A Study on "Climate Change Vulnerabilities and Agriculture cum NRM Based Resilience Strategies in Selected Areas of Rajasthan"

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Acronyms/Abbreviations

ASMO – Area Sown More than Once
BPL – Below Poverty Line
CEDSJ – Centre for Environment and Development Studies, Jaipur
CGWB– Central Ground Water Board
CMGW - Community Management of Groundwater
DCB – Dug Cum Borewell
FAO – Food and Agriculture Organisation
FPC – Farmers Producer Company
FPO – Farmers Producer Organisation
GOI - Government of India
IWRM – Integrated Water Resources Management.
IFS- Integrated Farming System
PRI – Panchayati Raj Institution
RWH- Rain Water Harvesting
SGWD – State Ground Water Department
VDC – Village Development Committee
VSC –Village Service Centre
SC – Scheduled Caste
ST – Scheduled Tribe
OBC – Other Backward Caste

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A STUDY ON CLIMATE CHANGE VULNERABILITIES AND AGRICULTURE CUM NRM BASED RESILIENCE STRATEGIES IN SELECTED AREAS OF RAJASTHAN

CHAPTER I
INTRODUCTION

1.0 Introduction

Meeting the demand of future food needs, while conserving natural resources, improving nutrition and improving farm livelihoods are the main challenges of 21st century. The Asian region is home to more than 60% of the world's population; natural resources are already under stress, andresilience of most sectors to climate change is poor. Many countries are socio-economically dependent on natural resources such as water, forest, grassland and rangeland, and fisheries, and changes to these resources because of climate change will have far-reaching implications. The Tribal Population is more vulnerable as even today their dependence on natural resources is highest compared to others.

Small farmers or family farmers, for whom farming is a way of life, produce about 80 percent of the world's food. Traditionally, farming was localized, meeting several needs of the household providing food, fodder, fuel, besides employment and small incomes. In its effort to meet the food sovereignty rather food security of the growing population through increased food production, the process of green revolution, pushed farmers to shift to high input intensive, mono-cropping agricultural systems. The severe negative consequences are already being felt across many facets of life on this planet – social, cultural, economic and ecological. This mono-croppingagriculturalsystem is more vulnerable to climate change compared to the traditional mix farming system. Solutions to environmentally and socially damaging human practices today require re-establishing connection with agriculture and other earth caring practices.

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The physical effect of climate change will have direct and indirect impact on economic and social structure and natural system of the selected areas of study in Rajasthan. The manifestation of climate change and impact will vary across regions, social and economic status of population and type of natural resources. Given this context, it is important to investigate the ways and means to build resilience at both the household and Panchayat level in the different Agro-climatic region of Rajasthan.

Resilience in a social system can be defined as the added capacity of humans to anticipate and plan for the future. Resilient livelihoods are those that can first recover (self-organize) after disruption and, following recovery, are capable of learning and adopting; they have a strong ability to cope with surprises and changes as condition require. Resilience as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

(1) The amount of change the system can undergo and still return the same controls and function and structure
(2) The degree to which the system is capable to self-organization,
(3) The ability to build and increase the capacity for learning and adaptation.

Strengthening the adaptive capacity of population at all levels from the local to the global is, as a result, among the most important challenge faced in the process of development. Our meaning of adaptive strategies starts from recognition that variability and change are inherent and often desirable features of natural and human systems. Rather than attempting to fundamentally reduce or eliminate inherent change process or variability, approaches need to work with them.

Traditionally the coping strategies of households in rural areas use to respond to climate variability and extreme events (drought and floods) can be grouped in three broad categories:

(i) **Risk Minimization**, involving crops and livestock, non-farm income diversification and accumulation of assets and savings;
(ii) **Risk Absorption**, involving the sale of livestock and non-productive assets, a search for new source of income, and collection of debts;
(iii)**Risk Taking to Survive**, involving reduced consumption, sale of productive assets, and reduce socialization.

While analysing livelihood strategies, it is essential to recognize that rural people are not just farmers, they also include factory workers, farm labourers, miners and mine workers, craft people, and so on. Different people at different stages of their lives adopt different livelihood

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strategies. The social and economic worlds that influence decision making at local levels go well beyond the farm gate and include networks of social relations. The national economic and social policies and conditions, international economic trends, price levels, market functioning, and levels of infrastructure and service support also affect them.

Vulnerability of a group of population or a household depends on their economic condition. Vulnerability indicators are mostly relative and qualitative and therefore, difficult to quantify for any population. However, some broad indicators can be listed, such as, forced migration, borrowings, skipping meals or food shortage, forced to change occupation, forced unemployment, falling health conditions etc. Most of these variables require deep probing to identify vulnerability of a household to climate variability and/or change.

Various agencies both government and non-government have taken initiatives to deal with the challenges emerged due to climate change in Rajasthan, such as, on policy side; Rajasthan State Environment policy 2010, Rajasthan Environment Mission & Climate Change Agenda for Rajasthan (2010-2014), Climate Change Action Plan, etc. In the past government, NGOs and civil society organization have been working seriouslyfor development of tribal areas and tribal population. Despite all good intensions the past efforts in building infrastructure, improving accessibility to these areas, education, health, natural resources management, agriculture, livestock, etc. could not change the condition-position of the tribal people to the desired level. Since not all these efforts fell in the category of integrated efforts, they could not address the future challenges particularly faced because of climate change and eroded the capacity of community to self-organize. Therefore, there is a need to draw new plans/strategies for the development of people/areas that makes the society more climate resilient and self-sustaining. The new interventions have to be evolved based on the socio, economic, and geographic specificities of the regions.

1.1 Scope of the Assignment

- Mapping of geographical, social and economic features of intervention regions.
- To list possible effects of Climate Change/Variability on agriculture and animal husbandry sectors or livelihood of the people in the proposed intervention areas.
- Document elements of climatic risk affecting livelihood of population in selected areas and the present practices of people to cope or adapt to climate variability/change.

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- To understand how pattern and trends of economic development affect vulnerability and exposure to climate impact on most poor and marginalized groups from tribal, Women and Dalit population and natural resources.
- Suggest strategies in the area of agriculture and allied activities to achieve greater climate resilience.

1.2 Methodology

For this study, range of tools are being used, such as, desk review, collection of primary data by organizing focused group discussion with key informants and other stakeholders, and direct field observations. As the selected regions differ in terms of geographical conditions, resource availability, socio economic condition of the population and livelihood pattern it will be essential to visit these areas to know vulnerability, coping and adaptation practices adopted by people. Detailed discussions will be organized with selected households and consultations with PRI representatives in the six selected regions. Broadly, Modified Sustainable livelihood framework will be used in identification of interventions for the selected regions.

The details on the selected regions are as follows:

Table 1: Blocks and Panchayats for the Climate Change Study

Region	District	Block	Gram Panchayat
Eastern	Baran	Kishanganj	Bakanpura
		Shahbad	Ranwas
	Kota	Kherabad	Alod (Khani)
Western	Jaisalmer	Jaisalmer	Kita
		Sam	Fatehgarh
	Nagour	Kuchaman	Todas
		Khivsar	Karnu
Southern	Udaipur	Kurabad	Sulavas (Rawatpura)
		Jhadol	Gejvi
	Pratapgarh	Pratapgarh	Devgarh

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CHAPTER II
MAPPING OF GEOGRAPHICAL, SOCIAL AND ECONOMIC FEATURES

Livelihood of people in a given geographical area is shaped by the availability of natural resource, climate, stage of economic development, and capacity of people to manage the given resources. In this section the status of natural resources and all the aspects listed above for the selected Districts, Blocks and Gram Panchayats are discussed and analysed to plan intervention for climate resilient development. The main features covered are; location, climate and rainfall, geomorphology, geohydrology, soil characteristics, groundwater and its quality, landuse, cropping pattern, livestock and human population.

2.1 NAGAURDISTRICT

Nagaur district is located almost in the middle of the state of Rajasthan and extends between North latitudes 26°25' and 27°40" and East longitudes 73°10" and 75°15". It covers an area of 17778 sq. km. out of which 17448.5 sq. km is rural area and 269.5 sq. km is urban. Nagaur district covers only 5.18 percent of the total area of the state. There are 13 tehsil headquarters in the district viz. Nagaur, Khinwsar, Jayal, Degana, Didwana, Ladnun, Parbatsar, Makarana, Nawa, Kuchaman, Riyanbadi and Mundwa. The district is divided into 11 blocks (Panchayat Samitis) viz. Nagaur, Mundwa, Jayal, Merta, Riyan, Degana, Didwana, Ladnun, Parbatsar, Makarana and Kuchaman.

Climate and Rainfall

The district experiences arid to semi-arid type of climate. Mean annual rainfall (1957-2018) of the district is around 410 mm (Figure 1) whereas normal rainfall (1901-1970) is lower than average rainfall and placed at 363.1 mm. It is obvious that there is significant decrease in rainfall during the last 60 years. Almost 80% of the total annual rainfall is received during the southwest monsoon. There is not much variation in aerial distribution of rainfall. However, the southern part of the district gets slightly more rainfall than northern part. The monsoon enters the district in the first week of July and withdraws by the middle of September. The nature of rainfall has changed as there are more sporadic rains, and stress period has increased. The five, seven, and ten years moving averages (Figure 1) shows that variability in rainfall has decreased during the last decade. The rainy days are limited and it has decreased from 23 in 1957 to 16 in 2018. Also shift in arrival and departure of monsoon has been observed.

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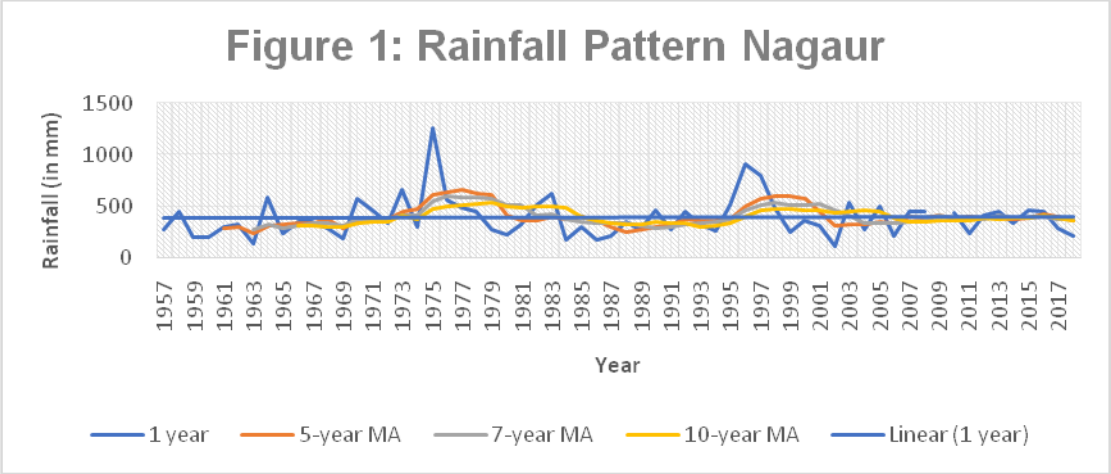
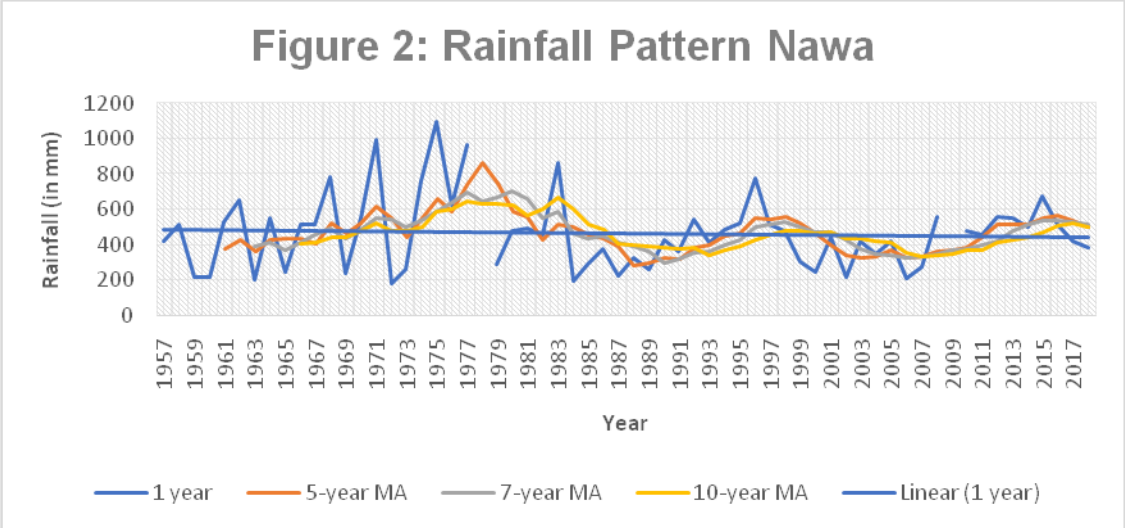


Figure 2 shows the rainfall pattern in the Nawa Block from 1957 to 2017. As mentioned above that there is an increasing trend average rainfall of the Nagaur district but in case of Nawa, reverse is observed. Trend line shows that rainfall has declined from around 500mm in 1957 to 415 mm in 2017. The five, seven, and ten years moving averages (Figure 2) shows that variability in rainfall has decreased during the last decade.



Geomorphology and Drainage

The general topography of the area is fairly even. Slope of the area is fairly even. Slope of the land surface is towards west and elevation varies from 250 meter above msl in south to 640 m above msl in north. South-eastern part of the district comprises small scattered hillocks. The northern, north-western and north-eastern parts of the district are covered by sand dunes. The offshoots of Aravalli range are projected along the common boundary of Ajmer district and Merta, Nawa and Parbatsar tehsils of Nagaur district.

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There is no river originating in the district. However, the river Luni which rises near Pushkar in Ajmer district, draining western slopes of the Aravalli, crosses the district in the southern part flowing for about 37 km in western direction. It is an ephemeral river and carries runoff that is generated in the upper reaches. Channel deposits of Luni facilitate percolation during rainstorm, thereby feeding the neighbouring wells along its bank. Other nalas and streams are also ephemeral in nature which originate and die out in the district itself.

Hydrogeology

Ground water occurs under unconfined to semi-confined conditions in rocks of Delhi Super Group, Nagaur Sandstone, Bilara limestone and unconsolidated sediments (valley fills and alluvium). These form the chief source of ground water in the district. Confined conditions is also met sometimes at deeper levels in the north-western part of the district.

Water Table

Based on the available data from State Ground Water Department (SGWD) the elevation of water table in the area ranges between 180 to 420 m amsl. Highest elevation of water table of nearly 420 m amsl in the south east part of the district while the lowest 180 m amsl in western part of Nagaur district.Depth of water level in the district varied from 5.00 to 68.46 mbgl and 4.97 to 68.06 mbgl during Pre-monsoon and Post-monsoon periods respectively.

Ground Water Quality

The State Ground Water Department's report for the district indicates that the quality of ground water in phreatic aquifer varies widely from saline to fresh. Electrical Conductivity (EC) ranges between 1380 to 16240 micromhos/ cm at 25^0C. It has been observed that by and large, EC conforms broadly with chloride concentration. In greater part of the area, it is within 5000 micromhos/ cm at 25^0C. Higher values of EC have been observed in the west central part of the district and in depressions near the saline lakes. The chloride content ranges from 50 to 5069 ppm in phreatic aquifer.

Fluoride in the ground water ranges between traces and 11.20 mg/l. Fluoride concentration in excess of maximum permissible limit of 1.5 mg/liter has been noticed in central and north-

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eastern parts of the district. Nitrate concentration in ground water varies widely. Its concentration ranges between traces to as high as 1000 ppm.

Soil Characteristics

Four types of soils have been reported in the district viz, clay, clay loam, sandy loam and sandy soil. The general texture of the soil in the area is sandy loam to clayey loam, which is further classified into “Barani” or un-irrigated and “Chahi” or irrigated soil. A part of Nagaur tehsil and south-eastern part of Merta tehsil have deep sandy loam, while red loamy soil exists elsewhere in Merta tehsil except on the banks of river Luni. Light loamy soil occurs in Parbatsar tehsil away from hill ranges. A longitudinal belt from Didwana to Nawa extending up to Sambhar Lake has the characteristics of alkaline soil.

Land Use

Total reported area for land utilization statistics in 2005-06 is 1764380 hectares and about 71% of the total areas are being cultivated (Net Sown Area) in the year 2005-06. General impression about the western districts of Rajasthan is that major area is either barren, grazing landor culturable waste landbut against this what is observed is that in Nagaur district these category lands are only around 13% or forestland comprises of 1%. Area sown more than once is 13%. It shows that most of the cultivated area is rainfed and sown in Kharif season only. The Land use pattern has marginally changed in the last 10 years (Appendix Table 1&2).

Cropping Pattern

The District is classified as Arid and Semi-Arid region. Bajra, pulses (Green gram, Choula and Mot), Guar and fodder crops (Jowar) are the main kharif crops in the region. The allocation of area under these crops vary according to pattern of rainfall. If there is timely arrival of monsoon people prefer to sow Bajra cropfollowed by green gram, Til, Jowar, and Guar. In case of delayed monsoon, Pulses and Guar are the preferred crops.

