 1997. Therefore, it was always there in a very high category for the entire period. The number of tractors in Jalore has increased from 0.84 00/ hectare in 1983 to 2.07 00/ hectare in 1992 and it classify as medium category. The number of tractor in Sawai-Madhopur, Udaipur, Jaipur and Alwar registered negative growth during 1997. In this period Jalore, Bundi, Bharatpur, and Kota were the only districts which changed their category. In Jalore and Bharatpur the

number of tractors increased from 2.07 /00 hectares and 1.94 hectare in 1992 to 9.30 /00 hectares and 5.29 /00hectare in 1997. Therefore, both of them changed their category from medium and low to very high category. While remaining irrigated districts also followed the same increasing pattern.

Table 2.13

Percent Change in Number of Tractors in Un-Irrigated Districts 1977, 1983, 1992, 1997

	(Number of Tractor /00hectare)				Growth Rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Jodhpur	0.34	1.11	1.67	4.54	21.8	4.64	22.14	13.84
Nagaur	0.13	0.75	1.34	2.56	33.92	6.66	13.82	16.07
Pali	0.08	0.39	0.85	0.65	30.22	9.04	-5.22	11.04
Sikar	0.05	0.16	0.62	0.9	21.39	16.24	7.74	15.55
Ajmer	0.04	0.26	1.27	0.84	36.61	19.27	-7.93	16.44
Barmer	0.01	0.09	0.24	0.65	44.22	11.51	22.05	23.21
Chru	0.01	0.07	0.22	0.59	38.31	13.57	21.81	22.61
Jhalawar	0.01	0.06	1.18	1.43	34.8	39.23	3.92	28.16
Jhunjhunu	0.01	0.05	0.2	0.39	30.77	16.65	14.29	20.1
Tonk	0.01	0.04	0.17	0.4	25.99	17.44	18.66	20.25
Bikaner	0	0.1	0.5	0.95	-	19.58	13.7	-
Jaisalmer	0	0.03	0.79	0.33	-	43.82	-16.02	-
Banswara	0	0.01	0.07	0.1	-	24.14	7.39	-
Dungarpur	0	0	0.18	0.16	-	.	-2.33	-
Un-irrigated	0.05	0.22	0.66	1.04	28.01	12.98	9.52	16.39
C.V					186.21	146.00	79.27	114.57

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1983 over 1977
B. 1992 over 1983
C. 1997 over 1992
D. 1997 over 1977

Table 2.13 shows that the number of tractors in un-irrigated districts was more or less the same as irrigated districts during 1977. The number of tractors was the highest in Jodhpur followed by Nagaur and Pali respectively in all un-irrigated districts. All other districts were placed in very low category in 1977. During 1983 the number of tractors increased significantly in all un-irrigated districts with the exception of Dungarpur. In Dungarpur it

was constant up to 1983. Among all un-irrigated districts, Jodhpur was the only districts which were put to low category during 1983. However, the number of tractors in all remaining districts increased significantly but they still were classified in very low category.

The above description revealed that the number of tractor in agricultural sector is continuing to increase in Rajasthan. However, in some irrigated and un-irrigated districts it declined in 1997 compared to 1992. It may be noted that the gap between the number of tractors in irrigated and un-irrigated districts was quite large.

Table 2.14

Districts Classified by Different Categories of percentage Of Number of Tractor in Different Year Over 1977

	Classes	1977	1983	1992	1997
Very-High	4and above			Ganganagar	. Ganganagar. Bharatpur, Jodhpur
High	3-4		Ganganagar,		
Medium	2-3			Jalore,	Kota, Nagaur,
Low	1-2		Jodhpur,	Kota, Bharatpur Jaipur, Alwar, Jhalawar, Ajmer, Nagaur, Jodhpur,	Bundi, Alwar, Jaipur, Jhalawar,
Very-low	0-1	Barmer, Bikaner, Churu, Jaisalmer, Jaipur Ajmer, Alwar Bharatpur Bhilwara, Bundi Ganganagar Jalore, Jhalawar, Kota Pali, Sawai-Madhopur, Sikar, Sirohi , Tonk, Banswara, Chittor, Dungarpur, Jhunjhunu, Jodhpur, Nagaur, Udaipur.	Bikaner, Churu, Jaisalmer, Dungarpur, Jhunjhunu, Nagaur. Banswara, Bhilwara, Ajmer, Alwar, Barmer, Bharatpur Bundi, Jhalawar, Jaipur, Jalore, Kota, Pali Sawai-Madhopur, Sikar, Sirohi. Tonk, Chittor, Udaipur	Bhilwara, Barmer, Bikaner Churu, Jaisalmer, Pali, Sawai-Madhopur, Tonk. Sikar Udaipur., Chittor, Sirohi, Bundi, Dungarpur, Banswara, Jhunjhunu,	Ajmer, Barmer, Bikaner, Churu, Bhilwara, Chittor, Jalore, Sirohi Jaisalmer, Jhunjhunu, , Pali Sawai-Madhopur, Sikar Banswara, Dungarpur, Tonk Udaipur

SPREAD OF PUMPSETS:-

The invention of pumping sets was an asset to farmer for increasing the efficiency of irrigation which was necessitated by the adoption of modern practices. In the initial phase, like other power equipment, pumping sets were available to large farmers only. This is evident from the facts that there were only 0.37 pumpsets 00/ hectares in Rajasthan during 1977. But in due course of time, it continued to increase from 1977s level.

Table 2.15

Percent Change in Number of Pumpsets in Irrigated Districts 1977, 1983, 1992, 1997

	(Number of pumpsets/00hectare)				Growth Rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Jaipur	2.54	13.43	8.37	33.53	31.99	-5.12	31.99	13.77
Alwar	1.17	14.98	20.91	32.92	52.95	3.78	9.50	18.16
Bharatpur	0.57	4.97	6.88	14.20	43.47	3.68	15.60	17.44
Jalore	0.46	3.39	2.19	6.19	39.50	-4.74	23.10	13.88
Udaipur	0.42	4.08	5.56	11.82	46.07	3.50	16.28	18.16
Chittor	0.26	1.99	2.98	5.18	40.38	4.59	11.69	16.14
Sawai-madhopur	0.15	1.91	3.87	3.52	52.81	8.16	-1.88	17.09
Bhilwara	0.15	1.12	1.46	4.00	39.80	2.99	22.33	17.84
Kota	0.11	0.53	1.50	3.60	29.96	12.25	19.14	19.05
Sirohi	0.08	0.71	2.15	1.57	43.89	13.10	-6.09	16.05
Bundi	0.06	0.82	1.63	4.30	54.62	7.93	21.41	23.81
Ganganagar	0.05	0.31	0.35	1.39	35.54	1.36	31.76	18.09
Irrigated	0.50	4.02	4.82	10.19	41.46	2.04	16.14	16.25
RAJASTHAN	0.37	2.84	5.26	8.04	40.45	7.09	8.86	16.64
C.V					336.62	233.95	224.05	189.97

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1983 over 1977
B. 1992 over 1983
C. 1997 over 1992
D. 1997 over 1977

Table 2.15 shows that the number of pumpsets in irrigated districts was only 0.50 /00 hectares during 1977. The number of pumpsets constantly increased from 4.02 /00hetare in 1983 to 10.19 /00 hectare in 1997 in all irrigated districts. During 1977, the number of pumpsets varied from 0.06 /00

hectares in Bundi to 2.54 /00 hectares in Jaipur. It is well known that no district was classified in very high, high, medium and low category. But in 1983 all irrigated districts were registered a very sharp positive growth about more than 30 percent.

Table 2.16

Percent Change in Number of Pumpsets in Un-Irrigated Districts 1977, 1983, 1992, 1997

	(Number of pumpsets/00hectare)				Growth rate			
Districts	**1977**	**1983**	**1992**	**1997**	**A**	**B**	**C**	**D**
Pali	0.70	5.36	8.62	9.75	40.39	5.42	2.49	14.08
Jhalawar	0.67	4.82	20.32	36.04	38.94	17.34	12.14	22.05
Nagaur	0.49	4.04	15.46	5.76	42.13	16.08	-17.92	13.11
Jodhpur	0.38	1.38	4.96	2.51	23.98	15.27	-12.74	9.90
Sikar	0.30	2.30	5.37	3.24	40.42	9.88	-9.61	12.63
Jhunjhunu	0.29	2.46	5.53	8.16	42.81	9.42	8.09	18.16
Ajmer	0.20	1.39	2.54	4.46	38.14	6.93	11.92	16.79
Barmer	0.15	0.73	1.98	2.82	30.18	11.72	7.33	15.80
Banswara	0.12	1.26	1.53	1.61	47.98	2.18	1.02	13.86
Tonk	0.12	1.14	2.64	6.02	45.53	9.78	17.92	21.62
Dungarpur	0.06	0.70	1.89	4.17	50.60	11.67	17.15	23.62
Chru	0.04	0.08	6.91	1.86	12.25	64.12	-23.09	21.16
Jaisalmer	0.01	0.01	0.03	0.04	0.00	12.98	5.92	7.18
Bikaner	0.01	0.00	1.25	0.31	-	-	-24.34	18.73
Un-irrigated	0.25	1.83	5.65	6.20	39.12	13.31	1.88	17.34
C.V					91.71	96.04	102.66	145.77

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

All irrigated districts registered significant increase during 1983, but only two districts were categorised as low (Jaipur 13.43 /00 hectare) and medium (Alwar 14.98 /00 hectares). The same increasing trend was also witnessed in 1992 with some exception. During this period the number of pumpsets recorded negative growth in Jaipur and Jalore from 13.43/00

hectares in 1983 to 8.37/00 hectares in 1992 hectares and 3.39/00 hectares in 1983 to 2.19/00 hectares in 1992 respectively. Alwar is the only district which was classified in high category during 1992, while remaining districts were still classified as very low category. The number of pumpsets increased from 14.98 /00 hectares in 1983 to 20.91 00/hectares in 1992. It is evident that in 1997 sharp changes were witnessed in Alwar, Jaipur, Bharatpur, and Udaipur. Among these districts Alwar, and Jaipur were classified in very high category and Bharatpur and Udaipur were classified in low category.

Thus, it can be inferred that number of pumpsets are comparatively less in those districts where the canal irrigation is prime mode of irrigation. For instance in Ganganagar, Bharatpur, Kota and Sawai-Madhopur the area under canal irrigation is very high as a result of this the number of pump sets in these districts was less compared to other districts.

Table 2.16 shows that the number of pumpsets in un-irrigated districts was just half of the irrigated districts in 1977 (0.25 /00 hectares). The number of pumpsets in all un-irrigated increased at very sharp rate but none of them shifted from very low category till 1983. The important changes took place in 1992 and 1997. In 1992, the number of pumpsets was the highest in Jhalawar (20.32 /00 hectare) followed by Nagaur 15.46/00 hectares and Pali 8.62/00 hectares and were placed in high, medium and low category respectively. Similar increasing trend was also witnessed during 1997 with some exception. During this period the number of pump sets registered negative growth in Nagaur, Jodhpur, Sikar, Churu and Bikaner. In Jhalawar the number of pumpsets increased from 20.32 /00 hectares in 1992 to 36.04 /00hectare in 1997 and it was placed in very high category.

Table 2.17

Districts Classified by Different Categories of percentage Of Number of Pumpsets in Different Year Over 1977

	Classes	1977	1983	1992	1997
Very-High	28 and above				Alwar, Jaipur, Jhalawar
High	21-28				
Medium	14-21		Alwar, Jaipur	Alwar, Jhalawar Nagaur,	Bharatpur,
low	7-14	,			Udaipur Jodhpur,
Very-low	0-7	Barmer, Ajmer, Alwar Bharatpur Bhilwara, Bundi Ganganagar Jalore, Jhalawar, Kota Pali, Sawai-Madhopur, Sikar, Sirohi , Tonk, Bikaner, Churu, Jaisalmer,. Jaipur Jhunjhunu, Jodhpur, Nagaur, Udaipur. Banswara, Chittor, Dungarpur	Dungarpur, Ajmer, , Udaipur Barmer, Bharatpur Bundi, Banswara, Bhilwara, Chittor Ganganagar, Jhalawar, ,Jalore, Kota, Pali Sawai-Madhopur, Sikar, Sirohi. Tonk, Bikaner, Churu, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur.	Ajmer, Bhilwara, Barmer, Bikaner Churu, Ganganagar Jaisalmer, Jalore, Jodhpur, Kota, Pali, Sawai-Madhopur, Tonk. Banswara, Udaipur. Jaipur, Bundi, Dungarpur, Jhunjhunu, Sikar Bharatpur, Chittor, Sirohi,	Ajmer, Barmer, Banswara, Dungarpur, Tonk Bikaner, Churu, Ganganagar. Jaisalmer, Jhunjhunu, Pali Nagaur, Sawai-Madhopur, Sikar Bhilwara, Bundi, Chittor, Jalore, Kota, Sirohi

CONCLUSION:-

Agricultural technology in Rajasthan had not spread at a uniform rate over the time and space. Districts characterized by low adoption level in the initial phase recorded higher rate of spread (expressed in terms of percentage increase over the base year) in order to attain the adoption level of their neighbourhood. This phenomenon is a typical example of spatial spread.

It has been noted that the percentage increase in gross irrigated area increased in northern and north western districts of the state where the base was strong while in the western districts it was comparatively low. The consumption of fertilizer recorded higher rate of increase in those districts which were provide with irrigation facilities. The pattern of area under high yielding varieties of crop revealed that these varieties were not so popular in the early year especially in un-irrigated districts which is indicate by low rate of percentage increase in these year. But with the passage of time, the area under HYV seeds recorded very high rate of increase. The same pattern was also witnessed in the context of tractor.

CHAPTER

3 CHANGES IN CROPPING PATTERN

Chapter-3

CHANGES IN CROPPING PATTERN

Cropping patterns are determined in large measure by agro-climatic factors: such as temperature, and rainfall distribution, i.e., the physical conditions of region. When crops suited to any given conditions are grown, the resultant can be considered as the traditional cropping pattern of a region. Generally, agro-climatic factors are fairly stable over time, while demographic, social and economic factors are less so, particularly in the present context of rapid induced changes. Thus, while agro-climatic factors determine the condition under which crop are grown, farmers are increasingly inclined to change cropping pattern in response to change in economics factors (input and out put price), institutional factors (market and infrastructure, and access to credit), technological factors (improved seeds and irrigation) and policy-induced factors (fertilizer, irrigation, subsidy and procurement prices etc.)[1].

Rajasthan has climatically been characterised by low and erratic rainfall, high temperature, and high wind velocity. In such types of climatic conditions, only coarse cereal-based cropping pattern has predominantly been found in the State. Although in the course of time, the expansion of irrigation facilities has brought some change in the cropping pattern. In general, cropping pattern has shifted from coarse cereal to wheat and oil seed based cropping pattern in the State. Similarly, at district level most of the districts, which were earlier engaged in the production of coarse cereal crops, have changed to fine cereal. However irrigation is the major determinant of cropping pattern as well as agricultural productivity, but we can never neglect the importance of rainfall as a determinant, because in Rajasthan

[1]Ashok Gulati and Tim Kelley, *Trade Liberation and Indian Agriculture: Cropping pattern Changes and Efficiency Gain in Semi-Arid Tropics*, New Delhi: Oxford University Press, 1999, pp. 16.

seasonal rainfall plays a very crucial influences on cropping pattern and agricultural productivity. Eleven districts of western Rajasthan which cover about 61 percent of geographical area of the state, are completely dependent on rainfall except in Ganganagar, irrigation facilities have been developed.

The gross cropped area and its growth has been shown in Table 3.1 and it shows that, at state level the GCA[2] has registered an increase from 6.36 lakhs hectare to in 1970-73 16.89 lakhs hectare during 2000-03.. On the other hand, when we consider the area under 14 major crops and their growth rate it shows a completely different picture from the growth of GCA.

Table 3.1
Growth of Agricultural Sector in Rajasthan
During 1970-73 to 2000-03

(Area in hectare)

	1970-73	1980-83	1990-93	2000-03	A	B	C	D
Gross cropped area and its growth rate	635893.9	690271.8	877318.7	1688980	.82	2.43	6.77	2.47
Area under 14 major crops	569148.2	554350	596364	515816.7	-.26	.73	-1.44	-.25
Gross irrigated area and its growth rate	97162.47	145314.5	195025.9	562939	4.11	2.99	11.18	4.49
Net shown area and its growth rate	418088.9	457387.4	443794.5	401891.4	.90	-.30	-.99	-.10
Net irrigated area and its growth rate	84377.31	116173.8	148146.2	188701.2	3.25	2.46	2.45	2.03

Source:-
- Directorate of Economics & Statistics, Rajasthan, various issues

Growth rate-
A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

Although the GCA registered a notable increment during whole period to 2.47 percent but on the contrary substantial decline had registered in area under 14 major crops. During 80s, it registered a growth rate of -0.26 percent but when we consider in real terms it decreased from 5.69 lakhs hectare to 5.54 lakhs hectare. In spite of this, a significant increment in area under 14 major crops was noticed during 1990-93 from 5.54 lakhs hectare in 1980-83 to 5.96 lakhs hectare in 1990-93. Again, it shows a sharp decline in area from 5.96 lakhs in 1990-93 hectare to 5.15 lakhs hectares in 2000-03.

[2] GCA- Gross Cropped Area

However, the gross irrigated area increased from 97.1 thousand hectare in 1970-73 to 5.6 lakhs hectare in 200-03. But the growth rate of gross irrigated area has increased from a mere 4.11 in 80s over 70s to a high level of 11.69 in 2000-03 over 90s. In the same way, gross irrigated area registered a sharp increase from 1.95 lakhs hectare in 1990-93 to 5.62 lakhs hectare during 2000-03. On the contrary the growth of net area has presented a totally contrast picture. The net area is comparatively constant during whole period, even though a significant increment have been noticed during 1980-83; then again, it continuously declined from 4.57 lakhs hectares in 1980-83 to 4.43 lakhs hectares in1990-93 and 4.01 lakhs hectares respectively. But the net irrigated area has been following relatively the same trend of gross irrigated area. However, gross irrigated area had declined in earlier period but the growth rate of net irrigated area has continuously increased up to 1990-93, and then it has declined. Therefore the above analysis reveals that, the irrigation facilities are more important then rainfall when we consider the growth of area as a parameter. Whenever growth of irrigation was too high in the state, the area under major crops had also increased. So far the matter of cropping pattern is considered, it completely depends on both the determinants (rainfall as well as irrigation).

CHANGES IN CROPPING PATTERN OF RAJASTHAN:-

Table 3.2 shows the cropping pattern of Rajasthan and reveals that food-grain claimed the highest area 75.89 percent of GCA during 1970-73 albeit a minor decline was noticed during 1980-83 and still claimed 72.91 percent area of GCA so there was hardly any diversification away from food-grains. During 90s and 2000, a sharp decline in area under food-grain had registered to 63.08 percent and 57.69 percent correspondingly.