In Kharif season, farmers having assured irrigation grow Groundnut and Cotton crops in different blocks of the district. As livestock rearing is subsidiary, occupation of most household’s preference for fodder cultivation is noticed. Jowar under both irrigated and

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unirrigated conditions and Barseem and other green fodder crops on irrigated lands is cultivated in the district.

In order to measure change in cropping pattern over last 10 years, i.e. between 2005-06 and 2015-16 (Appendix Table 3&4),it is observed that in Kharif Bajra and Pulses account for 70 to 75 percent of cultivated area, Jowar less than 5%, Fodder crop 14 to 16%, and Groundnut less than 2%. Cotton has emerged as preferred crop in areas where groundwater availability has been recently identified, mostly towards Phalodi Block. Good number of tubewells have come up and on irrigated fields cotton and groundnut crops are widely cultivated. The water table is at 600 ft. with high TDS and farmers' have no idea how long this groundwater will last yet over extraction of water by installing motors of 40 to 50 HP capacity.

Traditionally, in Rabi season, on irrigated lands Wheat, Mustard, Gram, Barley and spices (mostly Chillies) and Onion crops were cultivated. The irrigated area use to be small but with the advent of drilling technology and electrification of villages the number of tubewell has increased many folds. Since 2005-06 the cropping pattern in the district has changed, as the area under Wheat and Mustard declined and area under vegetables and spices increased. Gram crop is sown mostly if there is good rainfall in Kharif season and soil moisture is retained till the winter crops sowing period or on availability of at least one initial watering (palawa) from well/tubewell.

Livestock

Large animals accounted for 29.6% of total livestock in the district in 2003 but their share increased to 33.6% in 2012 (Appendix Table 5&6). This marginal increase in the number was of both cattle and buffaloes. Small ruminants dominated the district as the share of goats was 41% and Sheep 28.2% in 2003 that was changed to Goats 47% and Sheep 18.6% in 2012.Total population of livestock in the district increased from 26.5 lac to 31.5 lac.

2.2 JAISALMERDISTRICT

Jaisalmer district lies in the western portion of the state between $26^0$04' and $28^0$08' north latitude and $69^0$30' to $72^0$20' east longitude covering 38401 sq.km. of area. Towards north and west the district is bounded with international boundary with Pakistan and towards south and east lies Jodhpur and Barmer and north east by Bikaner district of the State. The district has been administratively divided into four tehsils as per 2011 Census data namely Jaisalmer,

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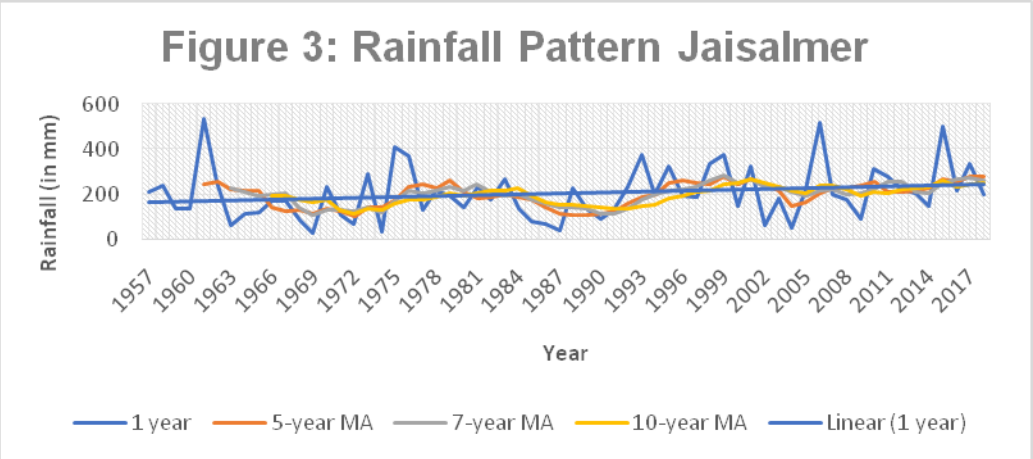
Pokaran, Bhiniyana and Fatehgarh. There are 16 ICR circles 117Patwar Circles and 799 revenuevillages. For developmental purposes, the district has been divided into three blocks; Jaisalmer, Sam and Sankra.

Climate and Rainfall

Jaisalmer district has arid climatic conditions, characterized by low precipitation, high evaporation and evapo-transpiration. There are 5 rain gauge stations in the district. The average annual rainfall in the district during the period 1901 to 2006 works out to be 184.34 mm and average rainfallfor the period 1957 to 2018 is 147mm.The five, seven, and ten years moving averages for Jaisalmer and Sam (Figure 3 and 4) for the period 1957 to 2017 shows that variability in rainfall. The average rainfall has slightly increased in case of Jaisalmer district during the period 1957 to 2018, but has declined in case of Sam region.The rainy days are limited and has decreased by 50% from 14 in 1957 to 7 in 2018Also shift in arrival and departure of monsoon was reported by the farmers during the survey in the area.



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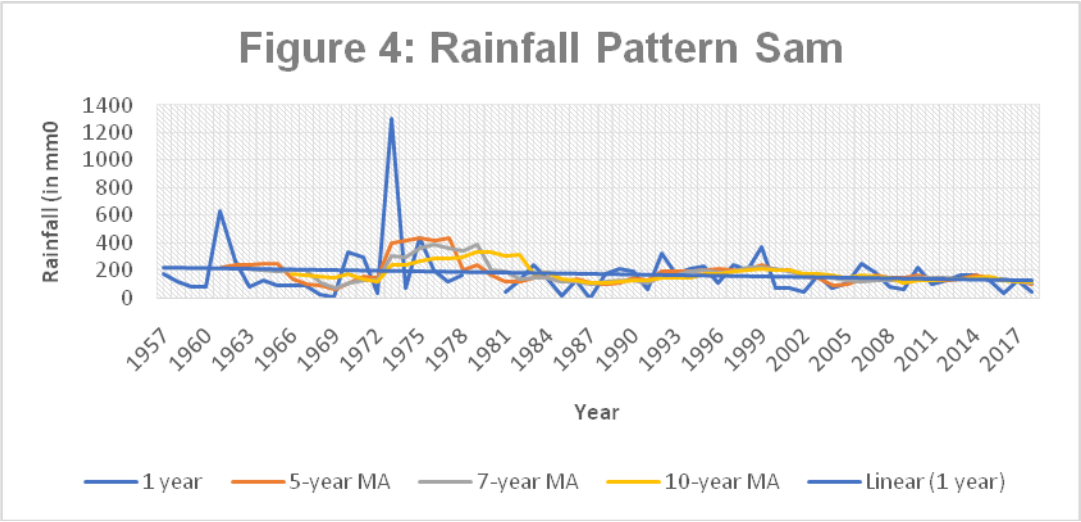

Physiography

Most part of the district is covered by a sheet of sand dunes but around Jaisalmer there are series of ridges and rocky Plateau. Physiographic set up of the district can be divided in to 4 categories. Valleys, Plains Hills, Hillocks and low elevated Plateau. The major part of the district is dissected plain bordered by valleys.

Topography and Drainage Pattern

Topography in the district is highly variable but in major parts it is undulatory plain, around Jaisalmer it is hillocky, uneven and dissected. In other parts, especially along borders it is uneven with sheet of dunal sand. In dunes, parallel ridges exist among these ridges narrow valleys are found. The elevation in general decreases from south to north or north west.The highest elevated area exists at Randha (368m.) in southern parts near to Barmer district border. But in western parts of the district the general elevation decreases towards west and in north eastern parts towards north east.

Drainage in major parts is internal only in few rocky exposures near Jaisalmer, Ramgarh and around Chandan and Sakra where it is dendritic to sub parallel(Ramgarh area). The major streams are Ghughari, Sukri Ramgarh, etc., which are ephemeral in nature. Small rivulets lost in sand dunes towards theirflow path.

Hydrogeology

The district Jaisalmer is a part of Indus Basin and on the basis of geological set up of the area the district is divided into different sub basins which are mainly structurally

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controlleddue to occurrence of fault.The basement of sedimentary rock determines the depth of sub basin. The major formations follow the NE-SW trend in major parts of the district, but in the western parts they show N-S strike following the Indus lineament. A change in strike of beds is seen in Ramgarh (40 I/7) also. Similarly, the Tertiary beds in the east show different strike. The thickness of Lathi beds increases towards south western side near Barmer district border. Even in the same sub basin there are faulting of different scale dislocating the normal sequence of beds.

Ground Water Scenario

The district represents a havoc picture of ground water due to hydro geological set up and scanty rainfall. The district in general has very deep water level in major parts of the district.Groundwater occurs in unconfined in shallow weathered, fractured Granite, Rhyolite, Limestone and sand stone and sandy alluvium to semi confined to confined condition in deeper aquifers.

Depth to Water Level

The depth to water level in the district varies from 0.8 mbgl to 124.39 mbgl. It follows the topography of the district. The central and south western part registers very deep water level which continued to neighboring district. The south western part of the district registers deep water level from Habur to further south up to Barmer district border. In general, the depth to water level decreases from south to north in the northern parts and from west to east in southern parts.

There is a small area in the district located from Nachna (40M/10) to Jaluwala (40M/13) where ground water is in artesian condition and wells tapping the deeper formation are in auto flow condition. Here thick clay is the confining layer. The deeper Tertiary formation is also in artesian condition. The underlying Tertiary formation has leaky aquifer in other parts specially in depressions/ valleys. Ground water in deeper formations is in confining conditions and the piezometric surface of the area is above the water table of the area which is according to the geometry of the aquifer.

Groundwater Quality

The chemical quality in the district is fresh to brackish. Variation of different radicals found in ground water. It is observed in the district that the deeper tube wellwater has more saline than the dug well water even in same village. It is point to note that ground water is

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abstracted only from those tube wells which have comparatively lesser salinity. The tube wells having higher salinity are not utilized. The rangeof radicals observed in the analysis of ground water in Jaisalmer district is given below in Table2.

Table 2: Range of chemical parameters in the ground water

Radicals	Minimum	Maximum
Electrical conductivity (micro Siemensat 25ºC)	450	9830
Total hardness	115	2457
pH	7.35	8.65
Total dissolved solids	293	6390
Carbonate (mg/ Liter)	0	96
Bicarbonate (mg/ Liter)	1	762
Chloride (mg/ Liter)	35	3474
Sulphate (mg/ Liter)	10	1255
Nitrate (mg/ Liter)	0	275
Phosphate (mg/ Liter)	0	1.2
Calcium (mg/ Liter)	23.2	346
Magnesium (mg/ Liter)	4	387
Sodium (mg/ Liter)	20	1600
Potassium (mg/ Liter)	0.7	226.2
Fluoride (mg/ Liter)	0.2	8.80
Iron (Total) (mg/ Liter)	0	8.4
Silica as (Sio2) (mg/ Liter)	5	48

Land Use Pattern

Total reported area for land utilization statistics in 2005-06 was38,39,154 hectares and only 13.5% of the total area(Net Sown Area) was cultivated in the year 2005-06. Forest area 0.68%, Area not Available for Cultivation 12%, Culturable Waste and Grazing lands 67.8% and ASMO only 1.6% (Appendix Table 1&2). As it is an Arid district with low rainfall, agriculture is a subsidiary activity and livestock rearing is theprimary activity of the people. In the Last 10 years there is significant change in land use as the area under Area Not Available for Cultivation, Culturable Waste and Grazing lands has declined by 10% and brought under cultivation. NSA increased from 13.5% in 2005-06 to 21% in 2015-16. Also, the area sown more than once has increased by 4%.

Cropping Pattern in the District

The land use pattern of Jaisalmer district shows that almost 68 percent of the total geographical area is classified as culturable waste and only 13.5 percent is net sown area in the year 2005-06. The rainfall in the district is very low and the source of water for agriculture is groundwater and IGNP canal water (in limited area). Livestock rearing use to be the main occupation of people

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but after availability of IGNP water (61% of net sown area) and identification paleo channels (in the buried channel of Saraswati bed called Lathi Series) of groundwater (irrigating around 38% area), agriculture became important source of livelihood. The crops grown in the Kharif season are; Bajra, Moong (Green Gram), Groundnut, Guar, Caster, Sesamum, cotton, etc. In the Rabi season, traditionally unirrigated Wheat and Gram were grown in Khadins but now the tubewells facilitated cultivation of Wheat, Gram, Cumin Seed, Isabgole, Mustard &Rayda crops. The net sown area increased from 13.4% in 2005-06 to 21% in the year 2015-16 (Appendix Table 3&4).

Irrigation Statistics

The irrigated area under different sources of irrigation is shown in Table 3.

Table 3: Irrigated area under different sources (Hectare)

Canal	Pond	Tubewell	Well	Other Sources	Total irrigated area	Non-irrigated area
210880	-	129732	1632	18	342262	685600

It is observed that at present ground water as source of irrigation covers about 38.4% of total irrigatedarea and about 61.6% area is irrigated by canal (IGNP). Most part of the area which use ground water for irrigation are underlain by Lathi formation, other formations are occasionally used for irrigation. The block wise irrigated area under different sources is given in Table 4. The number of tubewells has significantly increased in the district.

Table 4: Block wise irrigated area under different sources

Block	Canal (Area ha.)	Ground water (Area ha.)	Total (ha.)
Jaisalmer	149996	45290	195286
Sam	60884	32127	93011
Sakra	0	53963	53963
Total	210880	131380	342260

(Source: Land record section, Collectorate: Jaisalmer)

The statistics of abstraction structures in the district are given in Table 5.

Table 5: Statistics of Abstraction Structures in the district

Electrified Tube wells	Diesel operated Tube wells	Total Nos. of Tube wells	Electrified dug wells	Diesel pump operated Dug wells	Fitted with Rahat

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5342	42	5390	1879	35	13

Livestock

In 2003, large animals accounted for 13.8% of total livestock in the district and the share remained almost same 13.7 % in 2012 (Appendix Table 3). Small ruminants accounted for 83% in 2003 and 84.4% in 2012. Jaisalmer is dominated by Sheep as the share was 50% in 2003 but that declined to 37% in 2012. Goats accounted for33% in 2003 and their share increased to 47.4% in 2012. Camels were 2% (in 2003) and 1.5% in 2012.Total population of livestock in the district increased from 17.7 lac to 31.9 lac. Presently goats are preferred over all other animals for ease in rearing and marketing live animal compared to other animals.

2.3 UDAIPUR DISTRICT

Udaipur district is located between 23°46' & 25°05' North latitude and 73°09' & 74°35' East longitude covering an area of 13419 sq. km. The district is part of Udaipur Division and is divided into eleven sub-divisions, viz. Girwa, GogundaKotda, Mavli, Vallabhnagar, Sarada, Salumber, Jhadol, Kherwada, Rishabhdeo, and Lasadiar. Administratively the district is divided into 11 tehsils and 11 development blocks. Total number of villages in the district is 2511.

Climate and Rainfall

Average annual rainfall of the district is 575mm for the period 1957 to 2018. The southern part of the district receives slightly more rainfall.The five, seven, and ten years moving averages for Jaisalmer and Sam (Figure 5 and 6) for the period 1957 to 2018shows that variability in rainfall. The average rainfall is almost same in case of Salumber Tehsil while it has increased in Jhadol Tehsil. However, the variability in the rainfall has declined but the nature of rainfall pattern has changed in both the tehsils.The rainy days has increased from 29 in 1957 to 31 in 2018.

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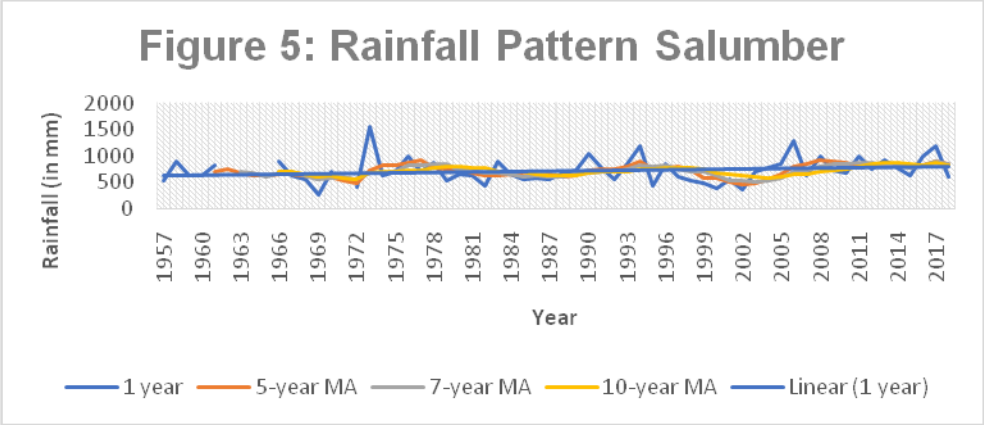

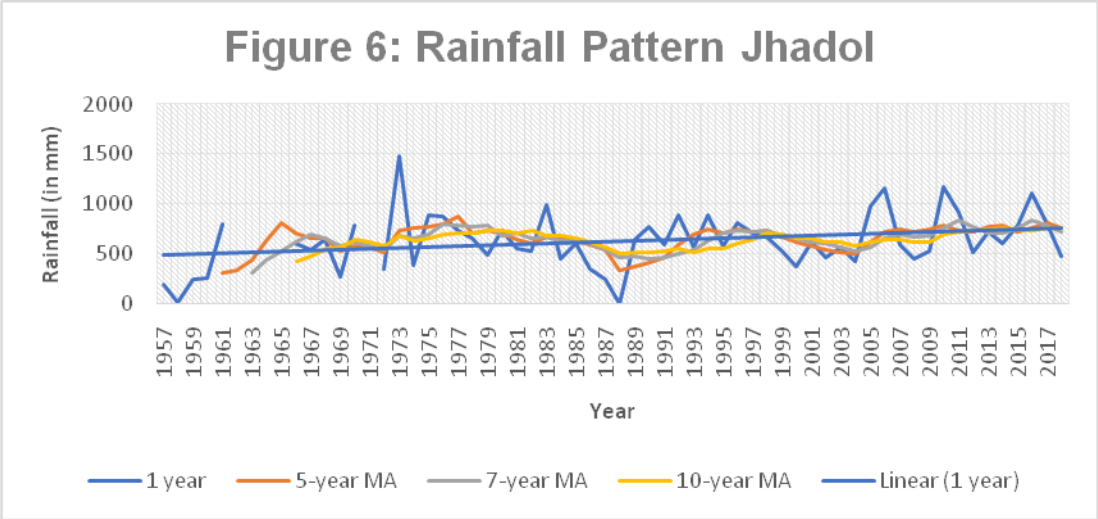

Geomorphology & Drainage

The district is characterized by undulating topography. Towards the western part of district, series of Aravalli hills run along NE-SW direction. A typical plain of gneisses and granites without any alluvial cover is observed to the east of Aravalli ridges. The district has a welldeveloped drainage system. The main rivers of the district are Jakham, Som, Wakal, Sei, Sabarmati, Gomti and Berach. These are monsoon fed rivers that flow more rigorously in rainy season.