Table 3.2

Cropping Pattern in Rajasthan, 1970-73, 1980-83, 1990-93, 2000-03

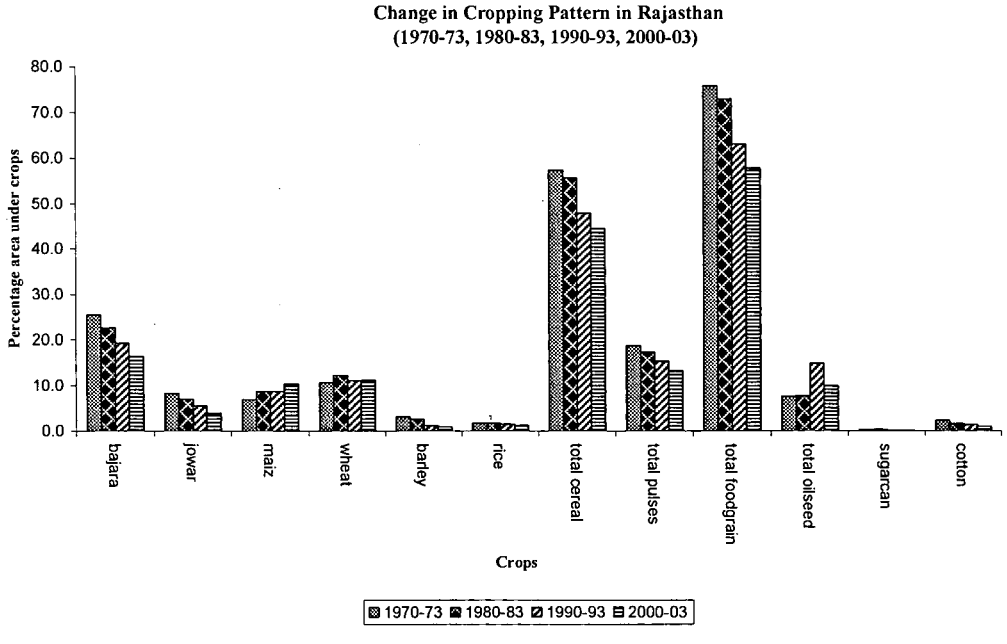
(Area in % hectare)

Years	1970-73	1980-83	1990-93	2000-03
Bajara	25.46	22.71	19.22	16.40
Jowar	8.28	6.97	5.57	3.96
Maize	6.94	8.68	8.66	10.39
Barley	3.13	2.56	1.29	0.93
Wheat	10.60	12.18	11.08	11.16
Rice	1.75	1.80	1.53	1.31
Total Cereals	57.26	55.62	47.82	44.46
Total Pulses	18.63	17.29	15.26	13.23
Total food-grain	75.89	72.91	63.08	57.69
Total Oilseed	7.60	7.68	14.89	9.94
Sugarcane	0.27	0.31	0.18	0.09
Cotton	2.24	1.62	1.44	0.94

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues

Figure 3.1



It is well known that Rajasthan's climatic condition is too arid so in these types of climatic condition coarse cereals have dominated the cropping pattern. Within total cereals Bajara accounted for the highest percentage of area claiming 25.46 percent of GCA during 1970-73 but later on it declined to 22.71 percent during 1980-83, 19.22 percent during 1990-93 and 16.40 percent during 2000-03. The area under Jowar and Barley follows the trends of Bajara and it has constantly declined. At the same time, the maize registered a notable increment in area from 6.94 percent to 8.68 percent during 1980-83 there after it was relatively constant in 80s and 90s. Further, it increased from 8.66 percent to 10.39 percent during 2000-03. The area under wheat registered a phenomenal increase during 1980-83, but in the later period it was constant. Rice did not register any significant change during the whole period and it remained almost constant in the entire period. The important cropping pattern changes took place in area under pulses, however, during 70s and 80s it was relatively constant but in 1990-93 it shows a swift change from 7.68 percent to 14.89 percent beside in 2000-03 it decreased to 9.94 percent. The area under sugarcane is not significant in Rajasthan while the area under Cotton has constantly declined.

Changes in Cropping Pattern in Irrigated District:-

The irrigation and rainfall have played a crucial role in the cropping pattern not only at state level but also at the district level. During 1970s, the percentage of gross irrigated area to gross cropped area was only 16.3 percent but in course of time, it increased tremendously and reckoned 21.8 percent, 27.9 percent, and 31.8 percent respectively during 80s, 90s, and 2000. Although at district level, wide fluctuations in percentage of gross irrigated area were see during the entire period of study. The spatial variations in the form of irrigation can be seeing from 45.7 percent in Ganganagar to 0.0 percent in Churu during 70s. Over the period of time this variation has increased and reached up to 51.2 percent in Ganganagar to 1.5 percent in

Churu in 2000. The annual rainfall fluctuates as of 62.19 cm in 90s to 39.85 cm in 2000 while the average rainfall is 57.54 cm in Rajasthan[3].

Table 3.3

Changes in Cropping Pattern in Irrigated Districts As the Aggregates level in Rajasthan 1970-73, 1980-83, 1990-93, 2000-03.

(Area in % hectare)

Crops/Period	1970-73	1980-83	1990-93	2000-03
Bajara	16	15.3	12.8	12.1
Jowar	9.3	7.2	4.7	3
Maize	7.1	11.3	11.1	13.1
Barley	4.4	3.3	1.8	1.2
Wheat	16.4	17.3	16.1	16.2
Rice	1	1.1	0.8	1.1
Total Cereal	55.1	56.3	47.6	47
Total Pulses	18.8	16.3	12.9	9.7
Total Food-grain	73.9	72.7	60.5	56.7
Total Oilseed	10.5	10.9	22.9	14.8
Sugarcane	0.5	0.6	0.3	0.2
Cotton	2.4	2.1	2.4	1.5

Source:-

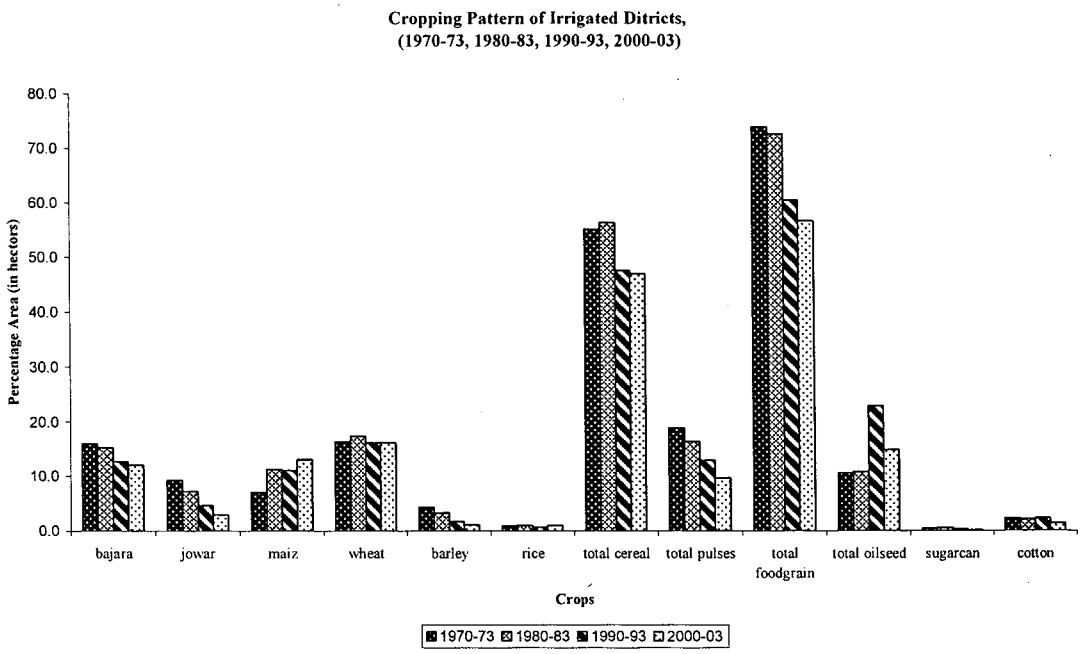
- Directorate of Economics & Statistics, Rajasthan, various issues

The cropping pattern of irrigated districts has been shown in Table 3.3. The irrigated districts are Alwar, Bharatpur, Bhilwara, Bundi, Chittor, Ganganagar, Jaipur, Jalore, Kota, Sawai-Madhopur, Sirohi, and Udaipur. The percentage of irrigated area of these districts was higher than state average (Table 3.4). Table 3.3 reveals the changes of cropping pattern in irrigated districts and it shows that during 70s, food-grains were the major crops in the irrigated districts and it accounted for 73.9 percent area of GCA even though in 80s food-grains still claimed 72.7 percent of GCA. Consequently, there was hardly any diversification away from food-grains. Nevertheless, the discernible change in the course food-grains has occurred during 90s and 2000. During these two periods, the area under food-grains decreased from 60.5 percent to 56.7 percent whereas within food-grains irrigated crops like

[3] Annexure 1

wheat is the dominated crop in this set. However certain significant changes took place among coarse cereals.

Figure 3.2



The area under Bajara recorded a slight decline during 70s and 80s (16.0 percent to 15.3 percent) however, notable decline had been registered during 90s. Again in 90s and 2000 it has registered a significant growth. A substantial reduction was recorded in area under Jowar during the whole period. In 70s it accounted for 9.3 percent of GCA later, it started declining (7.2 percent in 80s) (4.2 percent in 90) and (3.0 percent in 2000). Maize presented a dramatically opposite picture from the coarse cereals and it has registered a significant increase during 80s and 2000. In 70s it accounted for 7.1 percent of GCA but in 80s it increased to 11.3 percent and in 2000 13.1 percent. Although Barley has also follow, the same trend of Jowar and it has continually declined.

The areas under Wheat, Rice, Sugarcane, and cotton have been more or less constant during the whole period. However, a slight increment has been register in Wheat during 80s and a slight reduction noted in Cotton during 2000. The area under oilseeds has shown some remarkable changes in the cropping pattern, even though up to 80s it did not show any change in area under the crops. In 90s it increased significantly from 10.9 percent in 1980-83 to 22.9 percent in 2000-03 while, during 2000 it declined to 14.8 percent. Therefore, the above analysis reveals that whenever the irrigated districts have experienced sufficient rainfall, the area under coarse cereals declined drastically. For example in 1990-93, irrigated districts had measured good rainfall subsequently the area under Bajara, Jowar, and Barley declined at significant rate[4]. Similarly, irrigation helps the area under irrigated crops like Rabi oilseeds and Wheat; however 2000-03 was mention as a drought year but this drought could not produce any phenomenal impact on irrigated crops like Wheat and Rice.

CHANGES IN CROPPING PATTERN IN UN-IRRIGATED DISTRICTS:-

Table 3.4 and Figure 3.3 presenting cropping pattern and their changes in un-irrigated districts. The un-irrigated districts comprise fourteen districts and their irrigated area is lower than the state average[5]. Table 3.4 also shows that among food-grain Bajara was major crop in whole period. The cropping pattern in these districts shows some special changes in cereal crops; however the area under pulses showed a slight decline. It was constant in 70s and 80s but a minor decline was recorded during 90s and 2000 from 18.1 percent to 17.3 percent and 16.3 percent respectively. The area under total cereals constantly declined as a result of the reduced area under Bajara, jowar and barley.

[4] Annexure

[5] Those districts, which irrigated area, have less then 24.4 percent.

Table 3.4

Changes in Cropping Pattern in Un-Irrigated Districts At Aggregate Level in Rajasthan 1970-73, 1980-83, 1990-93, 2000-03

Area in % hectare

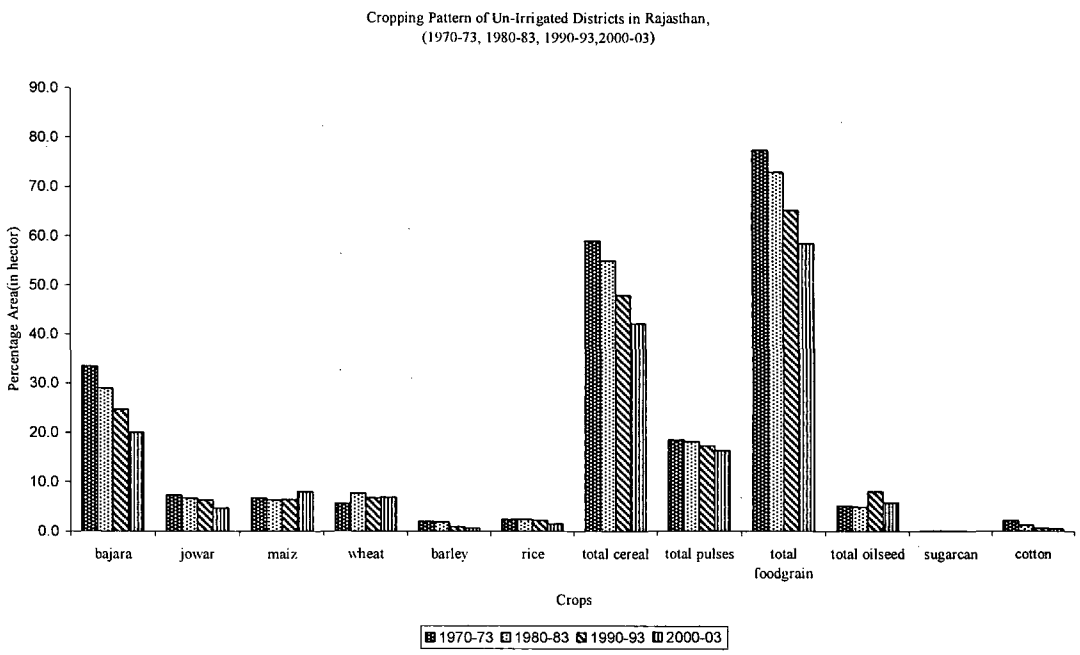
Crops/Period	1970-73	1980-83	1990-93	2000-03
Bajara	33.6	29	24.8	20.1
Jowar	7.4	6.7	6.4	4.7
Maize	6.8	6.4	6.5	8
Barley	2.1	1.9	0.9	0.7
Wheat	5.6	7.8	6.7	6.9
Rice	2.4	2.4	2.2	1.5
Total Cereals	59.1	55	48	42.2
Total Pulses	18.5	18.1	17.3	16.3
Total Food-grain	77.6	73.1	65.3	58.5
Total Oilseed	5.1	5	8	5.8
Sugarcane	0.1	0.1	0.1	0
Cotton	2.1	1.2	0.7	0.5

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues

Area under Bajara accounted for 33.6 percent of GCA in 70s but during 80s, 90s, and 2000 it declined to 29, 24.8 and 20.1 percent respectively. The area under jowar was somewhat constant up to 90s but in 2000, it showed a sharp decline from 6.4 percent to 4.7 percent. Among coarse cereals, Maize was the only crop, which showed some increment in area. Up to 90s however, it was constant but in 2000 it had increased from 6.5 in1990-93 percent to 8.0 percent 2000-03. Similarly, the area under wheat increased from 5.6 percent in 1970-73 to 7.8 percent in1980-83 while in later period it declined to 6.7 percent. Area under Rice was constant up to 90s but later it declined. The area under cotton registered a notable decline from 2.1 percent in 1970-73 to 0.5 percent in 2000-03. On the other hand, the area under oilseed showed a fluctuating trend, it remain constant till 80s but in 90s it registered a sharp increment from 5 percent to 8 percent but afterward it declined to 5.8 percent.

Figure 3.3



Thus the above analysis for un-irrigated districts presents a totally different picture from that irrigated districts, though Bajara was the dominant crop in both of them. In contrast, the area under irrigated crop like Wheat has covered less area in un-irrigated districts as compare to irrigated districts.

Changes in Area Under Bajara:-

Bajara is mainly a kharif and un-irrigated crop. It is also a hardy and drought resistant crop because it needs comparatively less water for its cultivation. It was dominant crop not only at state level but as well as at district level and it accounted for 25.5 percent of GCA during 70s after which it declined constantly. Table 3.5 and Figure 3.4 reveal that there was wide variation in area among the districts under Bajara. Jaisalmer, Barmer, Jodhpur, and Jalore accounted for the highest area from 55.8 percent to 77.6 percent in 1970-73. In course of time, all these districts showed a significant decline in area under Bajara. Jaisalmer and Jodhpur registered a notable

decline during 90s at the rate of -10.3 percent and -4.9 percent respectively, while in Barmer it decreased at constant rate of 1 percent during the whole period.

Table 3.5

Percentage Change and Growth Rate of Area under Bajara 1970-73, 198083, 1990-93, 2000-03

(Area in percent) Growth rate

Districts	1970-73	1980-83	1990-93	2000-03	A	B	C	D
JAISALMER	77.6	64.6	45.0	15.1	-1.8	-3.6	-10.3	-4.0
BARMER	74.2	67.6	56.2	50.9	-0.9	-1.8	-1.0	-0.9
JODHPUR	56.0	50.4	50.7	30.8	-1.1	0.1	-4.9	-1.5
JALORE	55.8	61.0	40.7	44.1	0.9	-4.0	0.8	-0.6
SIKAR	45.5	40.9	43.1	36.2	-1.1	0.5	-1.7	-0.6
NAGAUR	45.4	42.4	10.2	26.9	-0.7	-13.3	10.2	-1.3
JHUNJHUNU	44.8	44.5	44.0	38.0	-0.1	-0.1	-1.5	-0.4
BIKANER	38.5	26.3	23.3	10.3	-3.7	-1.2	-7.8	-3.2
CHURU	35.8	31.3	29.4	35.1	-1.3	-0.6	1.8	-0.1
JAIPUR	30.2	27.2	29.3	27.2	-1.0	0.8	-0.7	-0.3
PALI	27.5	18.2	19.8	14.5	-4.0	0.9	-3.1	-1.6
SIROHI	25.0	11.0	13.2	11.1	-7.9	1.8	-1.7	-2.0
ALWAR	24.8	26.5	23.7	22.4	0.7	-1.1	-0.6	-0.3
SAWAI-MADHOPUR	23.4	24.1	22.3	16.6	0.3	-0.8	-2.9	-0.9
BHARATPUR	21.5	28.7	19.4	18.9	2.9	-3.8	-0.3	-0.3
AJMER	14.1	11.4	16.7	14.4	-2.1	3.9	-1.5	0.1
GANGANAGAR	10.3	4.3	3.4	4.3	-8.4	-2.3	2.4	-2.2
TONK	8.6	7.6	7.8	8.4	-1.2	0.3	0.7	-0.1
RAJASTHAN	25.5	22.7	19.2	16.4	-1.2	-1.7	-1.6	-1.1
C.V[6]					93.4	97.3	95.0	94.7

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate-

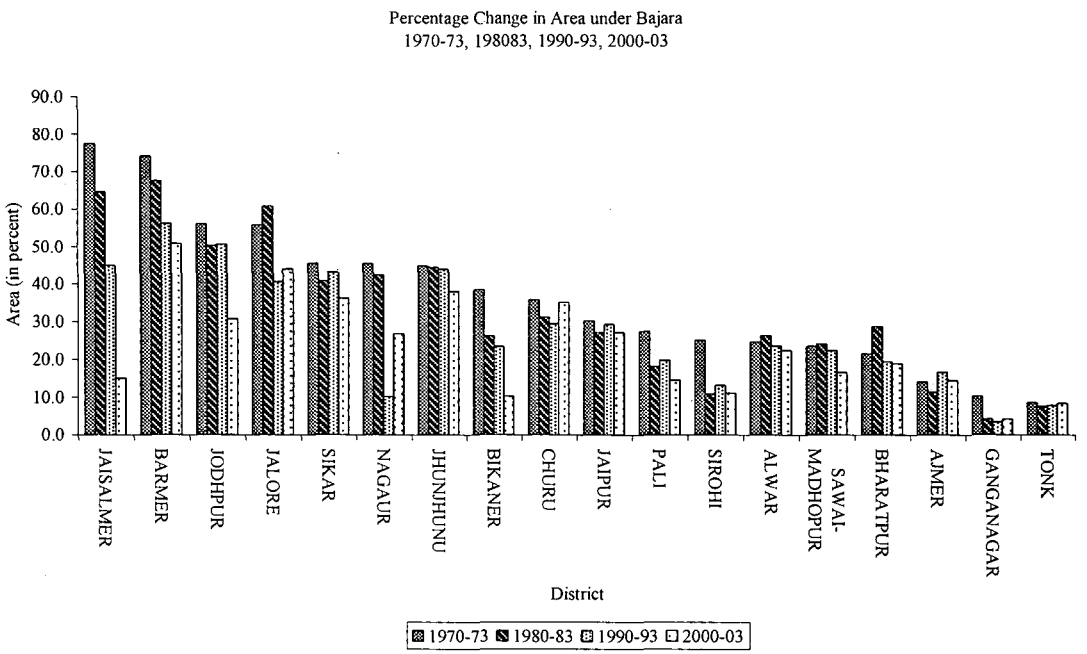
A. 1980-83 over 1970-73
B. 1990-93 over 1980-83
C. 2000-03 over 1990-93
D. 2000-03 over 1970-73

Jalore showed an opposite trend as it registered increment in area in 90s at the rate of 0.9 percent and 2000 from 0.8 percent but in the whole period, it decreased to -0.6 percent. All these districts have been mentioned as

[6] Coefficient of variation

un-irrigated districts except Jalore as irrigation has created a negative significant impact on area under Bajara. When the gross irrigated area increased, the area under Bajara was declined consequently. On the other hand, rainfall and the area under Bajara have also negatively correlated. Whenever rainfall was deficient the area under Bajara had increased, and visa-versa.

Figure 3.4



Similarly, Sikar, Nagaur, Jhunjhunu, Bikaner and Churu districts accounted for 35.5 percent to 45.5 percent in 1970-73. They are also known as un-irrigated districts. The figure 3.4 displays that the area under Bajara in these districts has continuously declined. However, Nagaur and Churu registered notable decline up to 90s but in 2000, it registered significant increment in area under crop. In contrast, the area under Bajara in Sikar, and Bikaner, also continuously declined, while it was constant in Jhunjunu up to 90s and afterwards it showed declining trend. Nagaur registered a sharp decline during 90s while Bikaner in 80s and 2000. The table and figure also

show that, Jaipur, Pali, Sirohi, Alwar, Sawai-Madhopur, and Bharatpur recorded area under Bajara for 30.2 percent to 21.5 percent during 1970-73. The area under Bajara does not show any remarkable change in Jaipur, Alwar, Sawai-Madhopur for the whole period while Pali and Sirohi registered a notable decline in area during 80s, after that they had did not show any change. Bharatpur is only district that shows remarkable increment in area during 80s otherwise it follows the same declining trend in later period. The area under Bajara in Ajmer, Ganganagar, and Tonk were claimed area from 8.6 percent to 14.1 percent during 70s. Ajmer and Tonk are more or less constant while Ganganagar shows a sharp decline in area for the whole period. The area under Bajara in Jahalawar, Dungarpur, Bhilwara, Kota, Bundi, Udaipur, Chittor, and Banswara, had not so remarkable. In these districts, it is less then 1 percent during the study period. It also did not show any significant change during the whole period. Thus, we never consider area under Bajara in these particular districts.

Therefore, the above analysis reveals that the area under Bajara continually declined. The gross irrigated area and rainfall are negatively associated with area under Bajara. When the GIA and rainfall have increased, the area under Bajara has decreased. The reduction of area under Bajara was compensated by growth of Barley, Pulses and Oilseed. These are the most gaining crop among these districts.

CHANGES IN AREA UNDER JOWAR:-

Jowar is a kharif and un-irrigated crop, and it has been used both as foods as well as fodder crop. It requires less moisture as compared to Bajara. It is largely concentrated in Jalore, Kota, Ajmer, and Sirohi, districts. Among these districts, the area under Jowar varies from 36.5 percent to 18.9 percent in 1970-73. Table 3.6 shows that the area under Jowar in these districts has

continually declined during the period of 1970-73 to 2000-03. Similarly, a significant decline have recorded in Jalore, Kota, Bundi and Tonk during 90s and 2000, while the area under Bajara witnessed an increasing trend in Ajmer and Sirohi during 80s and thereafter the area declined gradually in Sirohi. In Ajmer it remains more or less constant. Therefore the area under Jowar (coarse cereal) among these districts was negatively correlated with rainfall.

Table 3.6

Percentage Change and Growth Rate of Area under Jowar 1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
JALORE	36.5	22.1	18.1	2.4	-4.9	-2.0	-18.3	-6.6
KOTA	28.5	25.8	11.8	2.9	-1.0	-7.5	-13.1	-5.6
AJMER	25.1	27.3	26.2	26.8	0.8	-0.4	0.2	0.2
BUNDI	19.7	14.6	8.9	1.4	-3.0	-4.8	-16.9	-6.4
TONK	19.5	3.3	4.2	4.7	-16.3	2.4	1.1	-3.5
SIROHI	18.9	27.7	23.4	14.7	3.9	-1.7	-4.5	-0.6
CHITTOR	12.3	9.7	5.7	2.9	-2.4	-5.2	-6.5	-3.6
PALI	10.5	8.5	13.7	15.8	-2.1	4.9	1.4	1.0
UDAIPUR	8.3	7.0	5.6	4.0	-1.7	-2.2	-3.3	-1.8
BHILWARA	7.8	8.5	7.4	8.3	0.9	-1.4	1.2	0.2
NAGAUR	6.4	4.0	0.8	3.5	-4.6	-14.9	15.9	-1.5
BHARATPUR	4.9	3.8	3.5	4.5	-2.5	-0.8	2.5	-0.2
JAHALAWAR	3.9	3.7	3.0	2.8	-0.5	-2.1	-0.7	-0.8
ALWAR	3.3	2.4	2.5	3.5	-3.1	0.4	3.4	0.2
SIKAR	2.3	2.7	2.3	3.0	1.6	-1.6	2.7	0.7
BANSWARA	1.8	2.4	1.4	0.3	2.9	-5.3	-14.3	-4.4
JODHPUR	1.7	0.7	1.7	1.9	-8.5	9.3	1.1	0.3
JAIPUR	1.2	1.0	1.1	0.3	-1.8	1.0	-12.2	-3.4
RAJASTHAN	8.9	12.1	6.3	2.0	3.1	-6.3	-10.8	-3.7
COFFICIENT OF VIRATION					124.0	134.0	132.4	153.4

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issue

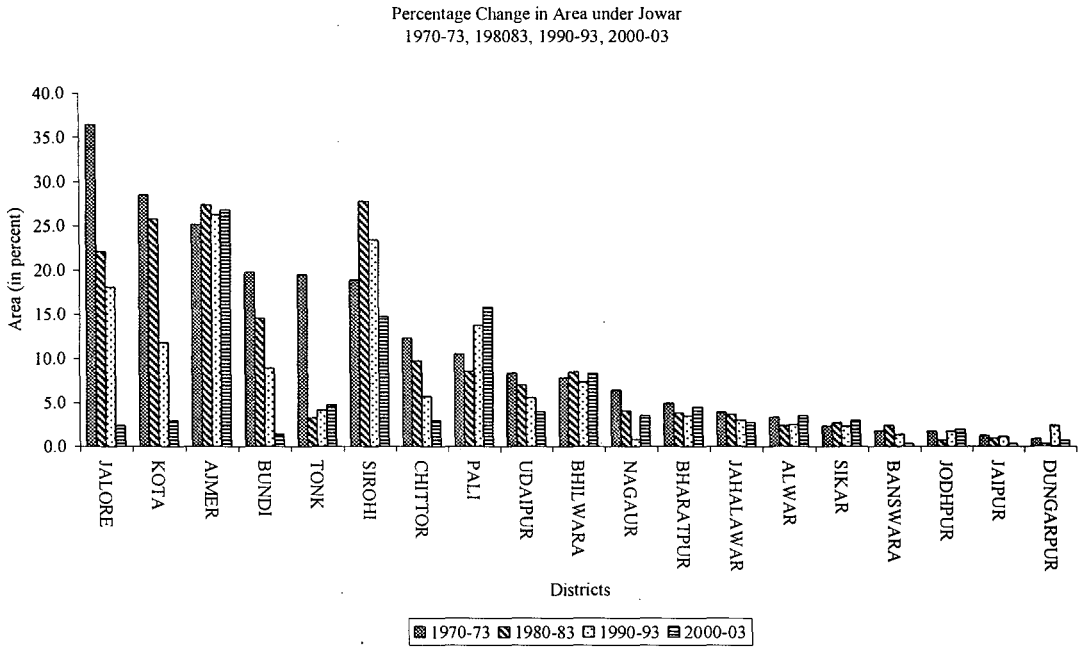
Growth rate-

A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

Tables also show that area under Jowar in Chittor, Pali, Udaipur, Bhilwara and Nagaur varied from 12.3 percent to 7.8 percent during 70s.

However, Chittor and Udaipur registered a notable decline through out the whole period, but Pali registered a steep increase during 90s and 2000. Bhilwara did not show any remarkable change in area under Jowar while in Nagaur, it has decreased up to 90s but in later period, it increased.

Figure 3.5



Rainfall and area under Jowar are positively correlated because during 70s and 90s all these districts measured good rainfall so this thing helped the area under Jowar. But in Pali both rainfall and irrigation facilities creates a cumulative impact on Jowar. During 80s rainfall was deficient in the district so the area under Jowar also decreased. In 90s, sufficient rainfall as occurred 66.23 cm; as a result, the area under Jowar increased from 8.5 percent to 13.7 percent; while in 2000 rainfall was deficient (36.4 cm) but irrigation mitigates the rainfall impact[7]. Area under Jowar in Bharatpur, Jhalawar, Alwar, Sikar, Banswara, Jodhpur, and Jaipur varied from 1.2 percent to 4.9 percent during 70s. Bharatpur, Jhalawar, Alwar, and Jodhpur recorded less variation in area under Jowar while, Banswara and Jaipur registered a notable decline in area

[7] Appendix-2

under crop. In contrast, Sikar is the only district that showed some increase in area of Jowar. The area under Jowar was not significant in Dungarpur, Jaisalmer, Barmer, Bikaner Jhunjhunu, and Churu. Because these district the monsoonal rainfall and irrigation facilities was very low. But in Ganganagar and Sawai-Madhopur it was competed by other Kharif crops. As a result, irrigated districts namely Ganganagar and Sawai-Madhopur engage with more irrigated crops like kharif pulses and oilseeds. Moreover, the area of un-irrigated districts has devoted to more drought resistant crop like Bajara during kharif season.

CHANGES IN AREA UNDER MAIZE:-

Maize has been predominantly sows in southern districts of Rajasthan, such as Dungarpur, Bhilwara, Banswara, and Chittor. Among these districts, the area under maize varied from 34.0 percent to 21.9 percent during 70s. Maize is a kharif crop and it sown as summer monsoon crop and needs higher moisture as compared to Bajara and jowar. Therefore, it grows in southern part of the state because this part gets higher rainfall. Dungarpur recorded the highest area among all the districts, 34.0 percent during 70s later marginally declined up to 90s but in 2000, it registered a sharp increase. Figure 3.6 reveals that Bhilwara, Banswara, and Chittor recorded area from 30.4 percent to 21.9 percent in 1970-73. Over time all these district registered increase in area under Mize.

The Table 3.7 and Figure 3.6 also show that area under maize in Ajmer has continually declined even though during 2000 it noted slight increase. On the other hand, in Jalore it recorded comparatively less variation and a sharp increase was registered during 90s while, it increases significantly in Sikar during the entire period. Bundi, Udaipur, Tonk, Sirohi, Pali, Kota, Jhalawar, and Alwar registered area from 1.8 percent to 8.7 percent in1970-73. Some

important changes took place with in this set of districts. The major change was noticed in Tonk district. In this district the area under jowar increased tremendously. In 70s, it had recorded only 5.6 percent area under Maize but during 80s, 90s and 2000 it record growth of 21.9 percent, 1.0 percent and 3.2 percent gradually.

Table 3.7

Percentage Change and Growth Rate of Area under Maize 1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
DUNGARPUR	34.0	30.5	28.3	46.8	-1.1	-0.8	5.2	0.8
BHILWARA	30.4	32.6	31.6	35.6	0.7	-0.3	1.2	0.4
BANSWARA	29.2	29.7	32.1	40.2	0.2	0.8	2.3	0.8
CHITTOR	21.9	22.4	23.5	29.5	0.2	0.5	2.3	0.8
AJMER	11.6	8.5	6.6	8.1	-3.1	-2.5	2.1	-0.9
JALORE	10.5	9.7	16.3	10.5	-0.8	5.3	-4.3	0.0
SIKAR	10.4	14.8	13.0	15.2	3.6	-1.3	1.6	1.0
BUNDI	8.7	11.5	12.4	9.1	2.8	0.8	-3.1	0.1
UDAIPUR	6.9	8.7	8.7	10.4	2.4	0.0	1.8	1.0
TONK	5.6	40.5	44.5	61.0	21.9	1.0	3.2	6.2
SIROHI	5.1	4.9	3.9	3.2	-0.4	-2.3	-2.0	-1.2
PALI	4.6	6.2	4.2	3.8	3.0	-3.8	-1.0	-0.5
KOTA	2.9	4.9	5.2	4.6	5.4	0.6	-1.2	1.2
JAHALAWAR	2.8	2.4	1.4	0.8	-1.5	-5.3	-5.4	-3.1
ALWAR	1.8	1.8	1.8	1.4	0.0	0.0	-2.5	-0.6
RAJASTHAN	0.7	0.7	0.4	0.3	0.0	-5.4	-2.8	-2.1
C.V.					143.3	134.0	141.5	158.5

Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issue

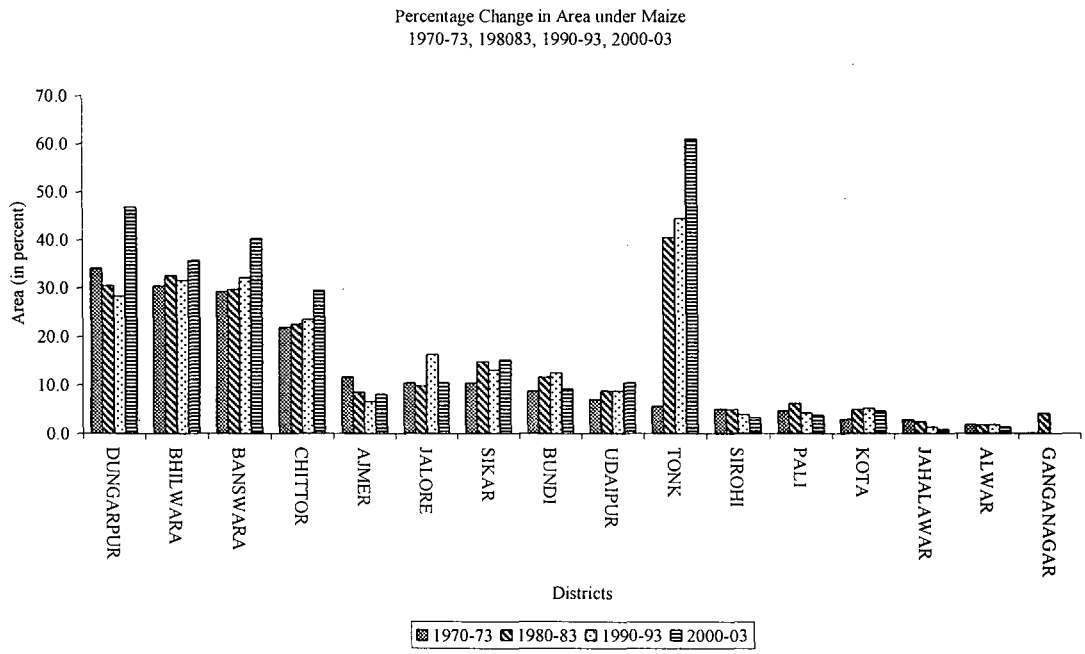
Growth rate-

A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

The area under Maize in Sirohi, Pali, Jhalawar, and Alwar has recorded a phenomenal decline for the entire period; however, some minor positive growth was registered in Pali during 80s. In contrast, the area under Maize in Kota and Ganganagar registered notable increase during the whole period. While in Ganganagar the area under Maize has record a significant increase

from 0.1 percent in 1970-73 to 4.21 in 1980-80. Even though afterward it was not so significant. In the same way, the remaining districts namely Nagaur, Bharatpur, Sawai-Madhopur, Jaisalmer, Jodhpur, Jhunjhunu, Barmer, Bikaner, Churu and Jaipur did not registered considerable area under Maize during the whole period. These districts basically, receive either very low rainfall or have a sound irrigation system. For example, Jaisalmer, having very low rainfall and Bharatpur has very sound irrigation system. Thus, they intend to either more irrigated crop or drought resistant crop.

Figure 3.6



Therefore the present analysis found that the increment in irrigation facilities has helped the area under maize. For instance, 2000-03 was a drought year but most of the districts registered an increment in area under maize because of the growth of irrigation facilities.

CHANGES IN AREA UNDER BARLEY:-

Barley is Rabi crop in India and it needs low temperature (i.e. winter season), higher soil and lower soil moisture. It has grown as both irrigated as well as un-irrigated crop in the state.

Table 3.8

Percentage Change and Growth Rate of Area under Barley 1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
JAHALAWAR	10.5	7.4	4.6	4.9	-3.4	-4.6	0.6	-1.9
BHILWARA	9.3	6.3	4.3	1.7	-3.8	-3.8	-8.9	-4.2
SIROHI	8.9	4.9	2.7	1.3	-5.8	-5.8	-7.1	-4.7
TONK	8.4	6.3	4.9	1.3	-2.8	-2.5	-12.4	-4.6
AJMER	7.4	5.4	3.3	1.9	-3.1	-4.8	-5.4	-3.3
ALWAR	5.7	5.6	2.0	2.1	-0.2	-9.8	0.5	-2.5
PALI	3.9	2.8	1.0	0.5	-3.3	-9.8	-6.7	-5.0
UDAIPUR	3.1	2.6	1.3	0.9	-1.7	-6.7	-3.6	-3.0
BUNDI	3.1	2.0	1.0	0.5	-4.3	-6.7	-6.7	-4.5
BHARATPUR	3.1	3.6	0.9	0.7	1.5	-12.9	-2.5	-3.7
GANGANAGAR	2.9	1.3	0.7	1.5	-7.7	-6.0	7.9	-1.6
SAWAI-MADHOPUR	2.9	2.1	2.1	3.0	-3.2	0.0	3.6	0.1
SIKAR	2.0	1.6	1.0	0.7	-2.2	-4.6	-3.5	-2.6
DUNGARPUR	1.9	2.3	1.1	0.3	1.9	-7.1	-12.2	-4.5
JHUNJHUNU	1.6	6.0	0.9	1.0	14.1	-17.3	1.1	-1.2
CHITTOR	1.2	1.1	0.7	0.5	-0.9	-4.4	-3.3	-2.2
RAJASTHAN	5.2	3.4	0.9	0.5	-4.2	-12.5	-5.7	-5.7
COFFICIENT OF VIRATION					107.2	93.2	114.2	117.1

Source:-

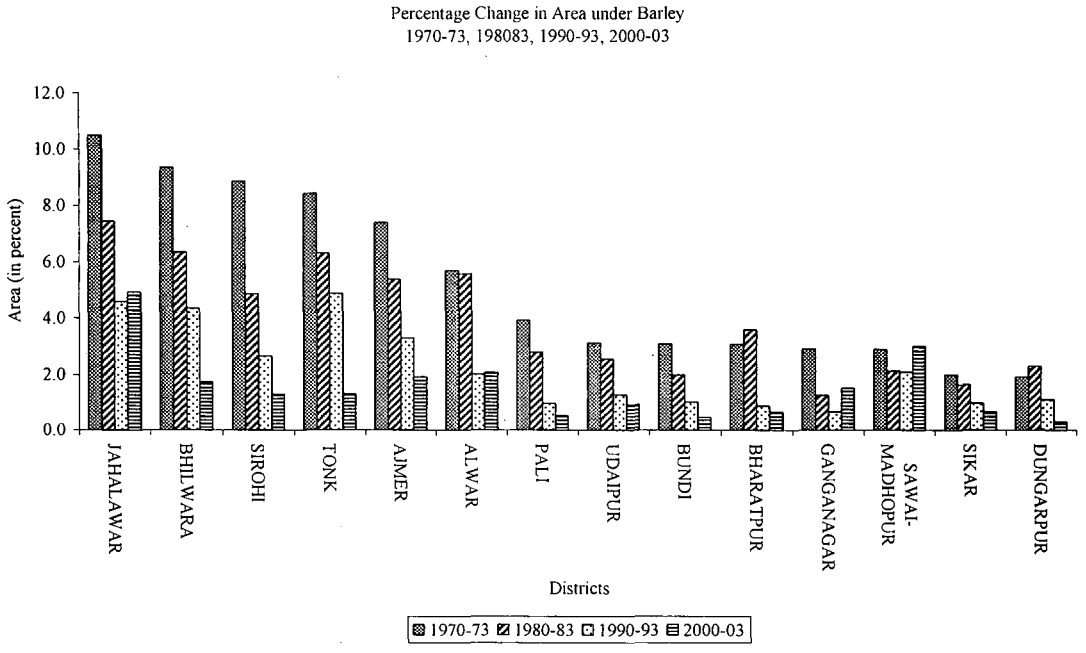
- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate
A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

Table 3.8 shows that at state level barley claimed 5.2 percent area of GCA during 1970-73; after that it has constantly registered negative growth -4.2 percent in 80s, -12.5 percent in 90s, and -5.7 percent in 2000 respectively. The

district also follows the same trend. The area under Barley in Jhalawar, Bhilwara, Sirohi, Tonk, and Ajmer varies from 7.4 percent to10.5 percent during 70s. In course of time, all these districts have registered a notable decline in area under Barley. All these districts registered a sharp decline during 90s. For example during 2000-03 the area under Barley in Bhilwara, Sirohi and Tonk has registers a negative growth -8.9 percent in 80s, -7.1 percent, -12.4 percent respectively. The Table 3.8 also presents the same declining tendency in area under Barley in Alwar, Pali, Udaipur, Bundi and Bharatpur during 90s and 2000-03. However, in Alwar, Pali, and Bharatpur it has registered a sharp negative growth during 90s by -9.8 percent, -9.8 percent, and -12.9 percent respectively.