Hydrogeology

The occurrence of ground water in the district is mainly controlled by the topographic and structural features present in the geological formations. Ground water occurs mainly under unconfined condition to semi-confined condition in saturated zone of rock formation. Its occurrence is controlled by topography, physiography and structural features of the geological formations. The movement of the groundwater in hard rock areas is governed by

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size, openness, interconnection and continuity of structurally weak planes while in unconsolidated formations, ground water movement takes places through pore spaces between grains.

Groundwater

The eastern part of the district is underlain by the rocks belonging to Bhilwara super group. These aquifers occur predominantly in Bhinder, Salumbar, Sarada and Mavli blocks. Few intrusive are also found which have low permeability. Ground water in these rocks occurs under water table conditions in the zone of weathering and fracturing, joints and foliation planes. When schists are inter mixed with gneisses, they form a better aquifer. The rate of recuperation is slow in gneisses and schists while it is comparatively faster in granites. The depth of dug wells ranges from 15 to 35 metres and the Yield varies from 20m^3/day to 60 m^3/day. The depth to water level in the area tapping this aquifer ranges from 3m to 35m.

Depth to Water Level

The depth to water level varies widely depending upon topography, drainage, bedrock geology etc. Depth to water varies from 3.68 to 23.87 m bgl. In general, DTW varies from 5 to 20m in greater part of the district. Deep water levels (>20m) are observed in parts of Bhinder and Mavli blocks. Shallow water levels in the range of 2 to 5m have been observed in Girwa, Kherwara, Gogunda and Salumber blocks.

Water Quality in Shallow Aquifer

In general, the chemical quality of ground water is very good except for small pockets. The pH of ground water varies from 7.3 to 8.04 indicating alkaline nature of ground water. The specific conductance ranges from 545 µS/cm at 25^{0}C at Paduna, Girwa block to 4370 µS /cm at 25^{0}C at Salumber. EC values are within 2000 µS/cm at 25^{0}C in major part of the district. EC values in the range of 2000 to 3000 µS/cm at 25^{0}C in parts of Mavli, Girwa, Kotra and Salumber blocks and higher EC values in excess of 3000 µS/cm at 25^{0}C have been reported from isolated pockets in Salumber and Kotra blocks.

The concentration of chloride in major part of the district is within 500 ppm. It varies from 35 mg/l at Paduna, Girwa block to 624 mg/l in Salumberblock.The fluoride in ground water

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generally falls within the maximum permissible limit of 1.5 mg/l. High fluoride is found in localised pockets located in the northern & southern part of the district covering parts of Mavli, Gogunda, Sarada &Salumber blocks.

The concentration of Nitrate ranges from 1.8 mg/l at SrimalikiKadia, Badgaon to 241 mg/l at Kurabar, Girwa. Nitrate values in major part of the district are within 45ppm. Higher values of nitrate occur in parts of Bhinder, Gogunda, Mavli, Kherwada, Girwa, Jharol and Salumber blocks.

Iron concentration in ground water in the district is generally within the maximum permissible limit of 1 mg/l. Higher concentrations of iron have been reported from isolated pockets in Gogunda, Salumber and Lasadiablocks.Electrical conductivity of tube wells water varies from 495 to 16235 µS/cm at 25°C. In general, electrical conductivity is within 3000 µS/cm at 25°C. Fluoride varies from 0.10 mg/l to 6.20 mg/l. The nitrate varies from 2 to 252 ppm in the deeper aquifer.

Soils

Most of the soil of Udaipur district has developed in situ. It varies from clay loam to heavy clay. The distribution of the soils in the district is given in Table 6.

Table 6: Soil distribution in Udaipur district

Type of soil	Tehsil
Clay loam	Mavli, Girwa and Vallabhnagar
Red clay	Salumbar,Kotra, Sarada, KherwaraandRashabdev
Heavy clay	Gogunda, Jharol and Girwa

Land Use

Total reported area for land utilization statistics in 2005-06 was14,62,105 hectares and only 13.5% of the NSAwas cultivated in the year 2005-06. Forest area 28.4%, Area not Available for Cultivation (Waste lands) 33.7%, Culturable Waste Lands 15.1% and area sown more than once 8%. Barren lands and Culturable waste lands are more than forest area and that is important feature of Udaipur district. In the last 10 years marginal change in land use pattern has been observed (Appendix Table 1).

Cropping Pattern

Udaipur district is categorized as hilly district with higher average rainfall, 28% area is having forest cover, 49% area is classified as culturable waste lands and net sown area is only 17% of the total geographical area. Ground water is the main source of irrigation and is

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utilized through dug wells, DCB's, and tube wells. Maize is the major crop grown in the Kharif season and the other crops are pulses, fodder crops and Paddy. The cropping pattern has changed since 2005-06 by introduction of Cotton and Soyabean crop in the kharif season (Appendix Table 3&4). In Rabi season Wheat, Gram and Mustard covers most of the cultivated area and the other crops;Garlic, vegetables, Spices, Alsi, etc. cover small area. The composition of Rabi crop has also changed as area under Wheat and Mustard has increased while Gram area has decreased. This change can be attributed to increase in groundwater based irrigation in the district.

Irrigation

The major source of irrigation in the district is wells/tube wells and remaining areas are covered by canals, tanks etc. Ground water is the main source of irrigation and is utilized through dug wells, DCB's, and tube wells. Tanks form the second most important source of irrigation in the district. Canal irrigates only a small area.

Livestock

Large animals account for 52.9 % of total livestock in the district in the year 2003 their share increased to 54.9% in 2012 (Appendix Table 5&6). During the same period the number of buffaloesincreased by 2%. Small ruminants accounted for 46% (Goats 39.3%, Sheep 7%) in 2003 and in 2012 the share marginally decreased to 44.8% (Goats 39.8%, Sheep 5%). Total population of livestock in the district declined from 29.6 lac in 2003 to 27.8 lac in 2012.

2.4 KOTA DISTRICT

Kota district covering an area of 5203.94 sq km is located between 24°32' & 25°50 N Longitude and 75°37' & 76°34' E Longitude in the southeast of the state of Rajasthan. Administratively, the district is divided into five development blocks and five tehsils. Total numbers of villages in the district is 805 and it has 5 urban towns including 1 municipal corporation.

Climate and Rainfall

Normal rainfall in the district for the period 1957- 2018 is estimated as732 mm. Climate of the district can be classified as semi-arid type.The rainy days have slightly decreased from 35 in 1957 to 34 in 2018. The rainfall pattern in Ladpura and Ranganj Mandi (Figures 7 and 8) show that variability in rainfall has increased.

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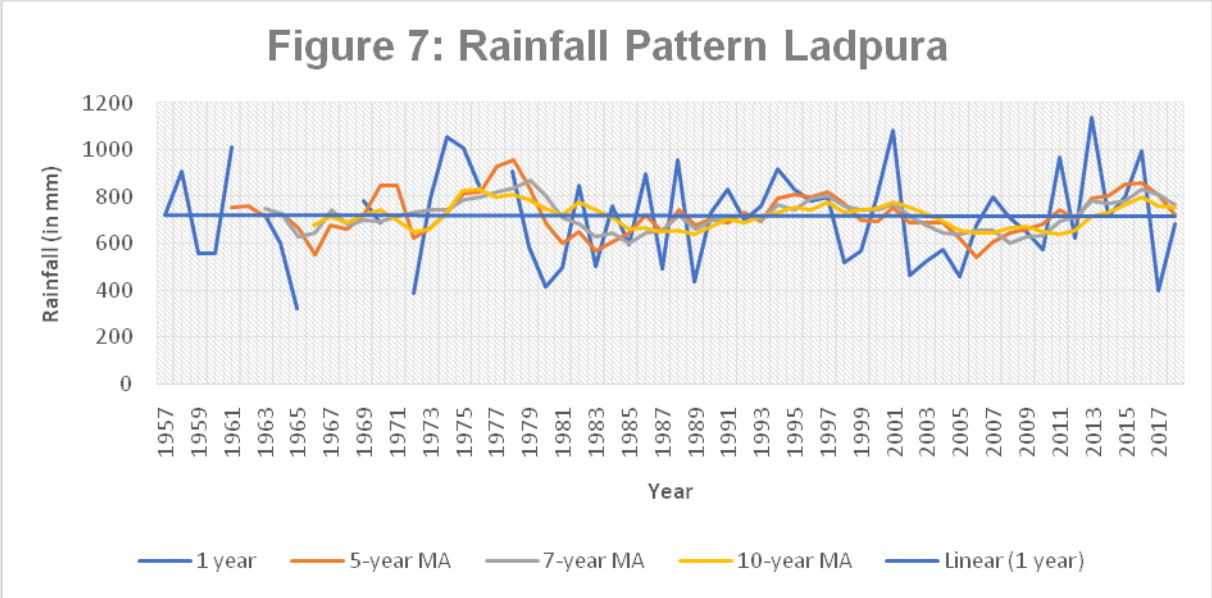

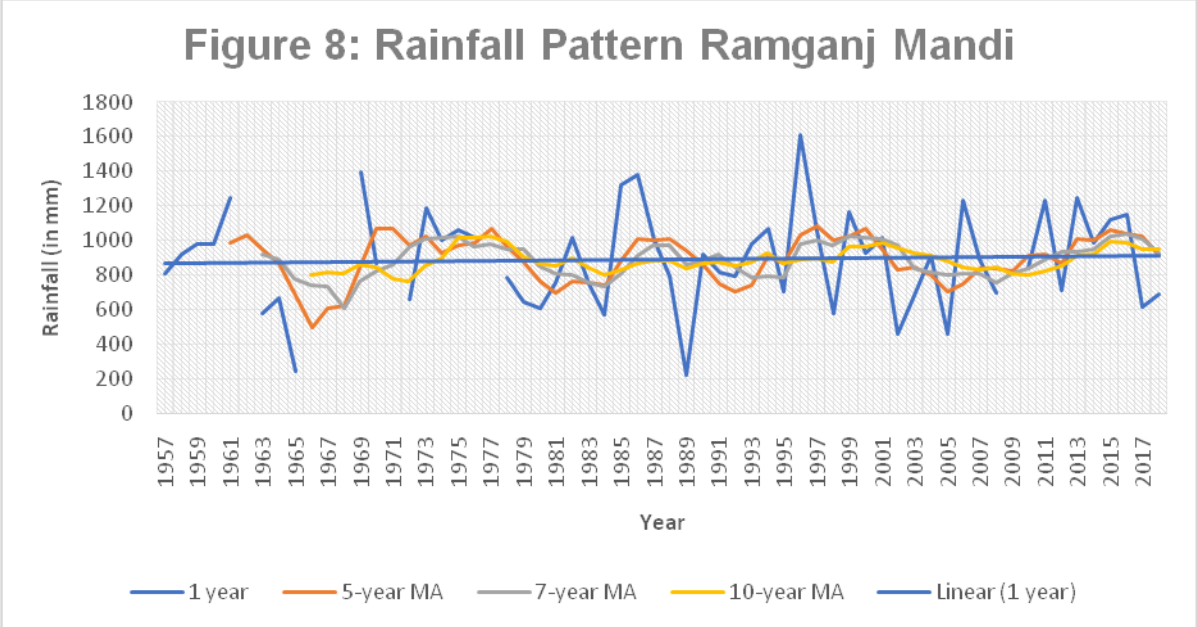

Geomorphology and Drainage

Physiographically, the district is characterized by undulating topography with gentle plains. The physiography is rugged and the tributaries of Chambal river drain through undulating plains which slope from SSE to NNW. The maximum height of the hills in the district is517 m amsl at village Borabas, block Ladpura and minimum height is 207mamsl at Khatoli in slopes from south to north and is drained by the river Chambal and its tributaries. In the south there is 145 km long Mumundra range of Vindhyan hills. The physiography is rugged and the tributaries of Chambal river drain through undulating plains which slope from SSE to NNW.

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Hydrogeological Condition

In Kota district, ground water occurs in mainly four hydrogeological formations. These hydrogeological formations are alluvium, sandstone, shale and limestone and among these formations alluvium is the most important formation as it covers the maximum area and also it is the most potential among different hydrogeological formations.

Occurrence of ground water depends upon topography, physiography and structural features of the geological formations. The movement of the ground water in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains. In the district, ground water occurs under water table condition both in unconsolidated and consolidated formations.

The main hydrogeological units are alluvium, limestones, sandstones and shales. Shale also occurs as intercalations with both limestone and sandstone. Limestone, sandstone and shale cover an area of 5123.17 sq.km out of which 2111.77 sq.km area falls under command area. Most of the command area is irrigated by Chambal Canal and comparatively small area by canals of Alniya, SawanBhadon and Harish Chandra Sagar Dams.

Land Use

Total reported area in the year 2005-06 for land utilization statistics is 521133 hectares and about 52.8 % of the total areas are being cultivated (Net Sown Area) (Appendix Table 1&2). Area under Forest 23.6%, Culturable Waste and Other Waste lands 19.7%, and Area Sown More than Once (ASMO) 27%. Major change in ASMO is noticed as it increased from 27% in 2005-06 to 46% in 2015-16. In the rest of the categories of land use there is marginal change in the last 10 years.

Cropping Pattern

Traditionally Maize, Jowar, Paddy, kharif pulses, Sesamum, etc. were the crops grown in the Kota region. Mix cropping system was practiced to take care of climate variability. Introduction of Soyabean in the farming system has significantly affected the cropping pattern and replaced the traditional crops. Presently it covers 77% of the kharif crop area

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reducing the area under Maize, Paddy and Jowar crops (Appendix Table 2&3). Also, it is riskier and input intensive crop.

Paddy is cultivated only in the canal command area or low lying area having irrigation facility, i.e. water availability. Crop biodiversity has been significantly affected as farmers have adopted sole cropping system of Soyabean in Kharif.

Rabi Season is dominated by Wheat, Mustard and Coriander crops. Garlic crop is also traditional crop of the region but it is price responsive, i.e. the area under crop varies according to the market price. Area under these crops is allocated based on availability of assured irrigation and/or amount of rainfall in the Kharif season, i.e. soil moisture condition. Gram was also important crop grown in unirrigated lands. The area under Gram is declining. Area under vegetables and spices is slightly increasing.

Depth to water level

The depth to water level varies widely depending upon topography, drainage, bedrock geology etc. The depth to water level during pre-monsoon (May, 2011) varied form 1.92 m to 20.72 mbglIn major part of the district water levels were between 2 and 10 mbgl (Figure 2). Depth to water level in the range of 10 to 20 mbgl were observed in southern half of Khairabad block, major parts of Sangod and Itawa blocks and some parts of Sultanpur block. Deeper water levels (20-40 mbgl) have been observed in localised pocket along the eastern border of Itawa block.

Groundwater Quality

The range of chemical constituents of ground water in Kota district during pre-monsoon' 2011 is given in Table 7.

Table 7: Range of chemical constituents in ground water

S.No.	Chemical constituent	Range
1	pH	7.35 - 8.5
2	Chloride	25-
3	Electrical conductivity at 25^0C	320 - 3650 µS/cm at 25°C
4	Total hardness as $CaCO_3$	90 - 710 mg/l
5	Calcium	16 - 192 mg/l
6	Magnesium	12 - 95 mg/l
7	Iron	0.12 - 2.6 mg/l
8	NO_3	9 - 125 mg/l
9	F	0.10 - 1.96 mg/l

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Soils & Irrigation Practices

The soils of the district are alluvial in nature. Soils are generally deep to very deep with texture varying from clayey loam to clay and are generally non-calcareous. Colour of the soil varies from brown to dark brown. This type of soil generally occurs in plains.

Irrigation

The principal means of irrigation in the district are canals and wells/ tube wells. Ground water is abstracted through tubewells, dug wells and dug cum bore wells. Net irrigated area in the district is 226019 ha which is about 93% of the gross irrigated area (243313 ha).