Figure 3.7



Similarly, the area under Barley in Ganganagar, Sikar and Dungarpur also decline at significant rate. However, Sawai-Madhopur noticed no change for the entire period. Thus, it seems that the area under barley in Jhalawar, Bhilwara, Sirohi, Tonk, Ajmer Pali, Udaipur, and Bundi show a negative

relation of area with irrigation while Alwar, Bharatpur, Sawai-Madhopur and Dungarpur show some positive relation in 80s and 2000[8]. Generally, the area under Barley in all districts has been negatively associated with rainfall; it means that whenever rainfall has deficient the area under barley has increased. The area under Barley was insignificant (more than 1 percent of GCA) in Banswara, Kota, Nagaur, Jalore, Jaislamer, Jodhpur, Barmer, and Jaipur. Therefore, their changes do not come under the study.

CHANGES IN AREA UNDER WHEAT:-

Wheat is grown in Rabi season. In Rajasthan, it is totally irrigated crop. It is cultivated in the entire state. The Table 3.9 and Figure 3.8 showed the area under Wheat had witnessed a widespread variation amongst the districts. It varied from 0.0 percent in Churu to 30.9 percent in Bundi in 1970-73. Over the period, this variation has increased from 2.1 in 1970-73 to 3.6 in 2000-03. During 70s, 16.4 percent area under wheat, was register at state level however, in 80s it has registered a positive and significant growth of 2.0 percent annually. On the contrary, in 90s, its growth rate was negative -3.4 percent annually then again; it increased to 2.1 percent in 2000-03. Bundi, Kota, Bharatpur Chittor, and Sirohi had claimed highest area under wheat among all districts during 70s. They claimed area from 18.9 percent to 30.9 percent during 70s. The important changes in area under wheat was noticed in 80s, 90s and in 2000. Generally, during 80s all districts show a significant decline in area under wheat except Sirohi. Sirohi was the only district that shows significant increase in area under wheat during this period from 18.9 percent in 1970-73 to 22.8 percent in 1980-83. Bundi and Chittor registered continuous decline in entire period while in Kota and Bharatpur the area under wheat decline up to 90s then it increased. In terms of over all growth, Bharatpur is the only district that record positive growth (0.4 percent) for the whole period (2000-03 over 1970-73). At the same time, Bhilwara did not show

[8] Appendix-1

any change in area under wheat during 70s, 80s and 90s and it still claimed 15.9 percent area.

Table 3.9

Percentage Change and Growth Rate of Area under Wheat 1970-73, 1980-83, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
BUNDI	30.9	27.1	26.7	24.0	-1.3	-0.2	-1.1	-0.6
KOTA	29.0	22.4	17.9	20.2	-2.6	-2.2	1.2	-0.9
BHARATPUR	20.3	20.2	17.7	23.7	-0.1	-1.3	3.0	0.4
CHITTOR	19.1	15.5	14.1	10.4	-2.1	-0.9	-3.0	-1.5
SIROHI	18.9	22.8	15.5	10.9	1.9	-3.8	-3.5	-1.4
BHILWARA	15.1	15.9	15.9	11.9	0.5	0.0	-2.9	-0.6
SIKAR	13.9	13.0	12.3	9.0	-0.7	-0.6	-3.1	-1.1
JALORE	13.1	9.9	10.0	8.7	-2.8	0.1	-1.4	-1.0
GANGANAGAR	12.8	14.2	17.4	22.5	1.0	2.1	2.6	1.4
TONK	12.5	14.5	17.4	8.1	1.5	1.8	-7.4	-1.1
ALWAR	11.3	19.1	17.4	23.3	5.4	-0.9	3.0	1.8
UDAIPUR	10.6	12.2	11.1	11.2	1.4	-0.9	0.1	0.1
DUNGARPUR	10.5	15.9	15.2	9.4	4.2	-0.5	-4.7	-0.3
JHALAWAR	10.0	18.5	17.3	20.0	6.4	-0.7	1.5	1.8
PALI	9.6	11.7	8.9	8.1	2.0	-2.7	-0.9	-0.4
AJMER	9.5	9.3	8.6	6.5	-0.2	-0.8	-2.8	-0.9
BANSWARA	6.9	11.5	16.2	15.2	5.2	3.5	-0.6	2.0
JAISALMER	5.9	7.7	5.2	3.8	2.7	-3.9	-3.1	-1.1
SAWAI-MADHOPUR	2.3	6.1	7.8	11.9	10.3	2.5	4.3	4.2
JODHPUR	2.2	2.6	1.8	3.1	1.7	-3.6	5.6	0.9
NAGAUR	2.0	11.5	0.6	5.8	19.1	-25.6	25.5	2.7
JHUNJHUNU	1.6	5.1	5.5	9.5	12.3	0.8	5.6	4.6
BARMER	0.9	0.6	0.9	0.8	-4.0	4.1	-1.2	-0.3
JAIPUR	0.6	0.5	0.8	1.9	-1.8	4.8	9.0	2.9
BIKANER	0.0	1.0	2.5	2.8	.	9.6	1.1	.
CHURU	0.0	0.2	0.2	1.3	.	0.0	20.6	.
RAJASTHAN	16.4	20.0	14.2	17.5	2.0	-3.4	2.1	0.2
C.V.					81.3	62.8	65.2	67.0

Source:-

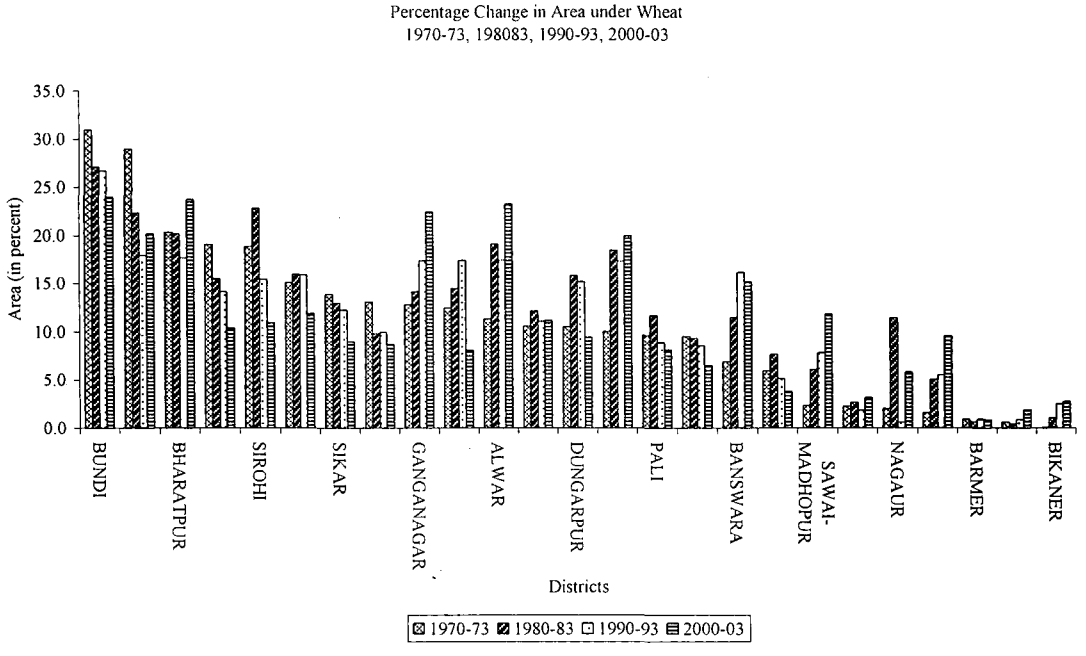
- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate

A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

However, in 2000 it experienced negative growth -2.9 percent in 2000-03. Similarly, Sikar is almost constant up to 90s and then it record sharp negative growth of -3.1 percent in 2000-03. The area under wheat in Ganganagar, Tonk and Alwar registered a sharp increase for 1.4 percent in Ganganagar and 1.9 percent in Alwar while in Tonk area increases up to 90s then it started declining. However, the growth of area under wheat for entire period was seen in Bharatpur (0.4 percent), Ganganagar(1.4 percent), Alwar (1.8 percent), Jhalawar (1.8 percent), Banswara (2.0 percent), Sawai-Madhopur (4.2 percent), Jodhpur (0.9 percent), Nagaur (2.7 percent), Jhunjhunu (4.6 percent) and Jaipur (2.9 percent).While Bikaner and Churu did not registered any remarkable area under wheat during 1970-73. Although during 90s and 2000, both districts have record significant area under Wheat.

Figure 3.8



Thus, it seems that the largest increase in area under Wheat came from the irrigated region. However irrigated Wheat displaced many other crops, but most of this increase came as a result of access to irrigation in area

previously dominated by dry-land cropping[9] such as western districts of Rajasthan.

CHANGES IN AREA UNDER PULSES:-

Pulses used to grow in the both agricultural seasons, i.e. Rabi as well as in kharif. It has also grown in irrigated and un-irrigated conditions. Table 3.10 and Figure 3.9 shows that the Pulses have grow in all over the state. The north-western districts of the state like Bikaner, Churu, Ganganagar, and Jhunjhunu have claimed highest area under pulses. These districts have claimed area from 32.5 percent to 42.2 percent during 70s. A major change has registered in area under pulses during 1970-73 to 2000-03. Table 3.10 and Figure 3.8 also show that these districts registered notable and significant decline in area under pulses for entire period. Although area under pulses in Jhunjhunu declined at significant rate in 80s and 90s, it showed positive growth 0.5 percent during 90s. Similarly, Churu also registered a phenomenal increase to 1.0 percent during 90s. The changes in area under pulses, for the entire period, in all these districts have shown a declining trend. Therefore, it can be inferred, that all these districts are un-irrigated districts with the exception of Ganganagar. Thus, whenever the rainfall is deficient, the area under pulses also increases. For example, in 90s, rainfall has measured 23.15 cm and it was far below from average rainfall, as a result the area under pulses had increased from 36.1 percent to 39.7 percent. On the other hand, the growth of irrigation facilities and area under pulses was negatively correlated. Jhunjhunu registered an outstanding growth in GIA but the area under pulses decreased impressively because the farmers shifted their preference towards irrigated crops or less water intensive crop like wheat and oilseed.

[9] Ashok Gulati and Tim Kelley, *Trade Liberation and Indian Agriculture: Cropping pattern Changes and Efficiency Gain in Semi-Arid Tropics*, New Delhi: Oxford University Press, 1999, pp. 27-28.

Table 3.10

Percentage Change and Growth Rate of Area under Pulses 1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
BIKANER	42.2	33.0	32.1	21.7	-2.4	-0.3	-3.8	-1.7
CHURU	39.3	36.1	39.7	21.2	-0.9	1.0	-6.1	-1.5
GANGANAGAR	39.0	33.8	25.2	17.2	-1.4	-2.9	-3.8	-2.0
JHUNJHUNU	32.5	26.4	20.6	21.6	-2.1	-2.5	0.5	-1.0
ALWAR	28.9	15.9	11.8	7.5	-5.8	-2.9	-4.4	-3.3
SAWAI-MADHOPUR	25.8	24.2	17.7	22.8	-0.6	-3.1	2.6	-0.3
JAHALAWAR	24.5	20.8	11.6	11.1	-1.6	-5.7	-0.4	-2.0
BHARATPUR	24.0	13.0	6.4	6.4	-6.0	-6.8	0.0	-3.3
NAGAUR	23.9	18.9	5.5	25.4	-2.3	-11.6	16.5	0.2
BUNDI	18.7	13.8	10.0	12.6	-3.0	-3.2	2.3	-1.0
UDAIPUR	18.6	17.3	15.3	13.2	-0.7	-1.2	-1.5	-0.9
KOTA	17.5	19.7	13.0	7.3	1.2	-4.1	-5.6	-2.2
JODHPUR	16.9	16.3	16.9	12.2	-0.4	0.4	-3.2	-0.8
BANSWARA	15.7	24.5	26.3	17.3	4.6	0.7	-4.1	0.2
DUNGARPUR	15.4	17.9	24.0	14.5	1.5	3.0	-4.9	-0.2
SIROHI	14.7	13.9	8.8	19.0	-0.6	-4.5	8.0	0.6
SIKAR	13.2	18.5	18.2	7.0	3.4	-0.2	-9.1	-1.6
JALORE	12.5	20.2	19.0	9.2	4.9	-0.6	-7.0	-0.8
CHITTOR	12.0	23.7	15.7	7.5	7.0	-4.0	-7.1	-1.2
AJMER	12.0	11.6	14.7	18.5	-0.3	2.4	2.3	1.1
TONK	9.0	10.4	13.0	6.5	1.5	2.3	-6.7	-0.8
BHILWARA	8.2	6.8	12.3	12.7	-1.9	6.1	0.3	1.1
PALI	5.7	6.5	8.5	8.1	1.3	2.7	-0.5	0.9
JAISALMER	5.3	5.3	8.3	9.4	0.0	4.6	1.3	1.4
BARMER	2.1	4.1	8.3	14.0	6.9	7.3	5.4	4.9
JAIPUR	0.1	0.1	0.2	2.4	0.0	7.2	28.2	8.3
RAJASTHAN	25.3	14.1	9.0	10.9	-5.7	-4.4	1.9	-2.1
COFFICIENT OF VIRATION					61.5	52.5	56.1	46.3

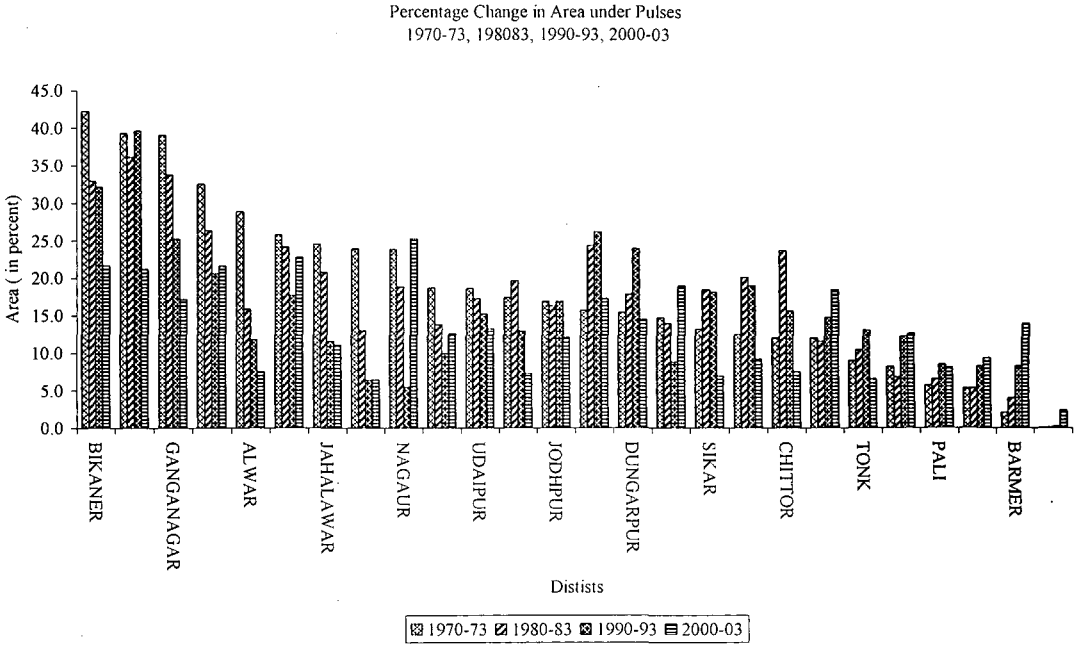
Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth rate

A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

Figure 3.9



The next set of districts has claimed areas from 23.9 percent to 28.9 percent. This set comprises of Alwar, Sawai-Madhopur, Jhalawar, Bharatpur and Nagaur districts. All these districts are well irrigated with the exception of Jhalawar and Nagaur, because they are registered as un-irrigated districts. The area under pulses in these districts registered a sharp decline during the whole period. In contrast, Sawai-Madhopur and Nagaur showed a declining trend up to 90s and then it increased significantly. Figure 3.9 reveals that area under pulses in Udaipur has declined during the whole period, while in Kota it has increased from 17.9 percent to 19.5 percent in 90s and thereafter by declined. At the same time, Jodhpur noticed constant status in the 90s and then it declined at a significant rate, while Banswara, Dungarpur, Sikar, Jalore, Chittor and Tonk registered a sharp increase during the 80s and 90s then decline subsequent. The area under pulses in Sirohi, Ajmer, Bhilwara, Jaisalmer, Barmer and Jaipur increased during 90s and 2000.

CHANGES IN AREA UNDER OILSEEDS:-

In Rajasthan oilseeds grow both as irrigated as well as un-irrigated crop. In Rabi season, it grows as an irrigated crop while in kharif season it is un-irrigated. However oilseeds are the major beneficial crop in terms of area increment among all the crops. But during the whole period it shows a wide fluctuation in area allotment. A major change in area under oilseeds in Rajasthan is presented in Table 3.11 and it reveals that 13.1 percent area of GCA accounted to oilseed in 70s and it was comparatively constant up to 80s. In 90s, a notable increase to 31.6 percent in area under oilseeds has registered, while 2000-03 registered a minor decline by 30.38 percent in area under oilseeds.

Table also reveals district level profile and it shows that there were widespread variations among districts especially in area under oilseeds. Bharatpur, Pali, Chittor, Alwar and Sikar had claimed as the highest areas under oilseeds from 14.6 percent to17.5 percent during 70s. Among these districts Bharatpur, Pali, and Sikar registered a significant increase during 80s and 90s. While Chittor and Alwar showed this increase only for 90s. In terms of growth rate, Bharatpur noticed an increase by 9.5 percent during 90s and Alwar witnessed the same by 11.9 percent. But in 2000 all these districts registered a very sharp decline in area under oilseeds. Similarly, Kota, Udaipur, Nagaur and Bundi registered a notable increase in area during 80s and 90s while the same trend was noticed in Jaisalmer during the 80s. During 90s and 2000 it declined to 15.2 percent and 6.2 percent respectively. At the same time, Jalore, Sirohi, Jhalawar, Bikaner, Churu and Tonk presented a totally different picture than that is presented above. All these districts witnessed a decline at a significant rate during the 80s but in the 90s they again increased and followed by a notable decline in area under pulses especially in Tonk. In Tonk, it declined at the rate of -6.2 percent during

2000s.The area under pulses had continuously increased in north-western districts viz. Ganganagar, Jhunjhunu, Barmer, Sawai-Madhopur and Jaipur.