Table 8: Source wise area irrigated (2010-11)

Source	Net irrigated area (ha)	Gross irrigated area (ha)
Canal	118535	129855
Tank	190	202
Tubewells	77378	82854
Other wells	27957	28441
Other sources	1959	1961
Total	226019	243313

Livestock

Large animals accounted for 64% of total livestock in the district in 2003 the share increased to 71.2% in 2012 (Appendix Table 5 & 6). The increase was because of 7.7% increase in the percentage share of buffaloes. Small ruminants share was 32.8% (Goats 29% and Sheep 3.8%) in 2003 it decreased to 26% in 2012. Pigs account for 2.7%.Total population of livestock in the district declined from 6.5 lac to 6.4 lac.

2.5 BARAN DISTRICT

Baran district with an area of 6992 sq km is located between latitude 24°25’00” and 25°27’00” east and longitude 76°12’00” and 77°25’00” north. The district forms a part of Kota Division. It is bounded by Kota district in the west and Madhya Pradesh in the northeast and in south by Jhalawar district. Administratively, the district is divided into eight tehsils and six development blocks. Total number of inhabited villages in the district are 1114 with 4 urban towns and 6 sub urban townships.

Rainfall & Climate

Baran district falls under the arid to semi-arid type of climatic zone according to the meteorological classification given by India Meteorological Department. The normal annual rainfall for the district for the period 1957 - 2018 is 829 mm. Rainfall pattern for Kishanganj

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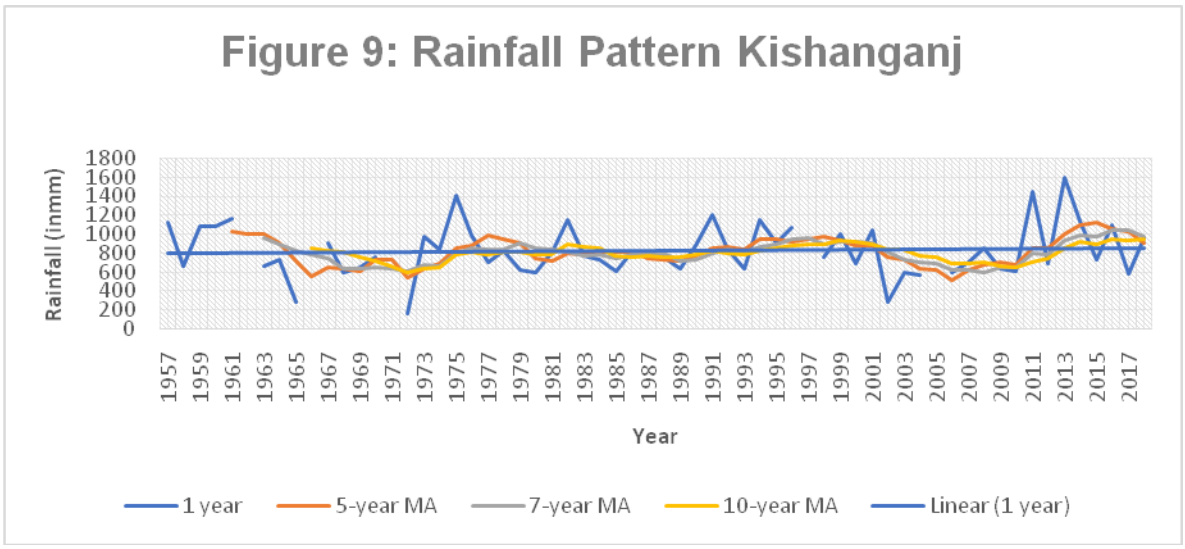
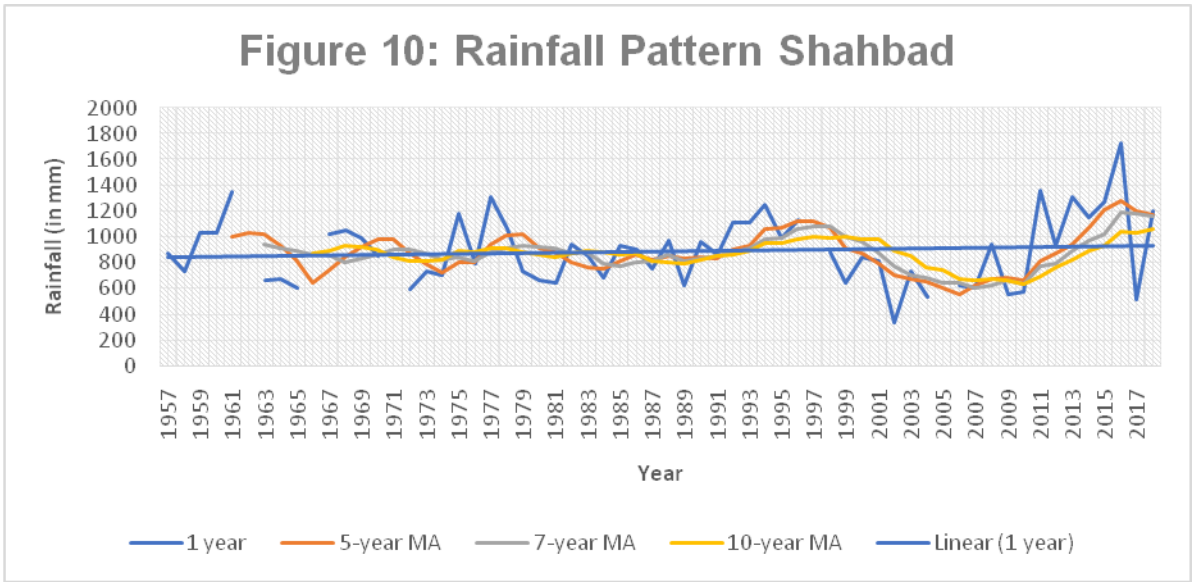
and Shahbad (Figures 9 &10) shows that in the last decade the variability in rainfall has increased likely due to climate change factors. The rainy days has increased from 27 in 1957 to 41 in 2018. The rainfall pattern has also changed from wide spared to more sporadic rains.





Geomorphology & Drainage

The district is a part of "Hadoti Region", which is a distinct geomorphic region of Rajasthan state. The hill ranges of the Vindhyan in the northeast and low rounded hills of Malwa plateau in the south bound the region, while sedimentary rocks belonging to the Vindhyan super group

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occupy northwestern part. The rivers and the streams of the district belong to the Chambal river system. The rivers drain through undulating plain that slopes from SSE to NNW. It attains a maximum height of 500 m at village Rajpur and a minimum of 220 m above mean sea level at village Ulthi. Geomorphologically, the district can be divided into the rocky uplands, pedeplains and alluvial plains.

Hydrogeology

The availability, occurrence and movement of ground water depends upon the rock formations present in the area. In Baran district, alluvium, limestone, sandstone, shale and inter trappeans are the main hydrolith units. Among these formations, alluvium is the most potential among different hydrogeological formations. The ground water in these formations occurs under water table conditions. At places, semi-confined conditions also exist.

Ground water in hard rocks viz. Vindhyan limestone, sandstone, shale and Deccan basalt occurs in secondary porosity developed by weathering and/ or fracturing. The ground water potential of these rocks depends upon the intensity of jointsand fracture systems and their interconnection. These formations are known to be water- bearing down to more than 100 mbgl. These deeper zones are tapped by bored wells mostly for irrigationpurpose.

The district has the hard rock forms as the main aquifer over large parts of the district. Depth of tubewells ranges from 20m to 150m.Yield of tube wells ranges from meagre to 2000 lpm.

Soils

The soils of the district are alluvial in nature and are generally non-calcareous. Its colour varies from dark brown to black. This type of soil generally occurs in plains. Mainly black kachari soils are found in Baran and Mangrol tehsils, which is highly fertile. Red gravelly loam hilly soils are found in the southern and eastern parts of the district.

Land use pattern

Total reported area for land utilization statistics is 699652 hectares and about 47.7 % of the total areas are being cultivated (Net Sown Area) in the year 2005-06 (Appendix Table 1 & 2). Area under Forest cover is 30.9%, different types of land not available for cultivation 17.2% and Fallow lands 4.2%. The Area Sown More than once was only 24%(2005-06).

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There was marginal change in the land use pattern in 2015-16 compared to 2005-06 (Appendix Table 1&2).

Cropping Pattern

The district is located in the southern part of Rajasthan with high average rainfall (829 mm), shallow soils, mostly rocky because of hilly terrain. The major crops grown in kharif season in the district are; Maize and Soyabean and other crops, namely paddy, jowar, bajra, sesamum, groundnut, cotton, Arhar, black gram and other pulses, other plantation crops and spices, etc. It is interesting to note that the area with full of biodiversity, used to grow larger number of crops as sole and mixed cropping has changed to only two crops in Kharif season, i.e., Soyabean (covering 75% in 2005-06 to 85 % area in 2015-16) and Maize (area 12% in 2005-06 to 3% in 2015-16 (Appendix Table 3 & 4). Rest of the crops occupy less than 5% area. It is all because of market, government crop support price policy and subsidies on various inputs. These two dominating crops are more risk prone to climate change and this year 2019 is good example of that as 100 percent crop loss because of excessive rains in the district.

The Rabi crops grown in the districts are; Wheat, Mustard, Coriander, Gram, Garlic, linseed, vegetables, spices, etc. There is marginal change in the cropping pattern in the Rabi season as the crops are mostly grown with assured irrigation or good soil moisture. Wheat is the safe and most common crop in irrigated conditions followed by mustard and coriander crops. Garlic is price responsive crop and therefore, its cropped area varies according to price in the market. Rabi crop is less prone to climatic change compared to kharif crop in the district.

Irrigation

The principal means of irrigation in the district are well/tube wells, though some areas are also irrigated by canals, tanks etc. Ground water is the main source of irrigation and is utilized through dug wells, dug cum bore wells and tube wells. Canal irrigates only a small area. Details of net and gross irrigated area by different sources are given in Table9.

Table 9: Details of net irrigated area and gross irrigated area by different sources

(Area in Ha.)

Source /Area	Canal	Tanks	Tubewells	Other wells	Other sources	Total
Net irrigated	54485	2376	191558	28252	16052	292723

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Gross irrigated	57488	3137	200258	28923	16820	306626

Depth to WaterLevel

The depth to water level varies widely depending upon topography, drainage and bedrock configuration etc. During pre-monsoon (May, 2011), depth to water level in the district was found to vary between 3.2 and 11.55 mbgl. In major part of the district, the depth to water level varied from 5 to 10 mbgl. Water level in the range of 2 to 5 mbgl was recorded in 11.11% of the monitoring stations, 5 to 10 mbgl in 66.67% of the monitoring stations and 10 to 20 mbgl in only 22.22% of the monitoring stations. Deep water levels beyond 20 m have not been observed in the district. Shallow water levels in the range of 2 to 5 m have been observed in parts of Anta, Kishanganj and Shahbad blocks. Water levels in the range of 10 to 20 m have been observed in parts of Anta, Baran Atru, ChhipaBarod and Shahbadblocks.

Water Quality

The range of chemical constituents of groundwater in Baran district during pre- monsoon' 2011 is reported in Table 10.

Table 10: Range of chemical constituents in ground water

S. No.	Chemical constituent	Range
1	pH	7.1 to7.9
2	Chloride	35 to 710 ppm
3	Specific conductivity at 25□C	630 to 3550 µS/cm at 25°C
4	Total hardness as $CaCo_3$	200 to 980 mg/l
5	Calcium	52 to 290 mg/l
6	Magnesium	14.6 to 153.2 mg/l
7	Iron	0.04 to 0.12mg/l
8	Nitrate	2 to 280 mg/l
9	Fluoride	0.0 to 0.5 mg/l

Livestock

Large animals (Cattle & Buffalo) accounted for 66% of total livestock in the district in the year 2003 and their number has increased to 74% in 2012 (Appendix Table 5 & 6). This change in the last 10 years was because of increase in the number of buffaloes in the district. Small ruminants (Goats and Sheep) accounted for 31.6% in 2003 has changed to 24.2% in 2012. Population of goats declined by 7% mainly because of lack of animal health facilities. Total population of livestock in the district increased from 7.8 lac to 8.0 lac.

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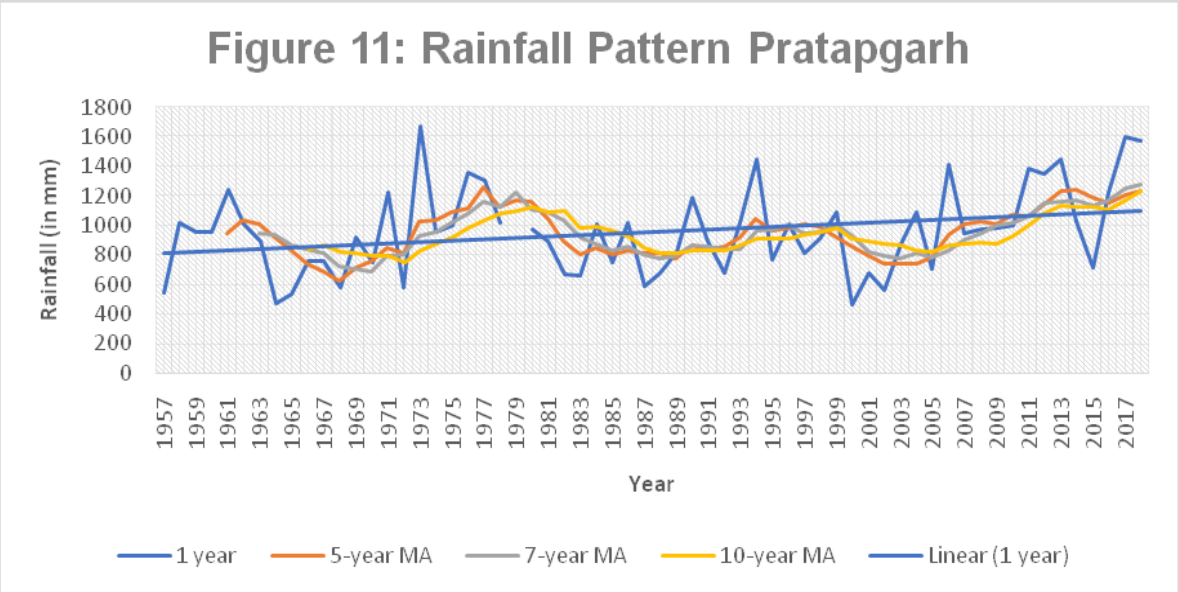
2.6 PRATAPGARH DISTRICT

Pratapgarh is newest constituted district in Rajasthan state. It came into existence on 26th January, 2008 as 33rd district of Rajasthan. It was carved out from Chittorgarh, Banswara & Udaipur districts. It is situated in the junction of the Aravalli mountain ranges and the Malwa Plateau; hence the characteristics of both prominently feature in the area. The district is part of Udaipur Division and is divided into five sub-divisions namely Arnod, Chhoti Sadri, Pratapgarh, Dhariawad, and Peepalkhoont. Administratively the district is divided into 5 tehsils and 5 development blocks. Total number of villages in the district is 1008 and it also has 2 urban towns.

Climate and Rainfall

Average annual rainfall of the district is 873 mm. The annual rainfall gradually decreases from southern part to northern part. The climate of the district is dry except Southwest monsoon season. The district experiences either mild or normal drought once in two years. Severe type of drought has been recorded very rarely. Most severe type of drought has never occurred in the district. The Rainfall pattern of Pratapgarh and Dhariyavad is shown in Figure 11 and 12. It shows that average rainfall in the Pratapgarh has increased in last 10 years and also the variability has increased. The rainy days has increased from 33 in 1957 to 46 days in 2018. The nature of rainfall has also changed.



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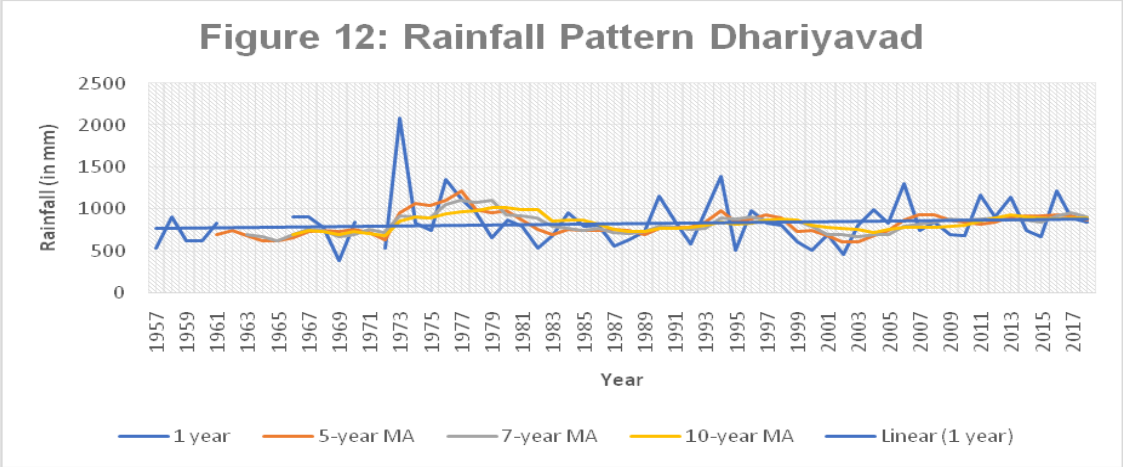

Geomorphology & Drainage

The district is characterized by undulating topography. The western, and southern parts are generally plain area. Hills are scattered in Chhoti Sadri, Dhariawad, Peepalkhoont and Pratapgarh tehsils. The major rivers of the district are Jakham, Mahi, and Siwana or shiv. Other seasonal rivers are Som, Era, and Karmoi.

Hydrology

Groundwater occurs under unconfined condition in saturated zone of rock formation. Its occurrence is controlled by topography, physiography and structural features of the geological formations. Movement of groundwater in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains.

Groundwater

Total annually replenishable ground water resource of the district has been estimated as 161.1583 mcm. Net annual groundwater availability is estimated to be 146.1703 mcm. Draft for all uses is 179.2197 mcm and overall stage of ground water development is 124.1%. Out of five blocks, three blocks viz. Arnod, Chhoti Sadri and Pratapgarh are Over-exploited, one block viz. Dhariawad Critical and the remaining Peepalkhoont block is Semi-critical.

Depth to Water Level: The depth to water level varies widely depending upon topography, drainage, bedrock geology etc. Depth to water level varied from less than 5m to more than 20m bgl (Fig. 3). In general, DTW varies from 10 to 20m in greater part particularly in the eastern part of the district. Water level is deep in northern and western parts of Chhoti Sadri block, and localized pockets in Dhariawad, Pratapgarh and Peepalkhoont blocks. Deep water levels (>20m) have been observed in parts of Chhoti Sadri Block.

Groundwater quality

Water Quality in Shallow Aquifer Shallow groundwater of dug well zone is alkaline in nature with pH ranging from 7.5 to 8.7. The Specific Conductance is within 1500 mmhos/cm at

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25^0C but higher values have been recorded in central part of the district. The Chloride content varies from 43 ppm to 376ppm. High Chloride content (>250ppm) has been observed in Arnod block. The fluoride content in ground water is generally within the maximum permissible limit (1.5mg/lit) in major part of the district. Nitrate concentration in major part of the district are within 45ppm. Higher values of nitrate occur in isolated locations in Dhariyawad& Pratapgarh blocks. Concentration of iron is within the desirable limit of 0.3 mg/litre in major part of the district and is within the maximum permissible limit of 1 mg/ litre in most part of the district (Figure 10). Higher values in excess of 1 mg/litre have been observed in north-western & south-western parts of the district falling in Chhoti Sadri, Pratapgarh, Dhariawad and Peepalkhoont blocks.

Soils & Irrigation Practices

The soils of the district fall under the broad categories of red soil, black soil and clayey loam. Irrigation The principal means of irrigation in the district are wells/tube wells, though some areas are irrigated by canals, tanks etc. Groundwater is the main source of irrigation and is utilized through dug wells, DCB's, and bore wells. Canals form second most important source of irrigation in the district.

Land Use

Total reported area for land utilization statistics in 2015-16 is 141736 hectares and only 44.2 % of the total area is cultivated (Net Sown Area) in the year 2015-16 (Appendix Table 1 & 2). Forest area 29.4%, Area not available for cultivation (Waste lands) 9.4%, Culturable waste lands 13.97% and area sown more than once 27.7%.

Cropping Pattern

Pratapgarh is a new district carved out from Udaipur and Chittor District, therefore, the time series data on different aspects are yet not available. The observation on cropping pattern followed in the district is based on the data for the year 2015-16 (Appendix Table 3 &4). In the Kharif season traditionally Maize, Pulses and Sesamum crops were grown but presently Soyabean (65%) is the most preferred crop followed by Maize (23%). Pulses cover around 8% area and cultivated as sole and mix crop with Maize. In the Rabi season the crops grown are; Wheat, Gram, Mustard, Garlic, Other spices and few other crops covering area less than 5% of total cropped area.

Livestock

Large animals accounted for 62.8 % of total livestock in the district in 2012 (Appendix Table 5 & 6). Buffaloes share was 20% and the remaining 40% were the cattle population. Goats accounted for 33.95% and Sheep 2.8%. Total livestock population in the district was 7.65 lac in the year 2012.

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CHAPTER III

ASSESMENT OF CLIMATE CHANGE VULNERABILTIES IN SELCTED AREAS

Around the world, farming is carried on a greater scale. Currently, about 37% of Earth's land is used for agriculture (approximately 11% for crops and 26% for livestock grazing). More and more countries around the world are experiencing record high temperatures, droughts, unprecedented floods and other extreme weather events. Increasing temperatures are already affecting agricultural productivity, placing fruit and vegetable supplies at higher risk. Unpredictable precipitation patterns and more frequent extreme weather events are adding to disruptions in the food system. Countries around the world are starting to experience stress on their water supply. A warmer planet could mean a big hit to G.D.P. in the coming decades. Climate change and its impact on the livelihood has become a big challenge for policy makers and planners.

As per the Government of India's data on land use about 46% land of India is used for agriculture (crops). India's agriculture sector accounts for around 15.9 per cent of the country's GDP and 49 per cent of total employment (2018-19).India became food self-sufficient because of Green, White and Blue revolutions. Despite that the problem of poverty, hunger and malnutrition still persists and the real income of farmer has declined. This achievement also affected our natural resources (degradation of soil, water, agro-biodiversity), changed the dietary patterns and climate change further contributed in affecting agriculture and allied sectors. Presently the new challenges before the country are; fragmentation of holdings making agriculture unviable enterprise, prime agricultural land gradually decreasing due to urbanization and industrialization, the forest and tree cover declining, the process of soil degradation continues unabated, farming becoming unprofitable, youth not interested in agriculture as occupation, livestock based activities are declining and disintegrated from crop husbandry, etc. As a result, the performance of agricultural sector is gradually declining.

Agricultural productivity in India is below its potential. Some of the constraints include limited use of modern farming methods, volatility of weather, weak agricultural support services and lack of market-oriented production. The frequent occurrences of natural disasters

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like flood, drought, storms, hails, cyclones have led to severe hardship and farm distress. The agriculture sector is a leading area that needs a re-look and re-invention.

The productivity-centred paradigm consolidated as part of the green revolution has continued to be the model for all agrarian futures envisioned in the country. Unfortunately, this has meant pushing for a strategy that requires extensive control over the environment. Rather than using a wide range of seed varieties across multiple crops that would fit into different agro-ecological niches, the monoculture model of the green revolution has promoted re-engineering of the environment to fit the needs of the single chosen seed variety, whether through plant breeding or genetic engineering. Alternative visions based on different kinds of crop choices, farming systems, technologies and practices, privileged farmers, innovations of non-governmental organisations, or traditional obscurantismshave been dismissed.

Further, to enable a given seed variety to express its yield potential to the highest possible degree, pests, weeds, nutrients, and water have to be controlled accordingly. But this pits farmers in a race against nature. They have to constantly catch up with newly evolving pests and weeds and deal with the declining fertility of soil, which chemicals alone are unable to replace. Farmers, in particular, are running on a treadmill and are more prone to vulnerabilities: first, in a market where they are unable to obtain remunerative prices (even when the minimum support prices (MSP) are increased by the state; second, from the state that is finding it increasingly difficult to deliver inputs like fertiliser, electricity and fuel to them on time and at a reasonable price; third, from the scientific research on new seeds and pesticides that is playing catch-up with the ever evolving pests and genetic vulnerability engendered by single varieties; and finally due to climatic vagaries, which irrigation and modern technology are unable to overcome.Over the last few decades, as dryland farmers have increasingly adopted monoculture farming with tube well irrigation, the same set of crises have manifested, but with a higher magnitude.

The farm sector today predominantly comprises small and marginal farmers (around 86%), and their contribution national economy is still quite significant. Farmers invariably face major problems in accessing the right knowledge and basic agricultural inputs/resources at affordable cost. Many farmers are in stress and becoming labourers or shifting to other means

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of livelihood. Also, farming is considered to be a low key activity and is not being sought as a profession/career by the younger generations.

In the light of this, it becomes difficult to justify the enormous negative consequences arising from adopting the green revolution model, let alone base Rajasthan's agrarian future on it. It is only through a comprehensive understanding of its agrarian past that we can begin to imagine a new vision and a new foundation for Rajasthan's agrarian future. Rajasthan is divided into 10 agroclimatic zones. Any planned new intervention has to take cognizance of this fact and suggest measures in the context of changing agro-climatic conditions in each region as discussed above in Chapter II.

In Rajasthan, livestock sector is very important for sustainable development of agriculture and nutritional security. Livestock provides employment to the family, acts as insurance during crop failures, contributes to gender equality by generating opportunities for women, generates in situ fertilizers for enhancing the soil fertility, contributes to day-to-day expenses of the farm family, recycles waste products and residues from cropping or agro-industries and supplies energy source for cooking and thus, provides a sustainable environment. The composition of livestock owned by people in the selected districts is reported in the Appendix Tables 5 & 6. The factors guiding composition of livestock in any of the district in Rajasthan are; land use pattern, cropped area, grazing lands, governments livestock policy, dairy network and road network, etc. The selected district wise observations on composition of livestock is discussed in Chapter II.

In this section first we will document our observations about the present livelihood practices adopted by people in the selected villages in the selected districts. Those practices will be analysed in the context of climate resilient development and identify constraints or negative trends leading to unsustainable agriculture and livelihoods. Finally, suggest strategies for climate resilient development.

3.1 NAGAUR

The team visited village Todas near Kuchaman city, located in the extreme east boundary of Nagaur District and second village Karnoo located extreme West of Nagaur District, near Phalodi city. The distance between the two villages is around 130 km. Focus group

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discussions were organised with man and women in there two villages to know about their perception on climate change and their livelihood.

Todas village: The village is around 35 km from Kuchman City. The village geographical area is 18 thousand bighas. There are 12 water bodies called Nadies. The catchment areas of these water bodies are the grazing lands of village livestock. Water bodies are being neglected and the catchment areas are being encroached. Productivity of grazing lands is declining. Around 90% farmers own tubewell. Presently the groundwater level is 400 to 600 ft. deep. Groundwater quality is poor as it contains fluoride. Agriculture is main occupation of 80% people, livestock 5%, 30 people engaged in business and 125 persons in service. People prefer to join defence services. The size of land holdings of 90% farmers is less than 2 hectares. Out migration of younger people in search of job in NCR area of Delhi for brick making and Maharashtra to work as labourer on orchards, is a regular practice and it increases in the drought year.

Climate (Rainfall and Temperature)

In the focus group meeting, the climate change and climate variability issues were discussed at length. The reference time period was of 30 to 40 years, as most of the participants were of higher age group they could narrate what they saw in their younger days. The group was unanimous in their view that there is major change in rainfall pattern. There used to be wide

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spread rains earlier and now sporadic rains, that has seriously affected the agricultural practices of rainfed crops. Rainy days and average rainfall have declined. Shift in the arrival and withdrawal time of monsoon has also changes. Winters starts late and the period is extended.The general feeling about temperature was that it has increased over years but they had no reliable evidence to prove the fact.

Water Resources:

Rajasthan had the tradition of rainwater harvesting in surface structures namely, Nadi, Talab, Kund, Johad, etc. In Western Rajasthan these surface water structures were the source of drinking water for human and livestock. Wells and some other structures were the source of groundwater for drinking and irrigation. Groundwater quality was major problem for drinking and in case of high salinity also problem for agriculture.

In Todas village there are 12 Nadies, source of drinking water for human and livestock population. Wells were limited in number but with the availability of drilling technology in last two decades the number of wells and tube wells has increased significantly. Rainfed agriculture is transformed into irrigated agriculture. This had adverse impact on traditional water structures, as their catchment areas were encroached, no repair maintenance, water storing capacity declined, etc. This situation forced people to drink low quality groundwater (Fluoride affected). Presently, 90 percent farmers own wells/tubewells and the groundwater is at the depth of 400 to 600 ft. deep.

Agriculture

i) Traditionally rainfed agriculture was practiced in the village. The selection of crops to be grown in the summer season (Kharif) was based on time of arrival of monsoon. If monsoon arrived in time then the crops grown were; Bajra, green gram, Guar, Mot, Til, etc. and sown as sole crops. In case of late monsoon mix cropping was preferred and reduction in area under Bajra crop. In Rabi season Wheat, Gram, Mustard, Cumin and Onion. Presently, the traditional Barley crop is replaced by Onion.

ii) The deep drilling technology facilitated farmers to own a tubewell and go far irrigated agriculture consequently the total economy of the village changed. Farmers started growing cash crop in both seasons. In kharif groundnut became the main crop and the area under traditional crops reduced significantly. In Rabi season Wheat became dominant crop and mustard, gram and Onion crops as supporting crops grown depending on the size of land owned and water availability. Some area is also allocated to Cumin crop.

iii) Nearness to Kuchman City has also affected the cropping pattern as farmers started growing Onion and other vegetables.

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iv) The cropping pattern changed from rainfed crops, low input low water demanding,organic farming to high input high water demanding chemical farming. The number of watering given in different crops is as follows: Wheat- 10 to 12 and Onion 10 to 15watering. In case of Onion it is grown in both the season. Use of insecticide and pesticides has increased and in the absence of adequate knowledge about their proper use over doses are applied, consequently affecting the groundwater quality and health of people.

v) Availability of groundwater has taken care partly of climate risk particularly delay in sowing time of crops and crop failure because of early withdrawal of monsoon affecting the final stage of crop production.

Livestock

The composition of livestock in a village is governed by the availability of grazing land and crop residue as fodder for large animals. In Todas village the small ruminants(Goats and Sheep) dominate in number because of large grazing fields. Sheep are preferred over goats as there are good number of shepherdscommunity in the village. Buffaloes and cows are kept for milk production. There is milk collection Centre in the village. One of the progressive farmers has started commercial goat rearing farm and claimed to be successful. There is a Goshal in the village having 350 cows.

Critical Issues/Challenges:

Based on the specific features of the district mentioned in the Chapter II, i.e. geographical features, soil type, size of land holdings, rainfall, agriculture &livestock, water availability and socio-economic conditions and our observation in the field the major issues are: Most farmers got Soil Health Cards and there is Agriculture Extension Worker deputed in the TodasPanchayat yet people have never sought advice from the expert in deciding cropping pattern and cultural practices, particularly in case of commercial crops namely groundnut and onion. It was reported by the farmers that information in soil health cards were not matching to their field conditions. It means the soil testing results needs recheck.

Lack of guidance on post- harvest activities resulting in lower price of produce particularly Groundnut and Onion. Farmers are ignorant about the process of getting MSP.

Over exploitation of groundwater is evident as water table is going down yet no measures taken by community at large. Over use of chemicals is affecting the groundwater quality, health and soils of the village. NGO working in the village helped setting up of FPO but for some reasons it is not effective to address the farmers problem.

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Out migration of people without skills fetch low wages and seasonal employment.

KarnooVillage: The village is located on the Nagaur- Phalodi highway near the border of Jodhpur District. Around 70% households reported Agriculture and livestock rearing as their main occupation. Around 4% households are in private jobs, 2% in government job rest are agricultural labourer. People of age group 20 to 50 years particularly owning land size less than 2 hectares have migrated in search of job within and outside Rajasthan. Many of them have landed in adjoining districts Jaisalmer, Barmer and Bikaner where irrigated agriculture is booming. They take land on lease and cultivate commercial crops. Younger generation is no more interested in continuing agriculture as their main occupation, rather prefer to diversify occupation, i.e. non-farm employment and prefer to migrate out side village. Presently around 400 people have out-migrated for employment.


Climate (Rainfall and Temperature)

Interaction with the group started with discussion on their perception about climate change. The time frame for discussion was last 30 to 40 years. Participants were very much aware about the changes taking place in rainfall and temperature in their village and in surrounding areas. The observations were as follows:

i) It was anunanimous view that rainfall pattern has changed. There used to be wide spread rains earlier now it is more of sporadic nature, even part of village remains dry and in other part good rains.
ii) Rainy days reduced from 40-50 days to 25-30 days and good rainy days are only 2 or 3 days. Mostly rains are of short duration, i.e. one to two hours with long stress period affecting crops significantly.
iii) Drought occurs more frequently than earlier.
iv) Temperatures are also fluctuating particularly more in summer season.

Water resources

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i) Traditionally, wells, Talab and Nadies were the main sources of drinking water for humans and animals. With the advent of tubewell drilling technology now tubewells with overhead tanks supply ground water for drinking and domestic use.
ii) The Number of tubewells in the village increased very fast in the last 15 years and presently there are around 400 tubewells. Over exploitation of groundwater is observed as the water table went down from 150ft. in 2010 to 300-350ft. in 2019.
iii) Peoples' perception is that groundwater quality is good, but was never got tested.

Agriculture

i) Traditionally rainfed agriculture was practiced in the village. Selection of crops to be grown in the summer season (Kharif) was based on time of arrival of monsoon. If monsoon in time then the crops grown were; Bajra, green gram, Guar, Mot, Til, etc. and were taken as sole crops. But in case of late monsoon mix cropping was preferred. Guar and Mot crops can be sown late and are drought resistant.
ii) Rainfed agriculture was prevalent in the villageas there were no tubewells in the village or even adjoining villages.
iii) After the tubewell revolution, farmers having access to deep groundwater adopted new cropping pattern.Presently, the crops grown in the Kharif season are;Groundnut andCotton and in unirrigated areas;Bajra, Green gram, Mot, Til. In the Rabi season crops grown are; Wheat, Gram, Cumin, Isabgol,Raida and Methi.
iv) Increase in area under irrigation has resulted in change in the nature of soils (soil texture) in the village.
vi) Size of holdings are getting smaller and smaller because of subdivision of holdings.
vii) Sprinklers technology is used for irrigation. Use of chemicals is increasing in the area. Framing changed from organic farming to chemical based farming.But farmers were not made fully aware of appropriate use of fertilizers and pesticides.