Table 3.11

Percentage Change and Growth Rate of Area under Oilseeds 1970-73, 198083, 1990-93, 2000-03

	(Area in percent)				Growth Rate			
Districts	**1970-73**	**1980-83**	**1990-93**	**2000-03**	**A**	**B**	**C**	**D**
BHARATPUR	17.5	18.4	45.6	21.0	0.5	9.5	-7.5	0.5
PALI	17.0	21.1	30.3	14.2	2.2	3.7	-7.3	-0.5
CHITTOR	14.8	11.5	23.3	10.0	-2.5	7.3	-8.1	-1.0
ALWAR	14.7	10.1	31.2	25.3	-3.7	11.9	-2.1	1.4
SIKAR	14.6	16.8	25.1	15.4	1.4	4.1	-4.8	0.1
BHILWARA	11.7	8.6	20.1	8.3	-3.0	8.9	-8.5	-0.9
AJMER	11.2	5.0	11.0	3.7	-7.8	8.2	-10.3	-2.7
JALORE	9.1	7.9	6.4	4.0	-1.4	-2.1	-4.6	-2.0
KOTA	8.4	10.2	20.6	16.3	2.0	7.3	-2.3	1.7
SIROHI	7.7	5.6	23.0	19.5	-3.1	15.2	-1.6	2.4
JAHALAWAR	7.7	5.3	21.2	13.9	-3.7	14.9	-4.1	1.5
UDAIPUR	7.6	7.7	14.9	9.9	0.1	6.8	-4.0	0.7
NAGAUR	7.3	9.7	11.2	5.0	2.9	1.5	-7.8	-0.9
TONK	7.2	6.4	7.6	4.0	-1.2	1.7	-6.2	-1.5
JAISALMER	7.0	19.2	15.6	6.2	10.6	-2.1	-8.8	-0.3
BUNDI	6.8	7.4	19.6	10.8	0.9	10.2	-5.8	1.2
BANSWARA	5.8	1.6	0.5	0.2	-12.1	-11.0	-8.8	-8.1
JODHPUR	5.1	5.7	8.3	4.6	1.1	3.8	-5.7	-0.3
DUNGARPUR	3.1	1.6	0.7	0.8	-6.4	-7.9	1.3	-3.3
GANGANAGAR	3.0	3.6	12.9	15.6	1.8	13.6	1.9	4.2
SAWAI-MADHOPUR	1.6	2.9	5.0	5.8	6.1	5.6	1.5	3.3
BIKANER	1.2	3.0	5.2	3.9	9.6	5.7	-2.8	3.0
BARMER	1.1	1.6	1.1	0.5	3.8	-3.7	-7.6	-2.0
JHUNJHUNU	0.9	3.1	8.4	11.7	13.2	10.5	3.4	6.6
CHURU	0.1	0.3	0.8	2.2	11.6	10.3	10.7	8.0
JAIPUR	0.0	0.3	0.8	4.5	.	10.3	18.9	.
RAJASTHAN	13.1	12.9	31.6	30.8	-0.2	9.4	-0.3	2.2
C.V.					71.5	78.6	79.8	74.7

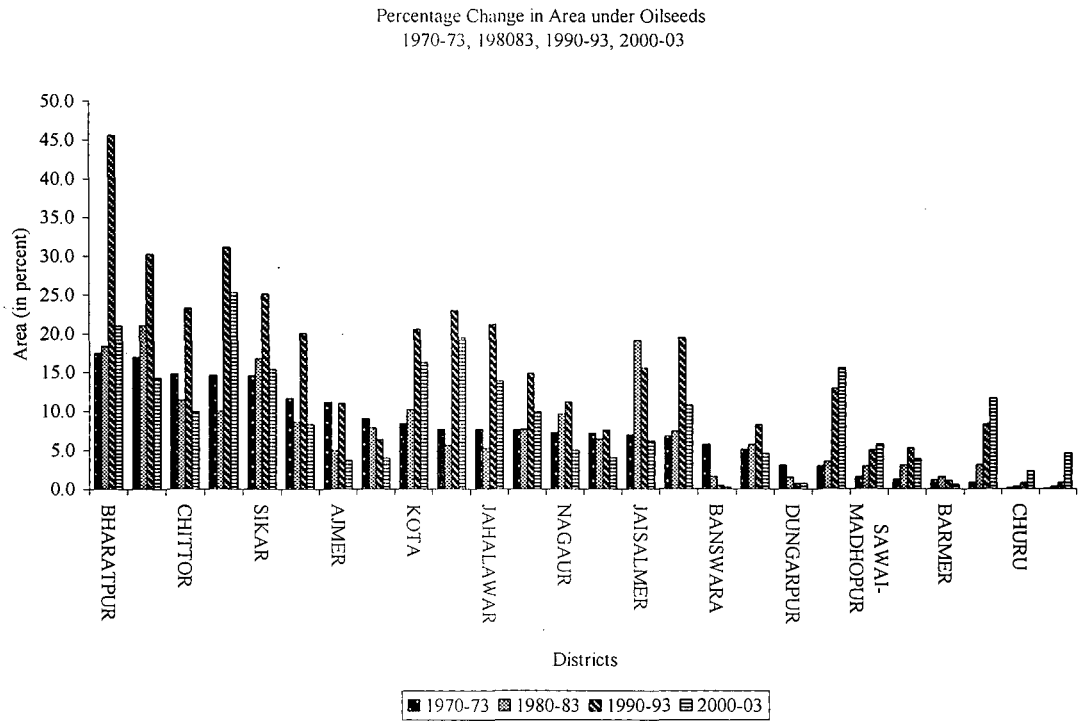
Source:-

- Directorate of Economics & Statistics, Rajasthan, various issues
- Department of Agriculture, Rajasthan, Jaipur
- Directorate of Economics & Statistics, India, various issues

Growth Rate

A.1980-83 over 1970-73
B.1990-93 over 1980-83
C.2000-03 over 1990-93
D.2000-03 over 1970-73

Figure 3.10



CONCLUSION:-

The objective of this chapter was to examine changes in cropping pattern during the period 1970-73 to 2000-03. We have approached this objective by presenting both absolute and relative changes in cropping pattern at districts level. The major finding of this chapter is that there has been distinct shift away from coarse grain to wheat and oil seeds. The loss in the area under coarse grain and pulses almost equals the gain in the area under wheat and oilseeds. However in some cases pulses is also gaining crop. Therefore in general we conclude that during the whole period the percentage of area under food-grains especially under coarse cereal and pulses has declined, while that of oilseeds has increased. Thus, the cropping pattern has undergone a drastic change in the study period, but there have been annual fluctuation in it.

CHAPTER

4 AGRICULTURAL PRODUCTIVITY AND ITS DETERMINANTS IN IRRIGATED AND UN-IRRIGATED DISTRICTS OF RAJASTHAN

Chapter-4

AGRICULTURAL PRODUCTIVITY AND ITS DETERMINANTS IN IRRIGATED AND UN-IRRIGATED DISTRICTS OF RAJASTHAN

Dry-land farming is practised in India on about 106 million hectares of total net cultivated area, with low and erratic rainfall condition through the system of soil and water management. These areas contribute about 42 percent of our food-grain production and bulk of pulses as well as a large amount of cotton which is grown under dry conditions. The crop production and yields in these areas are low to very low from the national level and are subject to wide fluctuation.[1]

These dry-land areas receive very little irrigation from conventional sources and also the amount of rainfall is not assured. Therefore, the crop production in dry areas hinges on the precarious balance of moisture availability. In tropical arid lands in general and in Indian arid and semi-arid zone in particular, it is the moisture factor which is crucial. The crop production of these areas in the country is largely dependent on rainfall.[2] Coarse grains like Jowar, Bajara, Pulses, Cotton and Oil-seeds are mainly grown in rain-fed areas. This vast area is likely to remain rain-fed for the considerable period of time in the future. Hence, the major concern of the farmers of these areas should be to work out ways and means to optimize the available moisture for ensuring successful crops.

Rajasthan is one of the states where package technology has been introduced lately. In Rajasthan the level of utilization of the present

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[1] Hifzur Rehman (1986), "New Strategies for Agriculture Reorientation in Dryland Areas in India" in Mohammad Shafi and Medhi Raza(Ed), *Dryland Agriculture in India*, Rawat Publication, Jaipur.

[2] M.H. Qureshi (1986), "The Area and Yield of Some Selected Crops in Dry Areas: an Evaluation of Water as a Determinant", in Mohammad Shafi and Medhi Raza(Ed), *Dryland Agriculture in India*, Rawat Publication, Jaipur.

agriculture potentials largely depends on positive and negative environmental and other technological factors. For instance, land may be fertile but may not be equally productive. Fertility and productivity are highly related, but the land may not be under the most suitable crops to derive maximum of fertility. Similarly advance technology also helps in increasing productivity. In Rajasthan, the agricultural potential is considerably high but existing potential cannot be exploited because of certain important factor in agricultural production such as the percentage of area under cultivation to the total culturable area is also very low, the cropping pattern is dominated by low yield giving crops. These characteristics are controlled by a single crucial factor, i.e. the insufficient availability of water and low moisture level in the soil.

Irrigation is an important determinant of agricultural productivity in states with higher level of irrigation development. In fact variation in yields of different crops in different regions of India is largely explained by irrigation development. Green Revolution in India has been successfully introduced where there was development of irrigation combined with the other inputs; of such as fertilizer, pesticides, HYV seeds, and mechanization etc Irrigation increased agricultural production in these areas substantially. Thus, the uses of modern agricultural inputs are highly correlated with the irrigation development. Productivity level of a crop has increased substantially, primarily due to increased soil moisture through irrigation. While this is the case with the irrigated areas, in un-irrigated areas rainfall and soil moisture play very crucial role.

Seasonal rainfall is the amount of rainfall occurring during the crop growing season. It is the major source of soil moisture. Adequate and timely south-west monsoon rainfall coincides with 'Kharif" season and has positive influence on the production of kharif crops. Water requirement of crops varies from one stage of growth to another. Hence, seasonal rainfall should be

adequate enough to meet the soil moisture requirement. Timely onset and drawl with of south west monsoon has positive influence on crop performance. Late onset and insufficient rainfall in the beginning of the season not only shortens the crop season but also has adverse effect on yield levels. It also results in temporary shift in cropping pattern. In such an eventuality particularly in semi-arid areas, water intensive and long duration crops are replaced by drought resistant and short duration crops because crops and their variety vary greatly in their suitability in relation to their date of sowing and tolerance to droughts. Some crop varieties could withstand prolonged drought while other are highly susceptible to moisture stress. However, the seasonal rainfall in time and space is responsible for variation in acreage and yield of crops.

This chapter is an attempt to analyse the influence of the irrigation and rainfall (seasonal) on the yield levels of some selected crops such as bajara, jowar, maize, barley, wheat pulses and oil seeds. Correlation matrix and regression analysis have been used for this purpose. The correlation matrix shows the nature and degree of relationship between the two variables. While the regression analysis gives the explanatory power of the independent variables.

LIMITATION OF THIS STUDY:-

While doing data analysis, some of the variables were giving unexpected results. But in real world one does not observe this kind of relationship. For instance, the gross irrigated area showed negative correlation with productivity during the period of 1970-73. Although in later period gross irrigated area is positively correlated with productivity. These kinds of contradictory result are also observed for some other variables. There can be many reasons for such type of relation. (1) The existence of unexpected results arising from widely differing agro-climatic conditions in some districts

such as highly irrigated and developed Ganganagar to very low rainfall, deserts districts like Jaisalmer might be distorting the estimate[3]. (2) The choice of crops in this study is biased towards coarse cereals and Kharif crops (Bajara, Jowar, Maize, Gram, Other Kharif pulses, Seasmum, Linseeds, and Castor seeds etc). In contrast the number of irrigated crops are few namely Wheat, Barley, and Rapeseed and Mustard. Therefore, due to this crop selection the Gross Cropped area, fertilizer and other agricultural determinants show negative relation with productivity[4]. In the same way the irrigated crops also mitigate the significance level of rainfall with productivity.

Selected Dependent and Independent Variables of Agricultural Productivity and Methodology are given below:-

The basic statistical tools employed in this analysis consist of correlation and step-wise regression. The analysis may be divided into two parts. In the first part an attempt has been made to analyse the relationship between agricultural technique and rainfall with agricultural productivity. In this study Karl Pearson correlation coefficient we have using. The following variables have been considered.

Agricultural productivity in money terms.
Percentage of gross irrigated area to gross cropped area.
Consumption of fertilizer per 100 hectares.
Use of HYV seeds per 100 hectares.
Number of tractors per 100 hectares.
Number of pumpsets per 100 hectares.
Annual average rainfall in cms.
Number of ploughs per 100 hectares.

[3] G.S.Bhalla and Gurmail Singh (2001), "*Indian Agricultuer: Four Decades Development*", Sage Publication New Delhi, pp.94.
[4] See Chapter-2, "*Table 2.1 Table 2.3 Table 2.5 Table 2.6 Table 2.8 Table 2.9 Table 2.11 Table 2.12 Table 2.13 Table 2.15 and Table 2.16*".

In second parts of analysis the role agricultural innovation in explaining variation in agricultural productivity has been analysed by using step-wise regression analysis. The dependent variable is agricultural productivity in money terms. The following variables have been considered in the analysis.

$Y = a + bx_1 + bx_2 + bx_3 + bx_4 \ldots\ldots + ui.$

Dependent variable

Y= Agricultural productivity in money terms.

Independent variables

X_1= Percentage of gross irrigated area to gross cropped area.

X_2= Consumption of fertilizer per 100 hectares.

X_3= Use of HYV seeds per 100 hectares.

X_4= Number of tractors per 100 hectares.

X_5= Number of pumpsets per 100 hectares.

X_6= Annual average rainfall in cms.

X_7= Number of ploughs per 100 hectares.

Correlation Matrix and Regression Analysis for Irrigated districts during 1970-73:-

The correlation matrix between agricultural productivity and its determinants in irrigated districts during 1970-73 has been shown in Table-4.1. The correlation matrix does not show a consistent pattern of relationship with agricultural productivity. The low to very low positive correlation has been seen in rainfall (+0.28), number of tractors (+0.23) and the number of plough (+0.18). None of these correlation coefficient values is significant. On the other hand the other major determinant of agricultural productivity viz. pumpsets, fertilizer, HYV and gross irrigated area are negatively correlated

with agriculture productivity. Similarly, they are not significant at 0.01 or 0.05 percent level of significance. It is interesting to note that the correlation between independent variables show high positive correlation. The gross irrigated area was positively correlated with HYV (+0.65) and fertilizer (+0.64) and they both were significant at 0.05 percent level of significance. Thus, it can be inferred that when the gross irrigated area has increased the consumption of fertilizer and HYV also increased at significant rate.

Table-4.1

Correlation Matrix of Agricultural Productivity and its Determinants in Irrigated Districts during the Period of 1970-73

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	-.046	.225	-.345	-.208	.178	-.210	.276
Pumpsets	-.046	1	.073	-.408	-.478	-.249	-.366	.263
Tractors	.225	.073	1	.050	-.071	-.387	.248	-.070
HYV	-.345	-.408	.050	1	.322	-.394	.654(*)	-.099
Fertilizer	-.208	-.478	-.071	.322	1	.001	.647(*)	.126
Ploughs	.178	-.249	-.387	-.394	.001	1	-.078	-.134
GIA	-.210	-.366	.248	.654(*)	.647(*)	-.078	1	.045
Rainfall	.276	.263	-.070	-.099	.126	-.134	.045	1
N	12	12	12	12	12	12	12	12

* Correlation is significant at the 0.05 level (2-tailed).

Stepwise Regression for irrigated districts 1970-73:-

The stepwise regression analysis for irrigated districts shows that variation in agricultural production is not explained by any independent variable during 1970-73.

Correlation Matrix and Regression Analysis for Un-Irrigated districts during 1970-73:-

The correlation matrix for un-irrigated districts during 1970-73 has been presented in Table-4.2. It is found that that all determinants of

agricultural productivity are positively correlated with it but all of them are insignificant except number of pumpsets and consumption of fertilizer per hectare. The agricultural productivity is correlated with number of pumpsets (+0.58) and fertilizer consumption (+0.64) and it significant at 0.05 percent level of significance. The correlation among independent variable was high and significant in many cases. The number of pumpsets was highly correlated with HYV (+0.76) and fertilizer (+0.56) and they were significant at 0.01 percent and 0.05 percent respectively. The gross irrigated area was positively correlated with HYV (+0.99) and with fertilizer (+0.58). They both were significant at 0.01 percent and 0.05 percent level of significance. The consumption of fertilizer and use of HYV was also positively correlated (+0.61) with productivity and significant at 0.05 percent level of significance. It may be inferred that there is a causal relationship among irrigation, HYV and fertilizer. When the gross irrigated area has increased in un-irrigated districts consumption of fertilizer and HYV has also increased. Similarly the number of plough was positively correlated with rainfall (+0.82) and it is significant at 0.01 percent level. It means in un-irrigated districts due to increased rainfall the gross cropped area increased due to the rainfall.

Table-4.2

Correlation Matrix of Agricultural Productivity and its Determinants in Un-Irrigated Districts during the Period of 1970-73

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.578(*)	.083	.495	.638(*)	.214	.451	.262
Pumpsets	.578(*)	1	.306	.761(**)	.555(*)	.125	.738(**)	.322
Tractors	.083	.306	1	.222	.045	-.326	.256	-.024
HYV	.495	.761(**)	.222	1	.612(*)	.010	.995(**)	.230
Fertilizer	.638(*)	.555(*)	.045	.612(*)	1	.160	.579(*)	.458
Ploughs	.214	.125	-.326	.010	.160	1	.000	.822(**)
GIA	.451	.738(**)	.256	.995(**)	.579(*)	.000	1	.213
Rainfall	.262	.322	-.024	.230	.458	.822(**)	.213	1
N	14	14	14	14	14	14	14	14

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table-4.3(a)

Stepwise Regression for un-irrigated 1970-73

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.638(a)	.406	.357	6101.89050

Predictors: (Constant), Fertilizer

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	29769.240	2052.896		14.501	.000
	Fertilizer	8980802.756	3132823.104	.638	2.867	.014

a Dependent Variable: Productivity

Table-4.3(a) shows the stepwise regression which reveals that in un-irrigated districts the R, value is 0.41 It means the consumption of fertilizer explained 41 percent variation in the agricultural productivity. In stepwise regression it was the only determinant (fertilizer) which is significant at 0.01 percent level.

Table-4.3(b)

Stepwise Regression for Un-irrigated districts 1970-73

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	-.038(a)	-.146	.886	-.044	.790
	Tractors	.054(a)	.233	.820	.070	.998
	Pumpsets	.324(a)	1.237	.242	.349	.692
	HYV	.168(a)	.580	.573	.172	.625
	Ploughs	.115(a)	.495	.630	.148	.974
	GIA	.123(a)	.435	.672	.130	.664

a Predictors in the Model: (Constant), Fertilizer
b Dependent Variable: Productivity

Table 4.3(b) shows the regression result of excluded variables and agricultural productivity. It showed none of the independent variables significantly regress with productivity. However the rainfall was negatively regressing with productivity.

Correlation Matrix and Regression Analysis for Irrigated districts during 1980-83:-

The correlation matrix for irrigated districts during 1980-83 as presented in Table-4.4 shows that the agricultural productivity was positively correlated with all independent variable, except gross irrigated area. The gross irrigated area was negatively correlated with productivity (-0.54) but it is insignificant. On the other hand the consumption of fertilizer (+0.58) was positively correlated with productivity and it is significant at 0.01 percent level. However the other determinants are also positively correlated but they are insignificant. The correlation matrix between independent variables gives some significant results.

Table-4.4

Correlation Matrix of Agricultural Productivity and its Determinants in Irrigated Districts during the Period of 1980-83

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.323	.107	.267	.743(**)	.310	-.540	.028
Pumpsets	.323	1	.219	.436	.039	-.253	-.234	.344
Tractors	.107	.219	1	.628(*)	-.149	-.613(*)	.433	-.024
HYV	.267	.436	.628(*)	1	-.260	-.219	-.175	.223
Fertilizer	.743(**)	.039	-.149	-.260	1	.505	-.321	-.061
Ploughs	.310	-.253	-.613(*)	-.219	.505	1	-.589(*)	-.128
GIA	-.540	-.234	.433	-.175	-.321	-.589(*)	1	.231
Rainfall	.028	.344	-.024	.223	-.061	-.128	.231	1
N	12	12	12	12	12	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

The number of tractors was positively correlated with HYV (+0.63) and it is significant at 0.05 percent level. In contrast the number of tractors is negatively correlated with the number of plough (-0.61) and it significant at 0.05 percent significance level. Similarly gross irrigated area also shows negative relationship (-0.59) and it is significant at 0.05 percent level.

Stepwise regression given in Table-4.4 shows that in first step fertilizer was introduced and the R^2 is 0.55 it means that 55 percent of variation in agricultural productivity is explained by fertilizer. In second step HYV was introduced and the R^2 is increased to 78 percent.

Table-4.5 (a)

Stepwise Regression for irrigated 1980-83

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.743(a)	.553	.508	7413.90452
2	.883(b)	.780	.732	5476.31782

a Predictors: (Constant), Fertilizer

b Predictors: (Constant), Fertilizer, HYV

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	32400.435	3647.920		8.882	.000
	Fertilizer	1224072.649	348201.928	.743	3.515	.006
2	(Constant)	25938.724	3425.896		7.571	.000
	Fertilizer	1435616.249	266364.095	.872	5.390	.000
	HYV	196.769	64.426	.494	3.054	.014

a Dependent Variable: Productivity

However in stepwise method fertilizer significant at 0.01 percent level in the first step and in second step fertilizer follow same significance standard and HYV significant at 0.01 percent level.