Livestock

The livestock composition in the village (as per the participants in the meeting) is; Sheep and Goats 65%, Cows 20%, Buffaloes 10%, and Camel & Horse 4%. Around 200 households are engaged in dairy activity, 40 to 50 households in Sheep rearing. The number of small ruminants is high because of availability of large grazing lands.

Issues: Based on the specific features of the district mentioned in the ChapterII, i.e., geographical features, soil type, size of land holdings, rainfall, agriculture &livestock, water availability and socio-economic conditions and our observation in the field, the major issues are: The agricultural lands are mostly inter duneal flat lands with low productivity and shifting sand dunes. Change from rainfed to irrigation requires knowledge of irrigated agriculture particularly when new crops are introduced. Input intensive crops with use of

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chemicals need complete knowledge about crops cultural practices and in the absence of that environment is affected. The present cropping pattern that is more guided by market and state agricultural policies do not match with the existing resource endowments of the village and therefore unsustainable. There will be serious water crisis as both cotton and groundnut crops are water intensive crops. The tendency of over abstraction of groundwater raises question about the future of agriculture in the area. The Farmers are carried away by irrigated agriculture, i.e.,shifting from the climate resilient integrated farming to more risky chemical agriculture and also ignoring the livestock component of the farming system.

3.2 JAISALMER

The team visited gram panchayat Kita and Fatehgarh in Jaisalmer district traditionally known for extreme water scarcity, low rainfall, almost no agriculture and livestock based livelihood. The aim was to understandthe changes in last 10 to 20 years in the people's livelihood pattern and also their perception about climate change and its impact on crops, livestock and overall livelihoods of different section of the society. Focus group discussion were organised in both the villages. In general, the groupsrevealed that there has been significant change in last two decadesin terms of infrastructure development, livelihood options, water availability and weather parameters. The specific issues related to the villages are discussed below.

Kita village

The village is located few kilometres off the Jaisalmer – Barmer national highway at 26 km form Jaisalmer. The population is mix of Pakistani refugees and locals. Traditionally livestock rearing was their main occupation. People adopted trans human migratory system of livestock management. Since average rainfall of the district is lowest in the state and groundwater is deep and brackish hence only rainfed agriculture was practiced. People had developed rainwater harvesting structure called *Khadin,* to cultivate crops using the conserved soil moisture. Over years, roads and communication improved, connectivity improved, canal water came in some part of the district, deep drilling technology helped in identifying availability of groundwater, mining and quarrying of stones and mining activity, providing employment and income to the people. The infrastructure and other development opened new opportunities for better livelihood of people in the area. Before 1981 there was no irrigated agriculture in the village, people were engaged in livestock rearing.

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There are around 400 households in the village. In the absence of any employment opportunity in the area, younger people migrate to adjoining districts to work as labourer in sand stone mines and construction work (40%), 10% of youth belonging to Muslim and Rajpoot community migrate to Gujarat and Maharashtra asdriver and 5% go to Bangalore to work in grocery shops. The tubewell irrigation in the village started in 2004 and that led to in-migration of 40 families in the village from Jodhpur, Nagaur, and Swai-Madhopur districts for cultivating irrigated lands on lease basis. Few of them have decided to permanently settle down in the village.

The focus group discussion was organised in the village and issues related to climate change, agriculture, livelihoods of people, livestock, water, etc. were discussed at length. The details are as follows:

Climate (Rainfall and Temperature)

The group was of the view that rainfall pattern has changed over years. Even the arrival and withdrawal of monsoon period has changed. Monsoon in the area use to arrive by end of July and withdraw in early September. Now even pre monsoon rains are also observed and monsoon is further delayed. The pattern of rains has also changed.There used to be 4 to 6 hours continuous rains and that too in entire area up to 50 to 100 km. Now there is more sporadic rains of short duration. The area is highly drought prone.

Water Resources

Traditionally *Beri*was the main source of drinking water for human and livestock. In good rainfall years surface water harnessing structures, namely Talab, Nadi and Khadinwere the drinking water sources for human and animals. There are 15 Nadi and one Talab in the village. State Ground Water Department and other agencies identified a unerground channel of water and in 2004 drilling of tubewells started.Presently there are around 100 tubewell in

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the village. The groundwater table is at 450 to 600 ft. deep. The water quality is good for agriculture but not very good for human consumption.People were not aware about testing of their tubewell water by any agency.

Agriculture

Traditionally only in a good rainy year people use to grow Bajra, Guar, Mot and Watermelon. The availability of tubewell water has completely changed the land scape of the area as one finds large irrigated farms with good crops standing in fields. The present cropping pattern followed in the village is as follows: Kharif season –Groundnut, Bajra, Green Gram, Mot and Watermelon.Rabi season – Cumin, Wheat, Isabgol (*Plantago Ovata*), and Mustard are the crops grown in Rabi season. Cumin is the preferred crop covering around 60% area, as the crop suites the environment well and also high value crop, grown in the entire belt of western districts of Rajasthan.Farmers also rotate the cropping pattern according to the soil conditions.There is high infestation of White Ant affecting groundnut crop in the area.

Use of insecticides and pesticides is very high in the Cumin and Groundnut. This will have serious impact on soil health and people's health.

Orchards of Dates, Ber, Pomegranate are tried in the area. The orchards are in gestation period therefore their economic feasibility, climatic adaptability and market support has to be tested.

Livestock

The composition of livestock in the village (as reported by the group) is as follows: The numbers reported by the group for each type of animals approximately are; Cows 3500, Sheep 8000, Goats 3000, and Camel.Cows are of four breeds namely, Rathi, Nagauri, Tharparkar and Pakistani. Sheep areJaisalmery breed and goats are again Jaisalmery and Nagauri (exact name of breed was not known to them as they consider them native/local breed). People migrate with animals to adjoining states on aone year migration cycle. Though in the village and the district there are large grazing areas but of low productivity because of scanty rains.

Issues: Based on the specific features of the district mentioned in the ChapterII and the features discussed above, namely geographical features, soil type, size of land holdings,

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rainfall, agriculture & livestock, water availability and socio-economic conditions, our discussion with the group of people in the village and observations in the field the major issues are:

i) In the absence of geo physical survey, the quantum of groundwater availability is not known, still the number of tubewells are increasing and over extraction groundwater in the area is taking place. Therefore, the sustainability of present set of agriculture is questionable.
ii) Over use of chemicals in crops, particularly Cumin and Groundnut is harmful for human health and soil health.
iii) Out-migration of people to other districts and states, while other district farmers leasing-in land and cultivating cash crops in the area, therefore, the issue is how to check outmigration from the area.
iv) Migration of livestock within state and adjoining states has become difficult over yearsbecause of financial loss and on route atrocities on Shepherds' and animals.
v) Lack of awareness about modern agriculture, livestock rearing in the changed condition and livelihood options.

Fatehgarh village:

The village is located in the Jaisalmer- Barmer national highwayat 45 km. The highway divides the village in two parts and most of the business activities takes place in shops on both side of the road. As per the group of participants,the geographical area of the village is around 21743 bigha and of that 60% area is agricultural land, 15% under grazing and water bodies, 23% revenue lands, and 1.6% residential area. Agriculture is main occupation of 57% of households, Livestock rearing 6%, Agricultural labour 29%, and Service 7%. There are around 20 households having large sheep herds. Muslims, particularly Pakistani refugees are in good numbers and are practicing agriculture and livestock rearing.

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Climate(Rainfall and Temperature)

The change in climate is manifested in terms of change in precipitation both in quantity and pattern and variation in seasonal temperature, differently than normally perceived by people was mentioned by the group attending the focus group discussion in the Village Panchayat Office. Group unanimously agreed that there is change in arrival period of monsoon, i.e. arrival delayed by 10 to 15 days, change from wide spread rains to sporadic, reduction in number of rainy days, raining hours reduced, etc. This has affected the runoff, resulting in less water in village water bodies. Late arrival and early withdrawal of monsoon is observed. Temperature variation is extreme hot and extreme cold. Number of peak temperature days increased and number and intensity of dust storms also increased.

Water resources

Rain water stored in Talab, Nadi and Kunds and ground water extracted through tubewells are the sources of drinking and irrigation water. There are 250 Kunds and 50 tubewells in the village. Tubewell water is at the depth of 400 to 600 fts. The abstraction of groundwater is by using electric motors of capacity 30 to 45 HP.

Agriculture

As the rainfall in the area is low and there are very few rainy years suitable for agriculture, therefore, mostly there is agricultural drought. In normal year the rainfall is just enough for regeneration of grass in the grazing lands to support livestock. If there is timely andenough rains in summers for sowing of kharif crops then farmers will grow; Bajra, Guar, Green Gram, Mot. If rains delayed then Pulses and Guar only. Now in tubewell irrigated farms the cropping pattern adopted in Rabi season is Cumin, Isabgol, Wheat and Mustard. Most of the agriculture activity in the district is by tenants belonging to other districts of Rajasthan. Use of chemicals in crop namely Cumin is very high.

Orchards of Dates, Ber, Pomegranate are recently tried in the area. The orchards are in gestation period therefore, their economic feasibility, climatic adaptability and market support has to be tested.

Livestock

Small ruminants dominate the composition of livestock in the village. There are 20 household exclusively keeps around 2000 sheep and they generally migrate after Diwali festival to areas

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in Rajasthan, Madhya Pradesh, Haryana, Punjab and Gujrat. There are descript breeds of cows and their milk productivity is also high. However, it has become difficult to maintain the purity of cow breeds. Migration of animals is becoming difficult whilethe productivity of grazing lands in the district is very low mainly because of over grazing and low rainfall.

Issues: Based on the specific features of the district mentioned in the ChapterII, namely geographical features, soil type, size of land holdings, rainfall, agriculture, livestock, water availability and socio-economic conditions, and our discussion with the group of people in the village and observations in the field the major issues are:

i) In the absence of geo physical survey, the quantum of groundwater availability is not known still the number of tubewells are increasing and over extraction groundwater in the area is taking place. Therefore, the sustainability of present set of agriculture is questionable.
ii) Over use of chemicals in crops, particularly Cumin and groundnut is harmful for human health and soil health.
iii) Out-migration of people to other districts and states while other district farmers leasing-in land and cultivating cash crops in the area.
iv) Migration of livestock within state and adjoining states is becoming difficult in terms of financial loss and on route atrocities.

3.3 UDAIPUR

In Udaipur district the villages selected for the field observations were; Rawatpura in Kurabad Block and Gejvi in Jhadol Block. The first village visited by the team was Gejvi, a tribal area village. The objective was to understand about the people's livelihood and how that has changed over last 20 yearsand their perception about climate change and its impact on crops, livestock and overall livelihoods of different section of population. Focus group discussion organised in the village was attended by both men and women. People were very vocal in expressing their views and willing to undertake activities for betterment of village and the people.

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Gejvi

The village is well connected by road and surrounded by forest area.The share of Cultivated Land in the total geographical area of the village is less than 20%, rest of the area is under forest cover, rivulets, unculturable lands, etc. Hilly terrain with high slops and smaller size of terrace plots of agricultural lands is the special feature of the area. Mechanization of agriculture has limited scope. Scattered settlement pattern and tribal culture of living also sets the household livelihood pattern. Lack of education facilities and employment opportunities forces younger people to migrate outside village, district and state in search of jobs. People mostly migrate to Gujarat as labourer in construction work, brick making or cotton cultivation. There was a period when very young children use to migrate to Gujarat for cotton cultivation and against that protest was organised by NGOs and other civil society groups to stop that and provide them education. That agitation was successful and out migration was almost controlled. That had led to change in cropping pattern in the area. Focus group discussion was organised in the village and was attended by men and women with active participation. The issues were discussed at length and their views were as follows;

Climate (Rainfall and Temperature)

The group was unanimous on the issue of change in rainfall pattern in the region. They were of the view that rainy days are reduced, no more continuous rains for seven to ten days, quantum of rains reduced, and more sporadic rains than wide spread rains. All these changes have resulted in less availability of water, low flow of water in rivulets and ponds and water scarcity in the month of April to June.The overall temperature in the village and region has increased. The group had no idea that these changes are linked to climate change rather they were more concern about climate variability.

Water Resources

The overall water availability, both surface and ground water has declined. Groundwater is the main source of drinking and irrigation in agriculture.Groundwater level is declining every year and presently it is 80ftdeep. It is resulting in high pumping cost and is the prime reason for unsustainable agriculture in the region. Flow in the rivulets has declined and period of water flow has also reduced consequentlyresulting in new issue of water scarcity in the month of April to June. In their view this is because of deforestation in the region and even the village forest has changed from dense forest to very thin forest.

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Agriculture

Agriculture with livestock rearing is the main occupation of the people. Traditionally, mix farming system was practiced in the area, i.e. crops with livestock, to best utilize the natural resources available in the area. In Kharif season,Maize was the main crop sown, as sole and mixed crop with Urd, Lobia, Lady finger, etc. Wheat and Mustard were grown in Rabi season. After restriction on child migration for cotton cultivation in Gujarat 'Contract Farming' has emerged in the area.Gujarti farmers have agreement with local farmers to cultivate cotton under their guidance and they purchase their entire produce on market rate. All input cost except human labour is born by the contractor. There is major change in the cropping pattern in the village/area. Cotton and Soyabean have become the most common crops in the Kharif season. Beside these crops the other crops are Maize, few other crops on small piece of lands. The root crops, namely Ginger, Jamikand, Ratalu, Arbi, Turmeric, were the traditional crops in the region and their marketing was organised by one of the lead NGO but now have been neglected. Use of chemicals in agriculture has increased.

Livestock

The composition of livestock in the village is as follows; Large animals (Cow and Buffalo) dominate in number followed by Goats. Cows of nondescript breed are less productive in milk but farmer keep them for two reasons; first, to get manure, as the soils in the area lack humus content and other minerals, and second, for animal power in farming, as on terraces agricultural operations cannot be performed by tractors only bullocks can be used. Buffaloes are kept for milk. Goats are very economic to be raised because of the large area of forest and uncultivated land with vegetation that is palatable to goats. All the animals are raised on very little private cost but has high social and environmental costs but do not account for that in their cost of livestock rearing.

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Issues:Based on the specific features of the district mentioned in the ChapterII and the above observations, namely geographical features, soil type, size of land holdings, rainfall, agriculture & livestock, water availability and socio-economic conditions, discussions with the group of people in the village, and our observations in the field the major issues are:

i) Out migration of people to the adjoining State namely Gujarat for work.
ii) Changing cropping pattern particularly introduction of Cotton on Contract Farming and Soyabean in kharif season.
iii) No attempt has been made to study the economics of contract farming.
iv) Low productivity of livestock and no concern about environmental cost in livestock rearing practices.
v) No attempt to diversify agriculture despite scope for horticulture, Bee keeping and growing medicinal plants in the area.
vi) Excessive use of chemicals in Soyabean and cotton crops.
vii) Agriculture extension input to farmers to practice modern/efficient agriculture is missing.

Rawatpura

The village Rawatpura, GramPanchayatSulavas, Tehsil Girva/Kurawad is located in the south-east direction at 45km from Udaipur. The village population is settled in two hamlets dominated by Rawat and Dangi community. Rawat's main occupation is farming while Dangi's are known for livestock rearing, particularly in milk trading. The hilly topography,small size of land holdings and terrace fieldsfor agricultural activity.Younger people migrate to Gujrat, Bombay and down south States in search of jobs as labourer, Marble fittings, shops, industry labour, etc. Young persons educated up to 10^{th} or 12^{th} belonging to Rawat family migrate to Gujarat and Bombay. Around 150 persons were reported to be migrated out on the day of our visit to the village. Focus group discussion was organised in the village and was attended by men and women with active participation. The issues discussed and their views on different subjects are as follows;

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Climate (Rainfall and Temperature)

The group comprised of old and young people therefore, they could answer the question on change in rainfall pattern over last 20 to 30 years. Change in annual average rainfall, arrival and withdrawal of monsoon season, and pattern of rainfall was mentioned and its impact on agriculture activities was discussed in details by the participants. The most important feature described by the group were change from wide spread rains to sporadic rains, shorter duration, and late arrival of monsoon. People responded to these climatic changes by adjusting cropping pattern, sowing time and other crop cultural practices. Keeping livestock is also part of taking care of climatic risk. Temperature variation affecting Rabi crops production was also reported.

Water resources

The undulating terrain provides small gullies, rivulets and low areas where rainwater harvesting is possible through different watershed development activities. NGOs supported people in putting anicuts at different places to enhance the supply of surface water and groundwater for irrigation. Groundwater table is at 25 to 50 ft. The irrigation from the structures and wellsis done by using 3 HP motor. Annual variation in rainfall is high, droughts frequency also high, therefore, in most years there is shortage of water for irrigation.

Agriculture

Farmer adopts cropping pattern, i.e., crops and sowing time and method (as sole or mixed crop) based on rainfall forecast for the year and actual arrival of monsoon in the region. In normal rainfall year the cropping pattern followed is;Maize, Urd (Black gram), Sesamum, Lobia and Guar. These crops are taken as mix crop if arrival of monsoon delayed and low rainfallis predicted. Tuber crops namely, Ginger, Ratalu, and Turmeric in small area are also cultivated. In Rabi season Wheat, Raida/Taramira, Alsi, and Barley crops are grown. Small area is also allocated to Gram crop. There is change in the cropping pattern after introduction

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of Soyabean crop in the area. NGOs in the area are recommending ‘Organic Agriculture’but only few farmers are interested in adopting it as there is fear of reduction in crop production/productivity and also uncertainty about themarket for sale of organic produce.

Livestock

The composition of livestock and change if any during last 10 to 15 years in the village was discussed. Presently the animals are; Cows, Buffaloes, Sheep and Goats. Dangi community prefer to keep buffaloes for milk while Rawats mostly cows and Goats. There are 150 households in the village of that 60 Dangi family and 50 Rawat households are engaged in milk business. As the demand for milk is increasing more families are likely to keep buffaloes. Goats provide good cash income particularly supports livelihoods of poor households. The number of large animals is increasing while small ruminants is decreasing. To enhance fodder availability for animals NGOs are trying to introduce a fodder plant specie in the area.

Issues:Based on the specific features of the district and village mentioned in the ChapterII,

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namely geographical features, soil type, size of land holdings, rainfall, agriculture & livestock, water availability and socio-economic conditions, and our discussion with the group of people in the village and also observations in the field the major issues are as follows:

i) Climate change is understood by people in terms of rainfall and temperature that is more related to climate variability and that to in short run. Need for study on impact of climate change on agriculture and livestock and make people understand and adopt climate resilience measures based on full knowledge.
ii) Introduction of Soyabean crop without understanding the overall implication on household income, soil health and availability of fodder for livestock.
iii) Biodiversity will become an issue as NGOs are pushing a tree crop as fodder for small ruminants without understanding its implication on other species of plants in the village common lands.
iv) No village level plan for milk producers.
v) Lack of knowledge about MSP and how to get it for their produce.
vi) Women play important role in household economy but literacy levels are low.
vii) Out migration of young people in the absence of alternative employment in or around village. People failed to reach government programs for skill development of youth.

3.4 PRATAPGARH

The village selected for observation in the newly formed district Pratapgarh was Devgarh, a historically famous area.It is located at 18 km from Pratapgarh. Meena community account for 90% of the total village population. The objective was to understand about the people's livelihood and how that has changed over last 20 years and their perception about climate change and its impact on crops, livestock and overall livelihoods of different section of population. Focus group discussion was organised in the village and was attended by number of young men. People were very vocal in expressing their views and willing to undertake suggested activities for betterment of village and the people.

Devgarh

The topography of the village is hilly, therefore agriculture fields are small in sizeand are in the form of terraces. Scattered settlement pattern. Lots of historical buildings in the village including few old Bawries, source of drinking water. Migration of youth is also common in this village as about 75% population of age group ranging between 20 to 45 years was reported migrates to Gujarat. Migrants are mostly unskilled workers. Agriculture and livestock rearing are the main occupation of people.

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Climate (Rainfall and Temperature)

The meeting was attended by young and old persons giving us opportunity to have a long term perspective of people about climate change. Peoples' observation were mostly about rainfall and temperature. There was consensus that there is a major change in the annual precipitation and pattern of rainfall. The average rainfall has declined, rainy days reduced from 60 days to 40 days, uncertainty in arrival of monsoon has increased and nature of rainfall changed from wide spread to sporadic rains. Average temperature has increased particularly in last 10 years.

Water Resources

There are 540 water bodies (500 wells, 31 Tlabs, Bawri and other structures) in the village. In last 15 years number of tubewells were dug for irrigation. There is lot of scope for watershed work to augment water resources in the village. Water quality is good. Water table in wells is 60 ft. while tubewells are dug at 500 ft. deep. Engines were used to lift water from wells while 5 HP electric motors are used in case of tubewells. Variation in rainfall has increased resulting in shortage of water in summer season.

Agriculture

Traditional cropping pattern followed in the village was as follows: Kharif- Maize, Urd, Cotton, Sugarcane, Jowar, Til and Groundnut. Rabi- Wheat, Gram and Mustard. There is a shift in the cropping pattern in both the seasonsas follows: Kharif- Maize, Soyabean and Urd. Even the sowing system has changed from mix cropping to sole cropping. In Rabi season the crops are; Wheat, Gram and Masoor. People prefer to grow more Gram than Wheat. The biodiversity in crops has declined. The villagers lack awareness aboutscope of horticultural crops. As largearea of the village is under forest, there is scope for growing medicinal crops. Use of chemicals has increased affecting the water quality and soils.

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Livestock

The availability of forest and grazing lands and nearness to Pratapgarh(18 km) provides market for milk have shaped the composition of livestock in the village. People keep cows for manure and animal power use in agriculture, buffaloes for sale of milk and goats and sheep for sale of live animals. People also prefer poultry at household level for own consumption and also for sale in the weekly market. Goats are preferred as there is no private cost involved in raising because of availability of large grazing fields. The group reported that on an average 5 goats per household are reared in the village. People are interested in raising poultry birds.

Issues:Based on the specific features of the district and village mentioned in the ChapterII and the features discussed above, such as, geographical features, soil type, size of land holdings, rainfall, agriculture & livestock, water availability and socio-economic conditions, and our discussion with the group of people in the village and also observations in the field the major issues are as follows:

i) Small size of holding and encroachment on forest lands. As the ownership of land is disputed, they can't get benefits of government schemes.
ii) Agriculture and household works are mainly performed by women but they are mostly illiterate and are not exposed to outside world.
iii) Adoption of Soyabean crop is unsustainable also use of chemicals is high.
iv) Despite high rainfall water is inefficiently managed.
v) Out migration of unskilled younger people.

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3.5 KOTA

Kota district is known for high rainfall and canal irrigation. The village selected for observation was Khani locate at 60 km from Kota near Ramganj Mandi. The objective was to know about the people's livelihood and how that has changed over last 20 years and their perception about climate change and its impact on crops, livestock and overall livelihoods of different section of population. The village is located on the state boundary adjoining to Madhya Pradesh surrounded by thick forest. Focus group discussion organised in the village was attended by men and women. People were very frank in expressing their views and willing to undertake activities for betterment of village and the people.

Khani

The Khanivillage small in size, populated by Patidar/Dangi and Tribals. Land distribution is unequal as Tribals own small size of holdings and Patidarsown large size of farms. Average rainfall is high yet there is shortage of water for irrigation. Agriculture and livestock rearing are main occupation of people but 75% of youth age group 25 years and above migrate for labour work to nearby stone quarries and cement industry. Though large farmers have diversified agriculture by plantation of Orange and other fruit plants Tribal households are still practicing traditional agriculture.

Climate (Rainfall and Temperature)

The average rainfall is higher than 850mm per year. The group was of the view that in last 10 years rainfall has increased. Earlier there used to be 40 to 45 rainy days that has increased to 45 to 50 days but rains in the months of January to March has declined significantly. Deforestation was evident in the area mainly because of encroachment of land for cultivation. There is a hilly range on the border of Rajasthan and Madhya Pradesh having dense forest and people were of the view that because of that we get good rains.On change in temperature in the area the view of the group was that it is increasing, variability is high and summer months temperatures are sometime intolerable. Mining and Quarrying activity is also contributing in the rise in temperature in the area.

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Water Resources

Village is mostly dependent on surface water sources. There is small river and rivulets passing through the village. People divert that water or lift it for irrigation.These sources dry up during summers.

Agriculture

The traditional cropping pattern practiced by the farmers was; Kharif – Maize, Jowar, Sesamum, Urd (Black Gram), and Green Gram. In Rabi season Wheat, Gram, Alsi, and Coriander. The present cropping pattern is; Kharif- Maize, Soyabean and Urd. Recently vegetable cultivation and Jowar as green fodderisintroduced by large farmers having assured irrigation. Rabi season- Wheat, Mustard, Garlic and Coriander. Large farmers practice intercropping in orange orchards. The productivity of most crops grown in the village was lower than the average yields of the district.

Livestock

Small ruminants dominate the composition of livestock in the village. As reported by the group that on an average 15 goats per household is owned by150 households in the village. Buffaloes are kept for milk and cows for animal power and manure. Forest area facilitates goat keeping but there is no awareness about breed and their productivity. People also want to keep poultry but cannot afford enclosures to protect them.

Issues: Based on the specific features of the district and village mentioned in the Chapter II and the features discussed above, such as, geographical features, soil type, size of land holdings, rainfall, agriculture & livestock, water availability and socio-economic conditions, and our discussion with the group of people in the village and observations in the field the major issues are as follows:

i) Majority of household own small size of holdings and without irrigation source. Though there are small water streams passing through the village that water can be lifted/diverted for irrigation.
ii) Soil erosion from agriculture lands is high in the absence ofmerbandi of fields.

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iii) livestock is raised on zero private cost and high social and environmental costs.
iv) Lack of awareness about government rural development programs.
v) Lack of awareness about new agriculture technology.
vi) People working in stone industry lack awareness about health issues and health risk covering schemes of government.


3.6 BARAN

The team visited gram panchayat Bakanpura and Ranwas in Baran district to aquent with the ground reality about the people's livelihood and their perception about climate change and its impact on crops, livestock and livelihoods of different section of population. In general, the group felt that there is change in weather parameters, i.e., increase in climate variability but had little idea about climate change. When asked about change in rainfall and temperature compared to last 20 years, they narrated the following:


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Climate (Rainfall and Temperature)

i) The seasonal calendar has shifted by 15 to 20 days. Monsoon arrives late and accordingly winters are shifted. Variation in temperature was reported.
ii) Rainfall pattern and quantum of rainfall has changes. Rainy days declined from around 60 days to 40 days. There are more sporadic rains than wide spread in the past. In the peak rainy season, there used to be continuous rains for a week or fortnight and that pattern is almost missing. Gap between first rain and subsequent rains has increased, i.e. stress period increased. Average rainfall declined.
iii) Winter rains have significantly declined.
iv) Wind intensity has increased.

Agriculture

i) People prefer to practice traditional agriculture because of small size of holdings. Women are the main actor in agriculture. Young man prefers to migrate within the district as agricultural labourer to work for large farmers. Large farmers are mostly outsiders, got land allotted/purchased and then started money lending business. As the indebtedness increased farmers sold land to moneylenders. Livestock rearing is their subsidiary occupation.
ii) Traditionally the crops grown in the area were; Kharif season – Paddy, Sugarcane, Jowar, Black Gram and some more crops grown on very small patches of land. Rabi season – Wheat, Gram, and Mustard. Major change in cropping pattern has taken place particularly in Kharif season. Soyabean crop has replaced all other kharif crops, only in low lands with almost no drainage paddy crop is taken in standing water or in case where canal irrigation is available. Monoculture is very much visible in the entire district. Sugarcane crop has been completely wiped out from the area. In Rabi season, wheat is preferred crop, on assured irrigated lands and mustard and gram crops depend on the availability of soil moisture.
iii) There is a shift from organic farming to chemical based farming. The use of insecticides and pesticides is very high in the district.

Livestock

i) Cows, buffaloes and goats are the main animals kept in the district. Milk yields of cows are very low as there is no descript breed. Buffaloes are preferred for milk. Goats are kept by almost all the households but again are non-descript breed. As the grazing lands are shrinking because of encroachments and converted into agricultural lands composition of livestock is shifting in favour of stall-fed animal, i.e. buffaloes. Adoption of Soyabean crop has also affected the animal population as the fodder availability has drastically declined.
ii) People have preference for poultry but not aware of bird keeping practices.

Based on the specific features of the district mentioned in the ChapterII, such as, geographical features, soil type, size of land holdings, rainfall, agriculture &livestock, water availability and socio-economic conditions and our observation in the field the

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major issues are as follows: Small size of holdings, outsiders have purchased the lands of locals and in the process compelled them to work as labourer on their own lands. Women are the main workers and are mostly illiterate and lack skills to undertake alternative employment. Present agriculture is moving towards monoculture, highly capital intensive, risky and high chemical using, i.e. most unsustainable affecting biodiversity of the region. Livestock is most neglected by people and the state departments. Youth unemployed get no guidance to build their capacity to look for alternative employment. People lack awareness about large number of rural development program initiated by the State and National Government.

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CHAPTER IV

STRATEGIES AND RECOMMENDATIONS FOR CLIMATE RESILIENCE

This proposal has an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. There can be three simultaneous goals and interlinking objectives: i) increased productivity and incomes, ii) adapting and building enhanced resilience, and iii) reducing emissions associated with agriculture. The question is how to adapt or mitigate the threats posed by climate change. Can we understand the local resource endowments, their use pattern and farmers perception of the climate change and its impact and design strategies for climate resilient agriculture?

4.1 Weather Monitoring and Agro-Advisory Services

Climate change at local level is perceived as change in water availability, temperature and its impact in terms of low crop yields. The water availability is directly linked to rainfall and its changing pattern. This changing pattern of rainfall and temperature affects the crop cultivation practices, particularly the sowing time of the crops and irrigation schedule. Though State has developed a system through which farmers in different regions are weekly informed about likely chances of occurrence of rainfall and likely temperature. But most farmers are not aware of this facility, that is available on mobile phone and that can be very useful in adopting climate resilient agriculture. Capacity building of farmers to access relevant metrological data and its use in taking timely decision about choice of crops and their cultivation practices should be the first step in planning any intervention on the subject.

4.2 Agro-ecology based Agricultural Planning

Considering huge variability in the geographical, topographical, social and environmental factors in different parts of the state, and that agriculture being the main livelihood option for our rural population, it is necessary to develop and delineate our major farming practices according to regions/zones in the state so as to improve agriculture, and make it demand driven as well as sustainable. It is known that the requirements of particular crops will depend much on aerial (temperature, radiation, humidity etc.), edaphic (soil, moisture and aeration), pedologic (soil depth, soil reactions), technological (fertilizer, pesticide) and other factors.

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Further, climate change is disturbing crop specific agricultural practices schedules differently in different agronomic zones. Forplanning the location-specific intervention, a status report has to be prepared for each zone covering information onthe natural resources, major crops, farming systems, production constraints, impact of climate change and socio-economic conditions.

The production system, as a concept, takes into account different components such as crops, trees and livestock, and various factors of production such as soil, water, labour, capital, energy and other resources, and the interaction among themselves as well as with the physical, biological and socioeconomic factors.It is holistic, acknowledges location-specificity of technological solutions, emphasizes on testing and adaptation of technological solutions based on agroclimatic and socioeconomic specificities, is farmer participatory, concerned with `bottom up' strategy, is interdisciplinary, emphasizes extensive on-farm activities, is dynamic, gives weightage to indigenous traditional knowledge (ITK) system, focuses on actual adoption and sustainability. It basically aims at generating and transferring technologies to improve the productivity on a sustainable basis.

Modern agriculture requires precise information of various agroclimatic parameters like soil types, rainfall, temperature, water resources, available genetic diversity, traditional agricultural practices, etc. These parameters affect the vegetation and fauna in an area which constitute an important part of ecological unit. Viewing the agro-ecosystem as a functional system of complementary relations between living organisms and their environment that are managed by humans with the purpose of establishing agricultural production provides a basis for integrating the overlapping ecological and environmental traits with sociological, economic, political, and other cultural components of agriculture. All of these may vary across spaceand time. Consequently, varieties and management methods have different optima in different places.

For Climate Resilient Agriculture develop Village Level Plan (VLP) which definestrategies to be taken up by farmers in response to major weather related aberrations such as delay in onset and break in the monsooncausing early, mid and late season droughts, floods, unusual rains, extreme weather events such as heat wave, cold wave, frost, hailstorm and dust storm. The enabling plan should include a strategy to follow an approach linking the multiplicity of

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agronomic, economic and environmental criteria that determine the performance of an agro-ecosystem, and then determine the nature and extent of changes that need to be introduced to achieve greater productivity. For improved, sustainable and secure agriculture, integrated farming system based on agroecological considerations be our future strategy. This aspect though recognized but has not been actually put in practice on a large scale. Forfuturesustainable agriculture,scientific landuse planning based on available natural resources would be extremely important to achieve the desired success.

The agro-ecology based agricultural crop planning would help us to understand the inter-relationships between agronomic, economic and policy factors, in order to develop conservation-effective and sustainable production systems to meet the food, fodder and fuel needs of the future. The ecologically smart agriculture wouldrequirefocus on three "3A" s i.e. adaptation, awareness and adoption, thus, requiring reorientation of research agenda around farmers needs and most suited farming practices for a defined ecology.

In Rajasthan, there exist significant yieldgaps between genetic potential, yield attained at experimental station/frontline demonstration and actual/average yields at farmers' fields. Second,significant yield gaps also exist between different regions/districts/states in different crops. These gaps are largely due to difference in farmers' resources endowments and management practices adopted. These yield gaps have to be bridged. There are wide variations in interstate/inter-district productivity (horizontal gap) also. The development and identification of disease resistant and climate resilient crop varieties, with enhanced tolerance to fungal/insect attack, heat, drought, flooding, chilling and salinity stresses are essential in order to sustain and improve crop yields to cope with the challenges of biotic/abiotic stresses.

There is a need to shift from commodity/crop to farming system's mode and focus on system diversification, information communication technology (ICT), geographic information system (GIS) and good agronomic practices (GAP) to attain resilience in agriculture with efficient input (water, fertilizers, pesticides) use. For resilience in agriculture, eco-friendly and climate resilient technologies and efficient farming systems in different ecoregions should be identified and adopted with focus on improving soil health through organic matter recycling, conservation agriculture, need based use of nutrients based on soil test, improved water use efficiency using micro-irrigation techniques, etc.