Table-4.5(b)

Stepwise Regression for irrigated districts 1980-83

Excluded Variables(c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	.073(a)	.331	.748	.110	.996
	Tractors	.223(a)	1.048	.322	.330	.978
	Pumpsets	.295(a)	1.473	.175	.441	.999
	HYV	.494(a)	3.054	.014	.713	.932
	Ploughs	-.087(a)	-.340	.742	-.113	.745
	GIA	-.336(a)	-1.623	.139	-.476	.897
2	Rainfall	-.031(b)	-.182	.860	-.064	.950
	Tractors	-.121(b)	-.580	.578	-.201	.605
	Pumpsets	.094(b)	.513	.622	.178	.785
	Ploughs	-.029(b)	-.151	.884	-.053	.737
	GIA	-.210(b)	-1.263	.242	-.408	.825

a Predictors in the Model: (Constant), Fertilizer

b Predictors in the Model: (Constant), Fertilizer, HYV c Dependent Variable: Productivity

Table 4.5(b) showed the regression between agricultural productivity and excluded independent variables. And the table delineates in first step HYV was the only independent variable which is significant at 0.01 level of significance. The other independent variables in first step were not significant at any significance level. But in first step the beta value of plough and GIA was -.087 and -.336 and they were produce negative impact on productivity. In second steps none of the excluded independent variable significant at any level of significance. However all of them negatively regress with agricultural productivity except number of pumpsets. The beta value for number of pumpsets was 0.094 but it was not significant at any level of significance.

Correlation Matrix and Regression Analysis for Un-Irrigated Districts during 1980-83:-

The correlation matrix for un-irrigated districts during 1980-83 presented in Table-4.6 shows that all independent variable are positively correlated with agriculture productivity except number of tractors. The number of tractors was negatively correlated with productivity (-0.09) but the r value is very low and it is insignificant. Among other independent variables HYV (+0.51) and rainfall (+0.43) show some strong correlation but they are still insignificant. The number of pumpsets is the only determinant which is positively correlated with productivity (+0.63) and it is significant at 0.05 percent level.

Table-4.6

Correlation Matrix of Agricultural Productivity and its Determinants in Un-Irrigated Districts during the Period of 1980-83

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.626(*)	-.091	.506	.264	.120	.333	.428
Pumpsets	.626(*)	1	.204	.831(**)	.330	.181	.807(**)	.434
Tractors	-.091	.204	1	.576(*)	-.194	-.392	.414	-.447
HYV	.506	.831(**)	.576(*)	1	.171	-.142	.809(**)	-.018
Fertilizer	.264	.330	-.194	.171	1	.638(*)	.004	.502
Ploughs	.120	.181	-.392	-.142	.638(*)	1	-.170	.767(**)
GIA	.333	.807(**)	.414	.809(**)	.004	-.170	1	.074
Rainfall	.428	.434	-.447	-.018	.502	.767(**)	.074	1
N	14	14	14	14	14	14	14	14

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix between independent variable shows that the consumption of HYV is positively correlated with pumpsets (+0.83) and gross irrigated area (+0.81) and they both are significant at 0.01 percent level. The

use of HYV is also moderately correlated with the number of tractors (+0.58) and it is significant at 0.05 percent level. The number of plough is also highly correlated with fertilizer (+0.64) and rainfall (+0.77) they both are significant at 0.05 and 0.01 percent level respectively. Because whenever rainfall has become more intense, the area under crop has increased. As a result of increased culturable land the consumption of fertilizer has increased significantly.

Table-4.7(a)

Stepwise Regression for un-irrigated 1980-83

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.626(a)	.392	.341	6380.33086

a Predictors: (Constant), Pumpsets

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	26880.424	2723.936		9.868	.000
	Pumpsets	4779.735	1719.032	.626	2.780	.017

a Dependent Variable: Productivity

The stepwise regression given in Table-4.7(a) shows that R^2 is 0.32 and it means 32 percent variation of agricultural productivity is explained by the number of pumpsets. In stepwise method only the number of pumpsets was significant at 0.01 percent significance level.

Table-4.7(b)

Stepwise Regression for Un-irrigated districts 1980-83

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	.192(a)	.756	.465	.222	.812
	Tractors	-.228(a)	-.991	.343	-.286	.959
	HYV	-.044(a)	-.104	.919	-.031	.310
	Fertilizer	.064(a)	.258	.801	.078	.891
	Ploughs	.007(a)	.028	.978	.008	.967
	GIA	-.491(a)	-1.331	.210	-.373	.350

a Predictors in the Model: (Constant), Pumpsets

b Dependent Variable: Productivity

Table-4.7(b) showed the regression result between excluded independent variables and agricultural productivity in un-irrigated districts. The table presents that rainfall, consumption of fertilizer and number of ploughs are regressed positively and its beta value are 0.192, 0.064, and 0.007 respectively. While the regression result for other independent variables was negative. However among these independent variables none of them significant at any level of significance.

Correlation Matrix and Regression Analysis for Irrigated districts during 1990-93:-

The correlation matrix in Table-4.8 shows that during this period the number of pumpsets, HYV, fertilizer, and gross irrigated area were positively correlated with agricultural productivity, but the correlation coefficient value is quite low and insignificant. In contrast the number of ploughs and rainfall were negatively correlated with agricultural productivity. Among all independent variables the number of tractors was the only variable which is

positively (+0.80) correlated and significant at 0.01 percent level of significance. The positive correlation between independent variables was noticed in pumpsets with HYV (+0.79) and plough (+0.62) and both were significant at 0.01 and 0.05 percent level of significance respectively.

Table-4.8

Correlation Matrix of Agricultural Productivity and its Determinants in Irrigated Districts during the Period of 1990-93

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.115	.800(**)	.376	.134	-.008	.354	-.008
Pumpsets	.115	1	.164	.793(**)	.412	.624(*)	-.471	.288
Tractors	.800(**)	.164	1	.458	-.102	.077	.178	-.117
HYV	.376	.793(**)	.458	1	.011	.322	-.165	.387
Fertilizer	.134	.412	-.102	.011	1	.483	-.078	-.248
Ploughs	-.008	.624(*)	.077	.322	.483	1	-.493	-.185
GIA	.354	-.471	.178	-.165	-.078	-.493	1	-.072
Rainfall	-.008	.288	-.117	.387	-.248	-.185	-.072	1
N	12	12	12	12	12	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table-4.9(a)

Stepwise Regression for irrigated districts 1990-93

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.800(a)	.640	.604	6482.93438

a Predictors: (Constant), Tractors

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	44234.173	3629.463		12.188	.000
	Tractors	15278.282	3621.265	.800	4.219	.002

a Dependent Variable: Productivity

The stepwise regression in Table-9(a) revels that the R^2 value is 0.64. It is quite high as compare to the entire study period. And this was totally attributed to good monsoonal rainfall[5]. 64 percent of variation in agricultural productivity was explained by tractors. In stepwise regression method only number of tractors was significant at 0.00 percent level. However, in simple enter method the number of tractors is significant at 0.05 percent level.

Table-4.9(b)

Stepwise Regression for irrigated districts 1990-93

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	.087(a)	.438	.671	.145	.986
	Pumpsets	-.016(a)	-.081	.937	-.027	.973
	HYV	.012(a)	.054	.958	.018	.790
	Fertilizer	.218(a)	1.163	.275	.362	.990
	Ploughs	-.071(a)	-.355	.731	-.118	.994
	GIA	.218(a)	1.148	.281	.357	.968

a Predictors in the Model: (Constant), Tractors

b Dependent Variable: Productivity

[5] Appendix

Here Table-4.9(b) shows the regression result between agricultural productivity and excluded independent variables by step wise method. The number of pumpsets and plough was the only independent variables which noticed negative beta value -0.016 and -0.071 respectively. However the other independent variables were positively regressing with productivity but none of them significant at any significance level.

Correlation Matrix and Regression Analysis for Un-Irrigated districts during 1990-93:-

The correlation matrix for un-irrigated districts during 1990-93 in Table-4.10 shows that the agricultural productivity was positively correlated with almost all the determinants except with the number of tractors (-0.04). In other determinants the number of pumpsets (+0.63), plough (+0.59) and gross irrigated area (+0.66) were positively correlated with productivity and it is significant at 0.05 percent level.

Table-4.10

Correlation Matrix of Agricultural Productivity and its Determinants in Un-Irrigated Districts during the Period of 1990-93

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.630(*)	-.043	.313	.310	.592(*)	.657(*)	.418
Pumpsets	.630(*)	1	.029	.488	.407	.316	.887(**)	.158
Tractors	-.043	.029	1	.229	.333	-.009	-.010	.438
HYV	.313	.488	.229	1	.942(**)	.287	.376	.302
Fertilizer	.310	.407	.333	.942(**)	1	.335	.283	.432
Ploughs	.592(*)	.316	-.009	.287	.335	1	.393	.715(**)
GIA	.657(*)	.887(**)	-.010	.376	.283	.393	1	.279
Rainfall	.418	.158	.438	.302	.432	.715(**)	.279	1
N	14	14	14	14	14	14	14	14

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed)

However, the correlation between independent variable was very high in HYV with fertilizer (+0.94) and ploughs with rainfall (+0.72) and it is significant at 0.01 percent level.

Table-4.11(a)

Stepwise Regression for un-irrigated districts 1990-93

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.657(a)	.432	.385	6110.65695

a Predictors: (Constant), GIA

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	36863.124	2963.565		12.439	.000
	GIA	459.819	152.247	.657	3.020	.011

a Dependent Variable: Productivity

The stepwise regression in Table-4.11(a) shows that the value of R^2 is .0.43 that means 43 percent of variation in agricultural productivity is explained by gross irrigated area. During this period only gross irrigated area was significant at 0.01 percent significance level.

The stepwise regression for excluded variables in un-irrigated districts during 1990-93 has been shown in Table-4.11(b) and it shows that only number of tractors was negatively regress with agricultural productivity among all excluded independent variables. While rainfall, pumpsets, HYV, fertilizer and number of plough are positively regress with productivity and the beta value is .0225, 0.221, 0.077, 0.134 and 0.395 respectively. However they are positively regressing with productivity but none of them significant at any level of significance.

Table-4.11(b)

Stepwise Regression for Un-irrigated districts 1990-93

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	.255(a)	1.138	.279	.325	.922
	Tractors	-.036(a)	-.158	.878	-.047	1.000
	Pumpsets	.221(a)	.454	.659	.136	.213
	HYV	.077(a)	.315	.759	.095	.859
	Fertilizer	.134(a)	.575	.577	.171	.920
	Ploughs	.395(a)	1.822	.096	.482	.845

a Predictors in the Model: (Constant), GIA

b Dependent Variable: Productivity

Correlation Matrix and Regression Analysis for Irrigated districts during 2000-03:-

The correlation matrix for irrigated districts in Table-4.12 shows that during this period only number of tractors was significantly correlated with agricultural productivity. The correlation value is +0.70 and it is significant at 0.05 percent significance level. Although rainfall and gross irrigated area also showed positive correlation with agricultural productivity, but they both of them were insignificant. However, the correlation between independent variable was significant only for the number of tractors with HYV (+0.66) and gross irrigated area (+0.60) and both were significant at 0.05 percent level of significance. The gross irrigated area was negatively correlated with the numbers of ploughs (-0.58) and it is significant at 0.05 percent level.

Table-4.12

Correlation Matrix of Agricultural Productivity and its Determinants in Irrigated Districts during the Period of 2000-03

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.101	.700(*)	.495	.190	-.559	.307	.240
Pumpsets	.101	1	-.348	.045	.223	.096	-.566	.286
Tractors	.700(*)	-.348	1	.661(*)	-.216	-.485	.603(*)	-.063
HYV	.495	.045	.661(*)	1	-.224	-.550	.419	.121
Fertilizer	.190	.223	-.216	-.224	1	-.173	-.264	-.060
Ploughs	-.559	.096	-.485	-.550	-.173	1	-.584(*)	.161
GIA	.307	-.566	.603(*)	.419	-.264	-.584(*)	1	-.287
Rainfall	.240	.286	-.063	.121	-.060	.161	-.287	1
N	12	12	12	12	12	12	12	12

* Correlation is significant at the 0.05 level (2-tailed).

Table-4.13(a)

Stepwise Regression for irrigated districts 2000-03

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.700(a)	.491	.440	7874.60256

a Predictors: (Constant), Tractors

Coefficients (a)

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	48582.453	4390.001		11.067	.000
	Tractors	7537.929	2428.676	.700	3.104	.011

a Dependent Variable: Productivity

The stepwise regression in Table-4.13shows that the R^2 value for irrigated districts during this period was 0.49 it means the 49 percent of variation in agricultural productivity was explained by tractors. Among all determinants only number of tractors was significant at 0.01 percent level.

Table-4.13(b)

Stepwise Regression for irrigated districts 2000-03

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Rainfall	.285(a)	1.306	.224	.399	.996
	Pumpsets	.392(a)	1.800	.105	.515	.879
	HYV	.056(a)	.177	.863	.059	.563
	Fertilizer	.358(a)	1.683	.127	.489	.953
	Ploughs	-.287(a)	-1.125	.290	-.351	.765
	GIA	-.182(a)	-.623	.549	-.203	.636

a Predictors in the Model: (Constant), Tractors

b Dependent Variable: Productivity

Here Table-4.13(b) shows the regression between agricultural productivity and excluded independent variables by step wise method. The number of plough and GIA was the only independent variables which noticed negative beta value -0.287 and -.182 respectively. However the other independent variables were positively regressing with productivity but none of them significant at any significance level.

Correlation Matrix and Regression Analysis for Un-Irrigated districts during 2000-03:-

The correlation matrix for un-irrigated districts showed in Table-4.14 shows that all the major determinants are positively correlated with agricultural productivity except number of tractors. The number of tractors was negatively correlated with productivity but it is insignificant. The positively correlated variables are also insignificant. However the correlation between independent variables has shown some significant results.

Table-4.14

Correlation Matrix of Agricultural Productivity and its Determinants in Un-Irrigated Districts during the Period of 2000-03

	Productivity	Pumpsets	Tractors	HYV	Fertilizer	Ploughs	GIA	Rainfall
Productivity	1	.117	-.258	.393	.112	.198	.378	.075
Pumpsets	.117	1	.586(*)	.665(**)	.638(*)	.325	.557(*)	.270
Tractors	-.258	.586(*)	1	.127	.080	-.323	.332	-.124
HYV	.393	.665(**)	.127	1	.649(*)	.683(**)	.229	.395
Fertilizer	.112	.638(*)	.080	.649(*)	1	.666(**)	.224	.410
Ploughs	.198	.325	-.323	.683(**)	.666(**)	1	-.220	.421
GIA	.378	.557(*)	.332	.229	.224	-.220	1	.255
Rainfall	.075	.270	-.124	.395	.410	.421	.255	1
N	14	14	14	14	14	14	14	14

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

The number of pumpsets is positively correlated with the number of tractors (+0.59), fertilizer (+0.64) and HYV (+0.67) among these three first two are significant at 0.05 significance level and last one is significant at 0.01 percent level of significance. The correlation between HYV with fertilizer is (+0.65) and with plough (+0.68) and they are significant at 0.05 and 0.01 percent level of significance respectively. The correlation between numbers of ploughs with fertilizer was also high (+0.67) and it is significant at 0.01 percent significance level.

Regression for un-irrigated districts (2000-03)

The stepwise regression analysis for un-irrigated districts shows that variation in agricultural productivity is not explained by any independent variable during 2000-03. However all the independent variables of agricultural productivity were removed by stepwise method.

Conclusion:-

In this chapter we conclude that the correlation between agricultural productivity and independent variables shows that the number of Pumpsets generally significant in un-irrigated districts during 1970-73, 1980-83 and 1990-93.Fertilizer, HYV, number of Tractors and Gross Irrigated area were significant. Similarly Gross Irrigated Area and the number of ploughs are also significant in un-irrigated districts. But it was significant during 1990-93 when state measured above normal rainfall. In contrast the consumption of fertilizer and number of tractors are significant in irrigated districts during 1970-73, 1980-83, 1990-93, and 2000-03.

The stepwise regression analysis follows the same correlation matrix pattern. However the determinants of agricultural productivity in irrigated districts during 1970-73 all the variables removed by the stepwise regression analysis and non on them significant at any significance level. This type of same result accrued in un-irrigated districts during 2000-03.

CHAPTER

SUMMARY AND CONCLUSIONS

Chapter-5

SUMMARY AND CONCLUSIONS

The availability of irrigation, modern biotechnological inputs and natural conditions of the area shape the cropping pattern and extant of multiple cropping. Land productivity depends directly upon three things: supplies of conventional inputs, the cropping pattern and cropping intensity, and the use of modern mechanical and chemical technologies.

Agriculture sector occupies an important place in the economy of Rajasthan even it is in a backward state. There has been very low level of commercialization of agriculture[1] and it depends on erratic climatic conditions, like low rainfall, high temperature and high wind velocity etc. In this type of climatic conditions cultivation is too difficult.

The present study aimed to investigate the changes in cropping pattern and agricultural productivity during 1970-73 and 2000-03. Cropping pattern represents the spatial crop sequence in a given area at a particular duration of time. It indicates the proportion of area under various crops. Such an exercise helps to identify the most important crops of the region and their area differentiation.

Agricultural technology in Rajasthan had not spread at uniform rate temporally and spatially. Districts characterized by low adoption level in the initial phase recorded higher rate of spread (expressed in terms of percentage increase over the base year) in order to attain the adoption level of their neighbourhood. This phenomenon is a typical example of spatial spread.

Irrigation is an important determinant of agricultural productivity in states with higher level of irrigation development. In fact variation in yields of different crops in different regions of India is largely explained by irrigation

[1] Adams, Johan and Balu, Bumb, "*Determinants of Agricultural Productivity in Rajasthan, India: The Impact of Inputs, Technology, and Context on Land Productivity*", Economic Development and Cultural Change, Vol.27, No.4, pp.705-722.

development. The use of modern agricultural inputs is highly correlated with the irrigation development. Rainfall and soil moisture play very crucial role in cropping pattern and agricultural productivity in dry area.

Well and canal irrigation are the main sources of irrigation in Rajasthan and the gross irrigated area in Rajasthan is continually increasing. It has been noted that the percentage increase in gross irrigated area has been higher in northern and north western districts of the state where the base is strong while in the western districts it has been comparatively low.

At district level, the regional variations in gross irrigated area have continually declined. Ganganagar is the only district, where irrigated area is more than 60 percent of gross cropped area. In Ganganagar, canal is the major source of irrigation. Consequently the area under canal irrigation has increased and as a result the gross irrigated area also has increased. Alwar, Bharatpur, Bundi, Jaipur and Kota have been the districts with highest gross irrigated area while Barmer, Churu, Dungarpur, Jodhpur and Udaipur are in the category of low gross irrigated area. In this group, most of the districts lie in the western part of Rajasthan. It is well known that this area is too arid and the ground water availability is extremely low. However, in these western parts of the State, the gross irrigated area has recorded a significant increase due to Indira Gandhi Canal Yojana.

The second constituent of technology is HYV seeds. It yields 74 percent more grains as compared to local variety. In Rajasthan, the area under high yielding variety seeds has continued to increase from the beginning of the green revolution. However, wide variation in the spread of area under HYV in irrigated and un-irrigated districts has been found. During 1970-73, most of the irrigated districts were in low and a few were in high category. Only two districts namely Ganganagar and Jaipur were classified in very high category. Udaipur, Jalore and Sawai-Madhopur were classified as medium category in the use of HYV seeds. The remaining irrigated districts viz. Chittor, Bundi and Bhilwara were put in low category. The important changes in

consumption of HYV seeds have been registered during 1980-83 and 2000-03. During this period, the HYV seeds consumption in highly irrigated districts have registered significant decline. The un-irrigated districts present a completely different pattern from irrigated districts. The consumption of HYV in these districts was far below from the irrigated districts in 1970-73.

Thus, we can say that the spread of agricultural technology over time and space has taken place at a varying level but the general trend has been of the increase, particularly in those districts where the base was very weak in the initial phase of adoption. This may be attributed to the fact that these irrigated districts were trying to keep pace with the adoption level of their neighbourhood[2].

Fertilizer is another important component of green revolution technology. The use of any type and quantity of fertilizer depends upon the requirement of the soil and crop. These two characteristics introduce variation in the consumption of fertilizers- both temporally and spatially. Fertilizer consumption in Rajasthan is far below the national average and also as compared to other agriculturally developed states like Harayana, Punjab, Gujarat and western Uttar Pradesh. Since fertilizer is more sensitive to irrigation facilities, the opportunity to use fertilizer is limited in Rajasthan. It is found that, the consumption of fertilizer recorded higher rate of increase in those districts which were provided with irrigation facilities. The major changes in consumption of fertilizer have occurred during 2000-03. In this period all irrigated districts viz.; Jalore, Bharatpur, Bhilwara, Sirohi, Kota, Ganganagar and Bundi have registered significant increase in fertilizer consumption.

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[2] Satish C. Sharma (1982), *Technological Response in Developing Agriculture (Rajasthan: A Case Study)*, National Publishing House, New Delhi.

The study reveals that, over the period, consumption of fertilizer has increased significantly in both sets of districts, irrigated as well as un-irrigated. But if we compare the consumption of fertilizer with irrigation and HYV seeds, a causal relationship among these three is found. The increased irrigation facilities helped the intensive use of HYV seeds, and HYV seeds require comparatively more fertilizer when compared to traditional varieties of seeds.

Plough is a traditional implement. However, the spread of tractor has limited the use of traditional plough. But in Rajasthan it is still used particularly by small farmers. The number of ploughs in Rajasthan has been almost constant. It is notable that the use of higher number of ploughs is not a positive sign of technological development. But it presents a clear picture whether the total area under crop or the area sown more than once increases with the increase of number of ploughs. If the number of ploughs decreased, it would mean either the farmers used more advanced technique (tractor) or the agriculture land was affected by drought or flood (in Rajasthan drought occurs frequently). Bharatpur, Chittor, Ganganagar, and Udaipur are those districts which recorded significant decline in the number of ploughs. The decline was the highest in Chittor followed by Ganganagar and Bharatpur. It means that the number of tractors in these districts had increased during this period. On the contrary, remaining irrigated districts recorded positive growth in the number of ploughs. However, the over all growth in plough (1997 over 1977) for all the irrigated districts has been negative barring a few cases.

The cultivation with tractor is more profitable as compared to plough. Tractor is also helpful in increasing the cropping intensity. The number of tractors in Rajasthan was at a low level in 70s. It has increased continuously in the later periods in both of the irrigated and un-irrigated districts. However,

the gap between the number of tractors in irrigated and un-irrigated districts is quite large.

Pumpsets are the main implements used in lifting water for irrigation. It is established that number of pumpsets is comparatively less in those districts where the canal irrigation is the prime mode of irrigation. For instance in Ganganagar, Bharatpur, Kota and Sawai-Madhopur, the area under canal irrigation is very high and consequently the number of pump sets in these districts was less as compared to other districts.

An analysis of cropping pattern reveals that the expansion of irrigation facilities has brought some change in the cropping pattern. In general, cropping pattern has shifted from coarse cereal to wheat and oil seed based cropping pattern in the State. It has been seen that though irrigation is the major determinant of cropping pattern as well as agricultural productivity, but the importance of rainfall as a determinant must not be neglected, because in Rajasthan seasonal rainfall plays a very crucial influences on cropping pattern and agricultural productivity. Eleven districts of western Rajasthan which cover about 61 percent of geographical area of the state, are completely dependent on rainfall except in Ganganagar, irrigation facilities have been developed.

While the Gross Cropped Area and Gross Irrigated Area registered a noticeable increment during whole period. The Net Irrigated area and Net Cropped Area have remained comparatively constant during the whole period.

The study has revealed that the irrigation facilities are more important than rainfall when we consider the growth of area as a parameter. Whenever, growth of irrigation was high in the state, the area under major crops had also

increased. The cropping pattern completely depends on both the determinants (rainfall as well as irrigation).

An analysis of cropping pattern of Rajasthan reveals that the food-grains claimed the highest area of GCA and hardly any diversification away from food-grains is expected. However, wide fluctuations in percentage of gross irrigated area have been found in the irrigated districts during the entire period of the study. The area under bajara recorded a slight decline while substantial reduction was recorded in area under jowar during the period of the study. Maize presented a dramatically different picture from the coarse cereals and it has registered a significant increase during 80s. The areas under wheat, rice, sugarcane, and cotton have been more or less constant during the period of study.

Among the un-irrigated districts bajara was major food-crop during the whole period. The cropping pattern in these districts shows some special changes in cereal crops; however the area under pulses showed a slight decline. The un-irrigated districts present a totally different picture from that of irrigated districts, though bajara was the dominant crop in both of them. In contrast, the area under irrigated crop like wheat has covered less area in un-irrigated districts as compared to irrigated districts.

It has been found that there has been distinct shift away from coarse grain to wheat and oil seeds. The loss in the area under coarse grain and pulses almost equals the gain in the area under wheat and oilseeds. However, in some cases pulses also have gained area. Therefore, in general, it can be said that during the whole period the percentage of area under food-grains especially under coarse cereal and pulses has declined, while that of oilseeds has increased. Thus, the cropping pattern has undergone a drastic change in the study period.

The analysis to find out the determinants of changes in cropping pattern and productivity has thrown up different determinants in different periods. High association between the explanatory variables has been found. The gross irrigated area was positively and significantly correlated with HYV and fertilizer. Thus, it can be inferred that districts with higher gross irrigated area consume more fertilizer and HYV.

For un-irrigated districts, significant and positive association of agricultural productivity has been found with gross irrigated area, number of pumpsets and fertilizer consumption. However, the role of different determinants of agricultural productivity has been different in different periods. Fertilizer has been found as a significant determinant of agricultural productivity during 1970-73 with beta coefficient 0.638 at 0.01 per cent level significance. It explains 40 percent of the variations in the agricultural productivity. Pumpsets has been found as a significant determinant during 1980-83 with beta coefficient 0.626 at 0.01 level of significance. It explains 39 per cent of the variations in agricultural productivity. Gross Irrigated Area has been found significant as a determinant during1990-93. It has the beta value 0.657 at 0.01 level of significance and it explains 43 per cent variations in the level of agricultural productivity in the un-irrigated districts of Rajasthan. However, no significant determinant was found during 2000-03.

For irrigated districts, positive association of productivity has been found with fertilizer, HYV and number of tractors. This result supports the determinants found by the regression analysis. However, no significant determinant has been found during the first period (1970-73). During the second period, fertilizer and HYV seeds have been found as significant determinants of agricultural productivity. Out of them, fertilizer has greater influence than HYV seeds as it has a higher beta coefficient. Both of them are significant at 0.01 level and together they explain 78 per cent of the variations in agricultural productivity. The number of tractors has been found as

significant determinant of productivity during rest of the two periods. During 1990-93 it explains 64 per cent of the variations in agricultural productivity with beta coefficient 0.80 while during 2000-03 it explains 49 per cent of the variations in agricultural productivity with beta coefficient 0.70. It is significant at 0.01 level.

Thus, it is evident that different factors determine the level of agricultural productivity in irrigated and un-irrigated districts. However, fertilizer is the common determinant in both areas. Apart from fertilizer, while pumpsets and gross irrigated area determine the productivity in un-irrigated areas, HYV seeds and tractors are the major determinant of productivity level in irrigated areas. The cropping pattern in these districts has significantly shifted from coarse cereals to kharif oilseeds and pulses and they are generally less water intensive crops and produce better out come compared to coarse cereals. As a result the gross irrigated area and number of pumpsets is significant in these districts.

Fertilizer and HYV seeds which have been found as significant determinants of agricultural productivity largely depend on the availability of assured supply of water. This is why gross cropped area and pumpsets are found as significant determinants of productivity even in un-irrigated areas. A little increase in irrigation facilities largely increases the productivity through impacts on fertilizer and HYV seeds.

Rajasthan is characterised by problem of year to year fluctuation in agricultural output. Much of the fluctuations arise because of vagaries of monsoon, absence of assured irrigation facilities and non development of appropriate technology for dry land and un-irrigated districts. The available technology is very costly and requires large investment. In un-irrigated districts rain water harvesting and less water intensive crops like kharif oilseeds and pulses are the only feasible solution to increasing productivity.

The price of oilseeds and pulses was much higher than coarse cereals in general circumstances. Due to this fact the large scale diversification towards coarse cereal to oilseeds and pulses during the 1970-73 to1990-93 was noticed. But in later period the price of oilseeds was decreased by government. This led to a dramatic fall in oilseeds price and resulted in highly reduced income for the producers. Therefore, there is a need for government to take a considered view about this matter before border trade is fully liberalised. A two- fold strategy of maintaining a wedge between domestic and border price through appropriate tariff on the one hand, and improving yield level of these oilseeds and pulses through technology improvement on the other, may be desirable[3]. In any policy focussed towards increasing level of agricultural productivity, the agricultural determinants should be given focus for irrigated and un-irrigated areas respectively. Some strategies can be suggested for increasing productivity especially in un-irrigated and dry areas. Tractors and pumpsets are manifestations of the mechanical revolution in farm production. They ease the burden of human and bullock labour. Therefore, Tractors may have some causal connection with higher yields, and they also manifest the prosperity of a region.[4] Though tractors have not been found as a significant determinant for un-irrigated districts, it may help speed the ploughing and sowing of crops and thereby increase productivity in those parts of Rajasthan with little rainfall and low moisture retention.[5] Further, rain water should be optimally utilised through water harvesting and the package technology of HYV seeds, fertilizer and irrigation should ensure that the water-intensive crops are not adopted freely as it results in loss of water.

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[3] Bhalla, G.S. and Gurmail, Singh (2001), *"Indian agriculture: Four Decades of Development"*, Sage Publication, New Delhi.

[4] Adams John and Balu Bumb (1979), ibid, pp. 715-716.

[5] Jodha, N. S., (1974) " A Case of the Process of Tractorization", *Economic and Political Weekly*, review of agriculture, pp. A111-A118

Appendix 1
Correlations Matrix for Coarse Cereal
1970-73

	rainfall	bajara	jowar	maize
rainfall	1	-.706(**)	.420(*)	.610(**)
bajara	-.706(**)	1	-.578(**)	-.616(**)
jowar	.420(*)	-.578(**)	1	.123
maize	.610(**)	-.616(**)	.123	1
N	26	26	26	26

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Correlations Matrix for Coarse Cereal
1980-83

	rainfall	bajara	jowar	maize
rainfall	1	-.670(**)	.276	.593(**)
bajara	-.670(**)	1	-.497(**)	-.673(**)
jowar	.276	-.497(**)	1	.047
maize	.593(**)	-.673(**)	.047	1
N	26	26	26	26

** Correlation is significant at the 0.01 level (2-tailed).

Correlations Matrix for Coarse Cereal
1990-93

	rainfall	bajara	jowar	maize
rainfall	1	-.506(**)	.327	.586(**)
bajara	-.506(**)	1	-.396(*)	-.652(**)
jowar	.327	-.396(*)	1	.102
maize	.586(**)	-.652(**)	.102	1
N	26	26	26	26

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Correlations Matrix for Coarse Cereal
2000-03

	rainfall	bajara	jowar	maize
rainfall	1	-.629(**)	.113	.451(*)
bajara	-.629(**)	1	-.190	-.596(**)
jowar	.113	-.190	1	.025
maize	.451(*)	-.596(**)	.025	1
N	26	26	26	26

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Appendix 2: District-wise Average Productivity of 16 Major Crops, Number of pumpsets, number of ploughs, consumtion of fertilizer, number of tractors, use of HYV seeds, gross cropped area, rainfall, percentage of gross irrigated area, net shown area and gross irrigated area

Districts/ 1970-73	Productivity in money terms	Pumpset	plough	Fertilizer	Tractor	HYV	gca1970	rainfall	% of GIA	NSA	GIA
AJMER	28205.78	1100.00	70239.50	2.04	104.50	84378.00	434973	52.4	21.3	353888	92735.3
ALWAR	48189.99	3261.50	114485.00	11.71	672.00	109454.50	679777	75.3	15.6	477366	105706.3
BANSWARA	42711.48	574.50	101477.50	3.50	15.00	13451.50	246951	88.2	5.2	186407	12880.7
BARMER	36233.94	900.50	132884.00	0.00	113.50	16468.50	1406990	14.4	1.1	1311649	15404.0
BHARATPUR	56048.89	3507.00	151571.00	4.57	956.50	158149.00	656579	69.2	23.2	511198	152199.7
BHILWARA	32259.6	1245.00	113469.00	10.06	118.50	156786.00	401256	75.5	39.6	246258	158788.3
BIKANER	21771.73	18.00	51156.00	0.00	10.50	4889.00	638233	21.5	0.6	507349	3746.7
BUNDI	37715.78	304.00	48464.50	9.70	71.50	125490.00	254936	57.4	43.4	205632	110722.7
CHITTOR	38033.59	2984.00	123332.50	14.59	71.50	116388.00	435323	76.4	25.8	304145	112230.3
CHRU	28755.34	78.00	91618.00	0.00	35.00	553.00	1235499	39.9	0.0	1083834	499.3
DUNGARPUR	43134.2	344.00	76089.00	0.00	6.50	14409.50	159045	70.7	8.7	107031	13847.7
GANGANAGAR	38344.64	605.00	264428.50	41.72	2045.00	654846.00	1437313	22.0	45.7	1268945	656747.0
JAIPUR	37983.76	10630.00	33393.00	5.46	812.00	257762.00	923899	51.9	26.7	735147	246543.3
JAISALMER	20395.51	25.00	69955.50	0.00	17.50	210.00	151205	16.9	0.2	178522	252.3
JALORE	39290.49	2795.00	62197.00	0.12	120.00	319250.50	721107	45.8	10.1	636735	73172.0
JHALAWAR	35782.01	1323.00	161306.00	3.54	13.50	38008.00	340195	92.0	10.8	276271	36847.3
JHUNJHUNU	27135	989.00	54079.00	1.06	49.00	20718.50	504006	40.6	3.7	444245	18798.7
JODHPUR	33391.29	1475.00	85291.50	3.09	946.50	33338.50	1173379	51.2	2.8	1037847	33068.7
KOTA	54368.32	1283.50	103437.00	20.41	212.00	154306.50	627447	58.2	24.3	546749	152693.7
NAGAUR	31931	1196.00	118300.00	0.00	546.00	30820.00	1231632	43.2	2.4	1116046	29453.3
PALI	36066.36	1663.50	86447.50	3.69	496.00	96791.00	609252	51.0	17.8	539399	108201.3
SAWAI-MADHOPUR	44319.15	1427.00	102684.00	9.54	125.00	108041.50	582490	66.0	17.8	459086	103838.3
SIKAR	32851.82	1747.50	70686.50	1.22	184.00	49362.50	581783	51.5	7.4	529449	43114.3
SIROHI	39958.05	866.00	35876.50	2.49	45.50	46277.50	186751	72.0	25.1	158519	46907.3
TONK	39911.17	784.00	65470.50	3.48	58.00	72928.50	460337	56.0	15.8	400338	72916.7
UDAIPUR	60370.96	1791.50	206853.50	3.77	77.00	121200.00	452884	63.4	27.6	301576	124909.0
RAJASTHAN	37890.76	1650.67	99815.08	5.99	304.69	107856.85	635893.9	54.7	16.3	535524.3	97162.5

Districts/1980-83	Productivity in money terms	Pumpset	plough	Fertilizer	Tractor	HYV	GCA	Rainfall	% of GIA	NSA	GIA
AJMER	33384.34	7283.0	66941.5	14.55	465.5	51815.7	437962.3	50.2	12.4	361954.3	128938.0
ALWAR	60680.82	43256.0	114918.5	122.58	3374.0	256737.3	669369.7	49.9	33.2	482790.7	222221.7
BANSWARA	41985.5	5887.0	121440	24.95	39.5	10467.3	291260	107.0	9.0	216106.3	26091.7
BARMER	29638.83	3496.0	170165.5	25.56	751.5	26055.7	1516108	17.5	2.5	1487852	37943.7
BHARATPUR	48150.9	27056.5	117392.5	10.86	3878.5	635182.7	617538	59.2	27.6	496694	170139.3
BHILWARA	31828.32	9214.0	117168.5	40.51	659.5	40245.0	412552	60.9	43.7	299012.3	180358.7
BIKANER	37924.66	21.5	63013.5	2.61	415.0	26133.0	917774	42.0	4.5	888785.3	41598.3
BUNDI	38442.12	3740.5	62126	10.12	699.0	29180.3	290861.7	61.9	47.0	227112.3	136597.3
CHITTOR	49630.68	22368.5	139535	78.19	584.0	73585.3	512881.3	74.5	25.5	346954.7	130881.7
CHRU	26937.17	124.0	99029	0.62	309.5	11973.7	1416812	35.7	0.1	1304999	1315.3
DUNGARPUR	38534.62	3602.0	88524	83.72	19.0	19359.7	179557.7	85.8	10.3	124469	18472.3
GANGANAGAR	38814.97	3425.0	279156.5	221.51	11183.5	169330.0	1886580	28.7	50.5	1521329	953256.0
JAIPUR	41133.73	48658.5	39776	35.35	3405.5	217036.0	960750.7	64.3	43.9	760562	421985.7
JAISALMER	21595.35	29.0	134966	13.62	130.0	0.0	265906	20.4	0.1	265729	142.3
JALORE	30197.56	18448.5	69658.5	0.25	1388.5	68672.3	554755.3	24.7	29.8	617649.7	165456.0
JHALAWAR	59440.52	7945.5	158640.5	67.55	99.0	31476.3	381533.3	69.3	12.3	303229	47021.3
JHUNJHUNU	25998.18	6977.5	60370.5	3.97	263.5	42475.3	558900.7	34.3	13.7	434269.7	76538.0
JODHPUR	36351.05	6122.5	95562.5	28.74	3203.0	109246.0	1185039	34.5	6.0	1152926	71455.3
KOTA	46500.67	7578.5	118824	64.94	1091.0	165405.0	663709.3	50.8	29.4	557082	195226.7
NAGAUR	22611.64	7125.5	107015.5	101.35	2657.5	99923.3	1279048	39.2	6.3	1181817	81079.3
PALI	29295.8	13394.5	75707	32.93	2299.5	126001.7	597117.7	26.8	28.1	544624.7	167753.3
SAWAI-MADHOPUR	50218.71	18549.0	105711	46.52	721.5	150353.7	582071	61.8	24.7	485821.3	143945.0
SIKAR	34561.98	13447.5	75351	9.50	710.5	73135.3	597111.3	64.3	21.7	510817.3	129295.0
SIROHI	27897.16	6372.5	38900	2.88	321.5	41352.3	179386	40.7	34.9	149658.3	62595.3
TONK	29974.84	6531.5	68084	27.37	383.5	34562.0	482930.3	68.3	20.1	434894.3	97253.3
UDAIPUR	40707.12	14439.0	146875.5	43.96	301.5	46381.0	509551.3	57.7	28.5	344343.3	145213.7
RAJASTHAN	37401.43	11734.4	105186.6	42.87	1513.635	98311.0	690271.8	51.2	21.8	596210.8	148183.6

Districts/1990-93	Productivity in money terms	Pumpset	plough	Fertilizer	Tractor	HYV	GCA	Rainfall	% of GIA	NSA	GIA
AJMER	36238.02	13672.0	56889	36.60	1579.0	62859.3	457101	69.2	21.3	393964.7	97324
ALWAR	67029.58	66128.5	84136	157.16	10179.0	273771.7	708156.7	65.9	43.1	498726.3	305278.3
BANSWARA	58669.01	9000.5	148074	59.68	340.0	36984.7	324132.7	130.4	23.3	226334.7	75575
BARMER	35428.88	8697.0	83088	71.12	2344.0	37712.0	1564632	54.5	2.4	1523398	38125.67
BHARATPUR	66682.83	44113.5	303036	116.89	12410.0	179076.3	653646.3	61.4	35.9	522010.7	234954
BHILWARA	46327.89	13961.0	20741	48.42	2139.0	28067.0	476835	61.8	40.8	352757.7	194640
BIKANER	43666.16	6015.5	64845	6.96	2109.0	40029.3	989960.7	26.7	13.4	945873	132609.3
BUNDI	55488.19	7616.0	66577	43.15	2419.5	35538.0	321073	76.7	57.3	238512.7	183860.7
CHITTOR	61286.8	31015.0	158242	115.32	1879.0	54762.0	554629	80.6	36.6	378085.7	202739.7
CHRU	37719.56	12326.5	129025	321.17	1280.0	22846.0	1394945	23.2	0.5	1024539	7139
DUNGARPUR	52870.08	10453.5	39629	180.45	878.0	631803.3	172634.7	84.0	30.8	131475.7	53228.33
GANGANAGAR	60608.22	5214.5	103157	298.67	16497.0	82657.3	1805619	24.2	64.4	1462293	1163597
JAIPUR	75612.15	34136.0	139177	51.35	18748.0	371531.7	1084191	56.2	41.9	837526.7	454484.7
JAISALMER	37730.78	147.0	39676	110.52	4345.5	184003.0	258791.7	23.1	1.4	257651.7	3535
JALORE	41479.78	13420.0	39592	4.73	3361.0	50838.0	762363.3	72.2	30.8	636472.7	235078
JHALAWAR	48642.05	32936.5	284513	124.43	2101.0	76055.3	416571.3	106.3	25.0	302494	104035
JHUNJHUNU	45252.72	16289.5	82051	3.69	998.0	75736.7	552155.7	40.1	18.4	433889.3	101496.7
JODHPUR	37498.95	23088.0	66604	50.45	5295.5	150555.3	1232910	52.6	8.1	842633.3	99547
KOTA	63648.06	22303.5	66650	204.65	5376.0	87226.0	729166.7	73.4	46.4	562583.7	338000
NAGAUR	44712.27	19215.5	138864	202.68	6123.5	143205.7	5223205	38.5	3.0	1260965	154449.3
PALI	49048.63	23467.0	68685	42.81	5429.0	153621.7	665437	66.2	26.9	600980	178806.7
SAWAI-MADHOPUR	57397.29	37771.0	50767	161.64	4145.0	158886.0	649637.3	69.7	28.4	470543	184787
SIKAR	45953.72	34339.0	109592	40.18	2873.5	183250.7	616915.3	34.2	25.1	521154.3	154816.3
SIROHI	55615.58	21092.5	73793	27.52	1469.5	116556.7	197397.3	98.8	41.0	158745.3	80893.33
TONK	38462.14	13433.0	32026	85.36	1621.5	60744.7	498874	60.8	24.4	453239.3	121873
UDAIPUR	45831.77	25435.5	69333	94.49	1789.0	98598.0	499305.3	66.6	34.0	351610.7	169801.3
RAJASTHAN	50342.35	20972.6	96875.46	102.31	4528.058	130650.6	877318.7	62.2	27.9	591863.8	195025.9

Districts/2000-03	Productivity in money terms	Pumpset	plough	Fertilizer	Tractor	HYV	GCA	Rainfall	% of GIA	NSA	GIA
AJMER	33723.12	35879.0	48252	152.82	4457.0	11687.0	449192.3	37.3	22.2	355845	84126.33
ALWAR	66276.47	101552.0	29221	442.66	16284.0	401725.3	799590.7	43.1	59.6	496845	455755
BANSWARA	53275.84	9835.0	187162	262.56	683.0	142729.3	308524	54.8	20.2	227941	57972.33
BARMER	56677.83	18106.0	166561	207.85	8091.0	0.0	1732228	22.1	9.9	1420562	165196.7
BHARATPUR	81917.72	113575.0	49202	468.82	42259.0	572371.7	1046765	47.1	45.8	702505.7	461719.7
BHILWARA	55140.8	49673.0	106477	464.34	3991.0	83159.0	455350.3	49.0	30.8	340828.7	119277
BIKANER	51220.39	1199.0	75221	28.62	4960.0	2428.7	1385629	23.3	17.7	1039097	228513.3
BUNDI	53443.62	30584.0	69147	57.36	4473.0	120346.3	381682	57.5	57.1	222964.3	177982.3
CHITTOR	61093.15	89696.0	160082	199.35	4259.0	228399.3	536613.3	52.7	25.1	393262.7	115429.7
CHRU	43201.12	3294.0	113138	375.07	3606.0	49114.3	1195251	26.2	5.2	927520.3	55746.67
DUNGARPUR	57076.75	14525.0	136389	142.91	610.0	100730.7	152344	46.6	14.0	114662.3	17625
GANGANAGAR	63532.69	19727.5	215841	616.25	42276.0	502596.0	1721510	18.3	70.5	1112882	1291228
JAIPUR	62176	150592.0	30315	111.21	20381.0	196782.0	1240912	34.3	49.1	800479.3	554861
JAISALMER	52295.9	232.0	50056	90.87	1145.0	0.0	531607.3	15.5	21.8	329572.7	93508.67
JALORE	50696.19	64748.0	87685	183.35	14164.0	349753.7	804394	30.6	29.0	602505	219495
JHALAWAR	55408.13	54907.0	75414	460.55	2535.0	21934.3	439874.3	72.0	31.9	301595.7	121099.3
JHUNJHUNU	66109.4	35881.0	61762	18.97	2731.0	78022.3	641186	32.5	38.1	395008.3	226026.3
JODHPUR	50309.06	13454.0	33276	108.14	13997.0	72293.3	1335840	23.6	15.8	872700.7	180130.7
KOTA	73019.96	62058.0	112467	494.53	10705.0	115027.0	696103.7	69.0	54.4	405729	395881
NAGAUR	53674.08	30637.0	31726	169.50	11645.0	369381.0	1418196	27.8	22.2	1061406	287734
PALI	44000.41	37218.0	39142	59.11	8963.0	49828.0	610770	36.4	22.1	486495	116440.7
SAWAI-MADHOPUR	55084.95	42065.0	48762	412.37	4506.0	100101.7	348191.7	41.5	42.9	223104.3	123221.7
SIKAR	57294.69	44919.0	51017	309.04	4844.0	248379.0	711657.3	32.1	39.7	483569	265909
SIROHI	56188.12	21029.0	34274	79.48	2226.0	124902.7	177117	51.6	33.0	133565.3	52178
TONK	41732.65	41872.0	491898	69.15	5333.0	25868.3	519544	43.8	32.9	381147	132722.7
UDAIPUR	58428.63	53823.0	305781	174.30	2476.0	41503.3	386255.3	47.4	15.0	320977.3	50600.67
RAJASTHAN	55884.53	43887.7	108087.2	236.89	9292.308	154194.8	770243.4	39.8	31.8	544337.4	232706.9

Appendix 3

Percentage change in area under various crops in Rajasthan and its districts during 1970-73, 1980-83, 1990-93 and 2000-03

RAJASTHAN	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	25.5	8.3	6.9	10.6	3.1	1.8	57.3	18.6	75.9	7.6	0.3	2.2
1980-83	22.7	7.0	8.7	12.2	2.6	1.8	55.6	17.3	72.9	7.7	0.3	1.6
1990-93	19.2	5.6	8.7	11.1	1.3	1.5	47.8	15.3	63.1	14.9	0.2	1.4
2000-03	16.4	4.0	10.4	11.2	0.9	1.3	44.5	13.2	57.7	9.9	0.1	0.9
AJMER	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	14.1	25.1	11.6	9.5	7.4	0.0	67.8	12.0	79.9	11.2	0.0	3.3
1980-83	11.4	27.3	8.5	9.3	5.4	0.0	62.0	11.6	73.6	5.0	0.0	4.1
1990-93	16.7	26.2	6.6	8.6	3.3	0.0	61.4	14.7	76.1	11.0	0.0	2.1
2000-03	14.4	26.8	8.1	6.5	1.9	0.0	57.6	18.5	76.1	3.7	0.0	1.5
ALWAR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	24.8	3.3	1.8	11.3	5.7	0.1	47.0	28.9	75.8	14.7	0.1	0.0
1980-83	26.5	2.4	1.8	19.1	5.6	0.0	55.4	15.9	71.2	10.1	0.0	0.0
1990-93	23.7	2.5	1.8	17.4	2.0	0.0	47.4	11.8	59.2	31.2	0.0	0.2
2000-03	22.4	3.5	1.4	23.3	2.1	0.0	52.7	7.5	60.2	25.3	0.0	1.2
BANSWARA	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.0	1.8	29.2	6.9	0.9	15.3	62.0	15.7	77.7	5.8	0.4	14.5
1980-83	0.0	2.4	29.7	11.5	1.2	16.5	66.5	24.5	91.0	1.6	0.4	6.2
1990-93	0.0	1.4	32.1	16.2	0.6	12.7	67.0	26.3	93.3	0.5	0.4	3.3
2000-03	0.0	0.3	40.2	15.2	0.4	11.4	69.3	17.3	86.6	0.2	0.2	2.6
BARMER	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	74.2	0.2	0.0	0.9	0.0	0.0	75.2	2.1	77.3	1.1	0.0	0.0
1980-83	67.6	0.1	0.0	0.6	0.0	0.0	68.3	4.1	72.4	1.6	0.0	0.0
1990-93	56.2	0.1	0.0	0.9	0.0	0.0	57.2	8.3	65.5	1.1	0.0	0.0
2000-03	50.9	0.1	0.0	0.8	0.0	0.0	51.8	14.0	65.7	0.5	0.0	0.0

BHARATPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	21.5	4.9	0.0	20.3	3.1	0.8	50.7	24.0	74.7	17.5	0.6	0.0
1980-83	28.7	3.8	0.0	20.2	3.6	0.4	56.7	13.0	69.6	18.4	0.2	0.0
1990-93	19.4	3.5	0.0	17.7	0.9	0.4	41.9	6.4	48.3	45.6	0.0	0.0
2000-03	18.9	4.5	0.0	23.7	0.7	0.4	48.2	6.4	54.7	21.0	0.0	0.1
BHILWARA	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.5	7.8	30.4	15.1	9.3	0.0	63.2	8.2	71.4	11.7	0.4	8.8
1980-83	0.4	8.5	32.6	15.9	6.3	0.0	63.8	6.8	70.6	8.6	0.3	6.3
1990-93	0.3	7.4	31.6	15.9	4.3	0.0	59.6	12.3	71.8	20.1	0.1	3.9
2000-03	0.3	8.3	35.6	11.9	1.7	0.1	57.9	12.7	70.6	8.3	0.0	1.3
BIKANER	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	38.5	0.1	0.0	0.0	0.0	0.0	38.8	42.2	81.0	1.2	0.0	0.0
1980-83	26.3	0.1	0.0	1.0	0.0	0.0	27.4	33.0	60.4	3.0	0.0	0.2
1990-93	23.3	0.2	0.0	2.5	0.0	0.0	26.1	32.1	58.2	5.2	0.0	1.2
2000-03	10.3	0.1	0.0	2.8	0.1	0.0	13.2	21.7	34.9	3.9	0.0	0.7
BUNDI	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.3	19.7	8.7	30.9	3.1	3.5	66.2	18.7	85.0	6.8	1.7	0.0
1980-83	0.4	14.6	11.5	27.1	2.0	5.6	61.2	13.8	75.1	7.4	3.4	0.0
1990-93	0.3	8.9	12.4	26.7	1.0	3.8	53.1	10.0	63.1	19.6	2.2	0.0
2000-03	0.5	1.4	9.1	24.0	0.5	7.5	43.0	12.6	55.6	10.8	1.2	0.0
CHITTOR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.0	12.3	21.9	19.1	1.2	0.8	55.5	12.0	67.5	14.8	0.7	5.7
1980-83	0.0	9.7	22.4	15.5	1.1	0.5	49.4	23.7	73.1	11.5	0.7	1.3
1990-93	0.0	5.7	23.5	14.1	0.7	0.2	44.3	15.7	60.0	23.3	0.4	0.3
2000-03	0.0	2.9	29.5	10.4	0.5	0.1	43.5	7.5	51.0	10.0	0.2	0.2
CHURU	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	35.8	0.0	0.0	0.0	0.1	0.0	35.9	39.3	75.2	0.1	0.0	0.0
1980-83	31.3	0.0	0.0	0.2	0.6	0.0	32.1	36.1	68.2	0.3	0.0	0.0
1990-93	29.4	0.0	0.0	0.2	0.0	0.0	29.6	39.7	69.3	0.8	0.0	0.0
2000-03	35.1	0.0	0.0	1.3	0.3	0.0	36.7	21.2	57.9	2.2	0.0	0.0

DUNGARPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.6	0.9	34.0	10.5	1.9	17.9	75.5	15.4	90.9	3.1	0.5	2.0
1980-83	0.1	0.3	30.5	15.9	2.3	17.2	71.6	17.9	89.5	1.6	0.5	0.4
1990-93	0.1	2.4	28.3	15.2	1.1	17.9	68.7	24.0	92.7	0.7	0.5	0.1
2000-03	0.1	0.6	46.8	9.4	0.3	9.7	70.0	14.5	84.5	0.8	0.1	0.1
GANGANAGAR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	10.3	0.4	0.1	12.8	2.9	1.0	27.5	39.0	66.5	3.0	0.5	8.9
1980-83	4.3	0.1	4.2	14.2	1.3	0.9	24.9	33.8	58.7	3.6	0.2	14.0
1990-93	3.4	0.0	0.0	17.4	0.7	1.0	22.5	25.2	47.7	12.9	0.1	21.4
2000-03	4.3	0.0	0.0	22.5	1.5	1.8	30.1	17.2	47.3	15.6	0.1	13.7
JAIPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	30.2	3.9	2.8	10.0	10.5	0.0	57.5	24.5	82.0	7.7	0.0	0.0
1980-83	27.2	3.7	2.4	18.5	7.4	0.0	59.1	20.8	80.0	5.3	0.0	0.0
1990-93	29.3	3.0	1.4	17.3	4.6	0.0	55.6	11.6	67.2	21.2	0.0	0.0
2000-03	27.2	2.8	0.8	20.0	4.9	0.0	55.6	11.1	66.7	13.9	0.0	0.0
JAISALMER	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	77.6	1.2	0.0	0.6	0.0	0.0	79.5	0.1	79.6	0.0	0.0	0.0
1980-83	64.6	1.0	0.0	0.5	0.0	0.0	66.0	0.1	66.1	0.3	0.0	0.0
1990-93	45.0	1.1	0.0	0.8	0.0	0.0	47.0	0.2	47.2	0.8	0.0	0.0
2000-03	15.1	0.3	0.0	1.9	0.0	0.0	17.3	2.4	19.7	4.5	0.0	0.1
JALORE	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	55.8	0.3	0.0	5.9	0.2	0.0	62.8	5.3	68.1	7.0	0.0	0.1
1980-83	61.0	0.2	0.1	7.7	0.5	0.0	69.8	5.3	75.1	19.2	0.1	0.3
1990-93	40.7	0.3	0.0	5.2	0.1	0.0	46.5	8.3	54.8	15.6	0.0	0.2
2000-03	44.1	0.4	0.0	3.8	0.0	0.0	48.5	9.4	57.8	6.2	0.0	0.0
JAHALAWAR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	1.0	36.5	10.5	13.1	0.4	0.5	62.0	12.5	74.5	9.1	0.3	8.2
1980-83	1.0	22.1	9.7	9.9	0.2	0.2	43.2	20.2	63.4	7.9	0.1	2.9
1990-93	0.3	18.1	16.3	10.0	0.1	0.1	44.8	19.0	63.8	6.4	0.1	0.5
2000-03	0.0	2.4	10.5	8.7	0.1	0.1	21.6	9.2	30.9	4.0	0.0	0.0

JHUNJHUNU	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	44.8	0.1	0.0	1.6	1.6	0.0	48.1	32.5	80.6	0.9	0.0	0.0
1980-83	44.5	0.0	0.0	5.1	6.0	0.0	55.6	26.4	81.9	3.1	0.0	0.0
1990-93	44.0	0.0	0.0	5.5	0.9	0.0	50.5	20.6	71.1	8.4	0.0	0.0
2000-03	38.0	0.0	0.0	9.5	1.0	0.0	48.5	21.6	70.1	11.7	0.0	0.0
JODHPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	56.0	1.7	0.0	2.2	0.1	0.0	60.0	16.9	76.9	5.1	0.0	0.1
1980-83	50.4	0.7	0.0	2.6	0.1	0.0	53.8	16.3	70.1	5.7	0.0	0.1
1990-93	50.7	1.7	0.0	1.8	0.0	0.0	54.3	16.9	71.2	8.3	0.0	0.2
2000-03	30.8	1.9	0.0	3.1	0.0	0.0	35.9	12.2	48.1	4.6	0.0	0.5
KOTA	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.3	28.5	2.9	29.0	0.8	1.3	62.8	17.5	80.2	8.4	0.2	0.0
1980-83	0.6	25.8	4.9	22.4	0.9	1.7	56.3	19.7	76.0	10.2	0.1	0.0
1990-93	0.3	11.8	5.2	17.9	0.4	0.5	36.2	13.0	49.1	20.6	0.1	0.0
2000-03	0.4	2.9	4.6	20.2	0.2	1.4	29.7	7.3	37.0	16.3	0.0	0.0
NAGAUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	45.4	6.4	0.1	2.0	0.8	0.0	54.6	23.9	78.5	7.3	0.0	0.1
1980-83	42.4	4.0	0.1	11.5	0.9	0.0	58.9	18.9	77.8	9.7	0.0	0.2
1990-93	10.2	0.8	0.0	0.6	0.1	0.0	11.7	5.5	17.2	11.2	0.0	0.1
2000-03	26.9	3.5	0.0	5.8	0.8	0.0	37.0	25.4	62.3	5.0	0.0	0.5
PALI	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	27.5	10.5	4.6	9.6	3.9	0.0	56.5	5.7	62.2	17.0	0.0	1.6
1980-83	18.2	8.5	6.2	11.7	2.8	0.0	47.7	6.5	54.3	21.1	0.0	2.7
1990-93	19.8	13.7	4.2	8.9	1.0	0.0	47.6	8.5	56.1	30.3	0.0	1.7
2000-03	14.5	15.8	3.8	8.1	0.5	0.0	42.7	8.1	50.9	14.2	0.0	0.9
SAWAI-MADHOPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	23.4	8.9	0.7	16.4	5.2	1.0	55.6	25.3	80.9	13.1	0.2	0.0
1980-83	24.1	12.1	0.7	20.0	3.4	0.8	61.2	14.1	75.4	12.9	0.2	0.0
1990-93	22.3	6.3	0.4	14.2	0.9	0.4	44.5	9.0	53.4	31.6	0.0	0.0
2000-03	16.6	2.0	0.3	17.5	0.5	0.1	36.8	10.9	47.7	30.8	0.0	0.0

SIKAR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	45.5	0.0	0.0	2.3	2.9	0.0	50.9	25.8	76.7	1.6	0.0	0.0
1980-83	40.9	0.0	0.0	6.1	2.1	0.0	49.2	24.2	73.4	2.9	0.0	0.0
1990-93	43.1	0.0	0.0	7.8	2.1	0.0	53.1	17.7	70.8	5.0	0.0	0.0
2000-03	36.2	0.0	0.0	11.9	3.0	0.0	51.1	22.8	73.9	5.8	0.0	0.0
SIROHI	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	25.0	2.3	10.4	13.9	2.0	0.0	61.0	13.2	74.3	14.6	0.0	1.7
1980-83	11.0	2.7	14.8	13.0	1.6	0.1	49.4	18.5	68.0	16.8	0.0	2.1
1990-93	13.2	2.3	13.0	12.3	1.0	0.0	45.5	18.2	63.7	25.1	0.0	1.6
2000-03	11.1	3.0	15.2	9.0	0.7	0.0	41.7	7.0	48.7	15.4	0.0	0.8
TONK	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	8.6	18.9	5.1	18.9	8.9	0.0	60.2	14.7	74.9	7.7	0.2	0.3
1980-83	7.6	27.7	4.9	22.8	4.9	0.0	68.0	13.9	81.9	5.6	0.2	0.2
1990-93	7.8	23.4	3.9	15.5	2.7	0.0	53.2	8.8	62.0	23.0	0.1	0.0
2000-03	8.4	14.7	3.2	10.9	1.3	0.0	38.6	19.0	57.6	19.5	0.0	0.1
UDAIPUR	bajara	jowar	maiz	wheat	barley	rice	total cereal	total pulses	total foodgrain	total oilseed	sugarcane	cotton
1970-73	0.2	19.5	5.6	12.5	8.4	3.2	51.9	9.0	60.9	7.2	1.1	2.9
1980-83	0.0	3.3	40.5	14.5	6.3	2.9	68.6	10.4	79.0	6.4	1.4	1.1
1990-93	0.1	4.2	44.5	17.4	4.9	2.6	74.2	13.0	87.2	7.6	0.7	0.6
2000-03	0.1	4.7	61.0	8.1	1.3	1.4	76.8	6.5	83.4	4.0	0.2	0.1

Source-

- Agriculture Statistics of India, 1970-73, 1980-83, 1990-93.
- Statistical abstract of Rajasthan,1970-73, 1980-83, 1990-93, 2000-03.

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