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4.2.1 Action 1

How to implement what has been discussed above is by selecting five willing farmers in each intervention village to organise IFS demonstration on their farms, i.e. crop demonstration, livestock and horticulture demonstration, etc., and provide them handholding support at least for two to three years. This will help them in economising on cost of inputs, labour use, and get higher yields but they also to be linked with value chains and markets. What this implicates is innovate appropriate farming system, adoption of integrated nutrient management (INM), integrated pest management (IPM), and agricultural diversification towards high-value crops, shifting orientation from cereal dominance to high value crops like horticulture and livestock &poultry/Bee keeping.

Horticulture, livestock, poultry and fisheries are the growth engines in present day agriculture. Promoting value chains and agro-processing hold the key to improving price realized by farmers, value addition and employment generation. Rajasthan's long growing-season, diverse soil and climatic conditions comprising several agro-ecological regions provide ample opportunity to grow a variety of horticulture crops. A new paradigm shift in farming in the recent past has been towards horticulture-based farming systems to ensure greening, environmental services and to provide nutritious food while enhancing farm profitability. Realising this dream requires capacity building and initial handholding supportto farmers to demonstrate the viability of suggested models and to build confidence of people. Additionally, the challenge will be to provide market information service and technology awareness, soft loans and credit linked back-end subsidy for commercial production, postharvest management, processing and cold storages facilities to the farmers. Major factors contributing to the horticulture sector's progress include expansion of area (cluster of producers), crop diversification, and technological interventions for production and post-harvest management.

Recognize the fact that nearly 80 per cent of the land holdings in Rajasthan are below 2 ha. And therefore, whatever suggested has to fit with this reality. However, improving small-farm production and productivity can make the greatest contribution to the elimination of hunger and poverty in Hilly and tribal areas of Rajasthan.

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4.2.2 Action II

Agriculture:

1. Facilitate adoption of Integrated Farming System (crops, livestock, horticulture, floriculture, beekeeping, etc.)
2. Introduce Mixed Cropping in place of sole cropping in both the season.
3. Gradually shift farmers from chemical farming to organic farming with full technical support.
4. Make soil health test compulsory and provide guidance in selection of cropping system.
5. Get conducted cost of cultivation survey of present crops and each recommended crop in the intervention villages.
6. Organise farm demonstration by selecting five farmers in each intervention village willing to act as per our advice and provide them hand holding support for at least three years.
7. Process documentation of all the interventions by professional staff.
8. Capacity building of different stakeholders by identification of their strength and weakness and design training manuals.
9. Ask implementation partner to employ at least one agriculture specialist (Agronomist) in the team to guide demonstration farmers. Organise capacity building of partner NGOs on climate change issues.

4.3 Value chain development

The initialsteps required for improving value chain are concentrating on post-harvesthandling,ambient controlled field storage, andprimaryprocessing including sorting, grading, cleaning, and preparingfor transportation.All these activities should be promoted at cluster level. Also, infrastructure status at collection centers and mandis need to be significantlyimproved. To gain access to remunerative or niche markets, to reduce marketing and transaction costs and to check monopolistic or oligopolistic tendencies of the traders/buyers, the producer-driven value chain may take form of a cooperative society or a producer association or a SHG (NGO in Udaipur district has demonstrated that this is doable). In order to engage small-scale producers, the development organizations, including NGOs and government agencies facilitate their organization into collectives, and extend benefits provided by the Government like tax exemptions and provisions of venture capital. FPOs have the potential to give farmers better bargaining power and create a more transparent agri-market, and they need to be nurtured to their full potential. There is also need for promoting women owned Farmer Producers Organisation and also livestock based Farmers Producers Organisation.

4.4 Risk Management

Agricultural production is exposed to a variety of risks. These include weather risks, natural catastrophes, and pests and diseases. Production risks are exacerbated by price risks, credit

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risks, and technological risks. The common risk management tools at operation include calamity relief, crop insurance, and interventions like Minimum Support Prices (MSP), price stabilization fund, futures market and contract farming. These measures of risk are long-felt inadequate tocope-up with the rise in the production costs. The cost of insuring horticultural crops is felt to be high and demands are made to lower the premium. Possibility of suchproposal needs tobe considered. The coverage of insurance in the livestock and fisheries sector is rather limited. In each region variety of risks have to be identified, look at the existing state provisions to deal with the, demarcate gaps and plan to deal with each risk at two levels; first, those where community action can deal with it, and second, gaps where state intervention and support is essential. Organise meetings/interactions at suitable forum to address the issues. At village level NGOs have to understand the process of government assessing the risk and its impact on farmers and calculating the compensation. Also gather data needed to process the claims and provide handholding support to affected farmers.

4.5 Natural Resource Management Sector

Sustainingqualityof natural resources (NRs) (soil, water, biodiversity and micro-climate) is the main stay of agricultural production and for decent survival of humanity and their animal support system. Since biophysical contours of NRs vary at scale across regions, so does their productive capacity (productivity). State natural resources are severely stressed due to much higher demographic, economic and socio-political pressures compared to rest of the country. More than nature, human's management (of soil fertility, moisture availability, aeration, biotic life and micro-climate) influences native productive capacity of NRs. Village level NR management plans with VDC be prepared and community be involved in their implementation. In the state Integrated Water Resources Management plans were prepared for around 3500 villages without serious/genuine participation of people and none was implemented. Therefore, the IWMP has to be prepared by participation of technical team, government line department officials, NGO representative and people based on correct estimation of resources.

4.6 Linkages with Government Schemes/programsand Services

Plan for opening up of a Village Social Service Centre, self-sustainable, stationed with multidisciplinary experts, providing various services (health, employment, skill development, agriculture, animal husbandry, horticultural, etc.) to village people at nominal cost. The

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Centre be governed by VDC and NGO jointly in close association with village Sarpanch. The Centre will liaison with regional KVKs and ITIs, and all government line departments to facilitate people to have access to benefits of various rural development programs by the State and Union Government.

4.7 Human Resource Development

Organise training of youth in skill development to facilitate self-employment and to get better wages in case of out migration. Government has a scheme of mobile van providing skill development training to men and women within village that facility be availed at each proposed village service centers. Link unemployed youth with the industries in the region.

4.8 Farmers Leadership and Gender Sensitive Institutional Building

Create a new institution namely, Village Development Committee (VDC), equally represented by men and women, to perform the role of village welfare/development think tank/group and farmers leadership building. The role of VDC will also be to motivate youth to undertake village development activities through Sarpanch, based on large number of various rural development programs/schemes of the state and national government.

4.9 Area wise specific interventions

Nagaur District -Todas village

1) The present cropping pattern that is more guided by market and state agricultural policies do not match with the existing resource endowments of the village and therefore unsustainable. There will be serious water crisis as wheat, onion and groundnut crops are water intensive crops and vegetables are also high water demanding. There is strong need to divert farmers to alternative cropping pattern and adoption of Integrated Farming or adopt Farming System Approach.
2) People are willing to undertake dairy activity, particularly buffalo based dairy as cows are comparatively less milk yielding. There already exist a milk collection Centre to ensure marketing of milk. Stall fed goatry can also be very productive and profitable activity. To support the sheep rearing farmers special attention has to be given on protecting village common lands from encroachments, increasing their productivity through community participation and rehabilitation of village water bodies.

Nagaur District - Karnoo village

1) The present cropping pattern that is more guided by market and state agricultural policies do not match with the existing resource endowments of the village and therefore unsustainable. There will be serious water crisis as both cotton and groundnut crops are water intensive crops and vegetables are also high water

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demanding. There is strong need to divert farmers to alternative cropping pattern and adoption of Integrated Farming or adopt Farming System Approach.

2) Organise crop demonstrations on five selected farms to show the economic viability of alternative cropping system and integrated farming system.

Jaisalmer District - Kita and Fatehgarhvillages

Since the issues are the same in the two villages visited in Jaisalmer District the suggested interventions are applicable to both the villages visited in the area. The areas of interventions are as follows:

1) The present cropping pattern is a business model for tenant farmers from outside district. The land owner is least interested in learning commercial agriculture from tenant farmers. Locals prefer to rear animals. In order to divert people to adopt modern agriculture and make the cropping as sustainable livelihood organise 'On Farm Training and Capacity Building program'. Organise exposure visits. Motivate farmers to adopt Integrated Farming.
2) Organise crop demonstrations on five selected farms to show the economic viability of alternative cropping system. Link farmer to the nearest KVK.
3) Plan livestock development activity for each type of animal separately by making groups and then build their capacity on modern heading, feeding and health care issues. Stall fed goat rearing can be viable option. BAIF model of Goat Keeping is suitable option for women in the area.
4) People are willing to have poultry activity at household level to earn supplementary income, therefore, arrange financial and technical support.

Udaipur District – Gajvi village

The suggested interventions are as follows:

1) Watershed works in the village be undertaken to augment water supply and conservation of soils.
2) Examine the contract farming carefully and make farmers aware of their exploitation by contractors. Plan Integrated Farming System for the village and adjoining areas.
3) In order to divert them to modern agriculture and make the cropping as sustainable livelihood organise 'On Farm Training' and capacity building program. Organise exposure visits. Motivate farmers to adopt Integrated Farming and Organic Farming.
4) Organise crop demonstrations on five selected farms to show the economic viability of alternative cropping system. Link farmer to the nearest KVK.
5) Plan livestock development activity for each type of animal separately by making groups and building their capacity on modern heading, feeding and health care issues. Stall fed goat rearing can be viable option. Goat keeping on commercial basis with scientific rearing and breed improvement is most suitable for the area, as farmer prefer goats.

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Udaipur District – Rawatpura Village

The suggested interventions are as follows:

1) Watershed works in the village be undertaken to augment water supply and conservation of soils.
2) Climate change impact study be commissioned for the area before designing climate resilient strategies/activities.
3) Revival of tuber crops will provide the farmers better income.
4) In order to divert them to modern agriculture and make the cropping as sustainable livelihood organise 'On Farm Training' and capacity building program. Organise exposure visits. Motivate farmers to adopt Integrated Farming and Organic Farming.
5) Plan livestock development activity for each type of animal separately by making groups and building their capacity on modern heading, feeding and health care issues. Stall fed goat rearing can be viable option. Goat keeping on commercial basis with scientific rearing and breed improvement is most suitable for the area as farmer prefer goats.

Pratapgarh District – Devgarh village

The suggested interventions are as follows:

1) Watershed works in the village be undertaken to augment and efficient management of water and conservation of soils.
2) Climate change impact study be commissioned for the area before designing climate resilient strategies/activities.
3) In order to divert them to modern agriculture and make the cropping as sustainable livelihood organise 'On Farm Training' and capacity building program. Organise exposure visits. Motivate farmers to adopt Integrated Farming and Organic Farming.
4) Plan livestock development activity for each type of animal separately by making groups and building their capacity on modern heading, feeding and health care issues. Stall fed goat rearing can be viable option. Goat keeping on commercial basis with scientific rearing and breed improvement is most suitable for the area as farmer prefer goats. Scope for taking poultry on scientific lines.
5) Organise capacity/skill development training activity both for men and women to provide people supplementary income through nonfarm employment or business based on local produce. Women capacity building needs NGO active participation in motivating them for trainings within and outside village.

Kota District–Alod (Khani) village

The suggested interventions are as follows:

1) Watershed works in the village be undertaken to augment and efficient management of water and conservation of soils.
2) Educate people about solar pumps to draw water from river and rivulets for irrigation.
3) Women are interested in alternative source of income. Organise skill development programs for women. Stall fed goat keeping and poultry was demanded by the women group in the village.

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4) The area is suitable for horticultural crops. Identify suitable crops and train selected farmers for adoption.

Baran District–Bakanpura and Ranwas villages

The suggested interventions are as follows:

1. Capacity building of people to understand the short and long term consequences of monoculture, particularly growing Soyabean with high use of insecticides and pesticides on human and livestock health, soils, groundwater, etc. Gradually shift to Integrated Farming System with organic farming. As the soil depth is low selection of alternative farming system has to be carefully planned. Scope of horticulture plantation is also limited.
2. Diversification of livelihoods (non-farm sector) by skill development of both men and women, to check outmigration alternatively encourage migration with skills so that they get better wages and employment opportunities.
3. Poultry and Goatry can easily be adopted by people. There are viable models of small scale, i.e. household level, developed by agricultural universities much suitable for this area. Also link people with nearest KVK for scientific input in their activities.
4. Cases of indebtedness are higher, therefore, plan activities that provide regular cash flow to meet their daily cash requirement.

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Appendix Tables

Table 1: Land use in selected districts of Rajasthan - 2005-06 **(Percentages)**

LAND	Baran	Jaisalmer	Kota	Nagour	Udaipur
1.Geographical Area according to Village papers (Hectares)	100 (699652)	100 (3839154)	100 (521133)	100 (1764380)	100 (1462105)
2.Forest	**30.90**	**0.68**	**23.61**	**1.04**	**28.35**
3.Not available for Cultivation	0.00	0.00	0.00	0.00	0.00
(A)Land put to non-agricultural use	3.63	3.41	5.68	4.92	10.73
(B)Barren & uncultivated	5.53	9.52	7.05	3.32	23.03
Total(A+B)	**9.16**	**12.93**	**12.73**	**8.24**	**33.76**
4.Other uncultivated excluding fallow land	0.00	0.00	0.00	0.00	0.00
(C)Permanent pasture & other grazing land	5.11	2.71	2.71	4.12	6.06
(D)Land under misc. tree crops & groves not included in net area sown	0.02	0.02	0.05	0.01	0.22
(E)Culturable waste	2.93	65.08	4.22	0.81	8.79
Total(C+D+E)	**8.06**	**67.80**	**6.98**	**4.94**	**15.06**
5.Fallow land	0.00	0.00	0.00	0.00	0.00
(F)Old fallow land	2.66	3.75	2.42	5.32	4.44
(G)Current fallow land	1.51	1.39	1.50	9.37	1.03
Total(F+G)	**4.17**	**5.14**	**3.91**	**14.69**	**5.47**
6.Net area sown	47.71	13.45	52.77	71.09	17.36
7.Total cropped area	**71.60**	**15.06**	**79.81**	**84.07**	**25.34**
8.Area sown more than once	23.89	1.61	27.05	12.98	7.98

Table 2: Land use in selected districts of Rajasthan - 20015-16 (Percentages)

Classification of Reporting	District						
	Baran	**Jaisalmer**	**Kota**	**Nagour**	**Pratapgarh**	**Udaipur**	**State Total**
Reporting Area	**100 (699461)**	**100 (3839145)**	**100 (518345)**	**100 (1763925)**	**100 (141736)**	**100 (1388255)**	**100 (34267365)**
Forests	**31.16**	**0.71**	**24.48**	**1.07**	**29.37**	**28.62**	**8.03**
Not Available for Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area Under Non-Agricultural Uses	4.03	5.14	5.97	5.13	2.57	11.20	5.68
Barren and Unculturable Land	5.24	9.78	5.94	3.14	6.83	22.82	6.99
Total	**9.27**	**14.92**	**11.92**	**8.27**	**9.40**	**34.02**	**12.67**
Other Uncultivated Land Excluding Fallow Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Permanent Pasture and Other Grazing Land	4.83	2.20	2.67	4.06	5.46	5.93	4.88
Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	0.03	0.01	0.16	0.00	0.06	0.04	0.06
Culturable Waste Land	1.72	56.32	4.41	0.66	8.46	8.75	11.37
Total	**6.58**	**58.53**	**7.24**	**4.73**	**13.97**	**14.71**	**16.31**
Fallow Lands Other than Current Fallows	1.94	3.52	2.36	6.21	2.23	4.42	5.74
Current Fallow	1.14	1.41	1.11	9.38	0.88	0.73	4.66
Total Fallow	**3.08**	**4.93**	**3.47**	**15.58**	**3.11**	**5.15**	**10.40**
Net Area Sown	49.92	20.90	52.90	70.36	44.15	17.49	52.60
Gross Cropped Area	**94.74**	**26.77**	**99.27**	**83.48**	**71.85**	**25.26**	**73.00**
Area Sown More Than Once	44.82	5.87	46.37	13.12	27.70	7.76	20.40

Table 3: Cropping pattern in the selected Districts of Rajasthan – 2005-06

	Year 2005-06					
ops	**Baran**	**Jaisalmer**	**Kota**	**Nagour**	**Udaipur**	**Rajasthan**
Rice	1.14	0.00	5.35	0.00	2.34	0.77
Jowar	1.28	1.30	7.81	4.55	2.00	4.75
Bajra	1.74	21.79	0.02	39.10	0.01	35.26
Maize	12.14	0.00	7.63	0.01	71.47	7.41
Arhar (Tur)	0.04	0.00	0.03	0.00	1.28	0.13
Other Pulses	0.70	0.54	4.39	36.26	6.63	15.64
Sugarcane	0.04	0.00	0.02	0.00	0.19	0.08
Chillies	0.09	0.00	0.09	0.06	0.29	0.13
Ginger	0.01	0.00	0.00	0.00	0.05	0.00
Turmeric	0.00	0.00	0.00	0.00	0.02	0.00
Groundnut	0.38	1.30	0.27	1.55	2.11	2.20
Sesamum	4.42	0.02	5.69	0.92	1.51	1.96
Soyabean	74.91	0.00	62.01	0.00	1.73	4.60
Linseed	1.06	0.00	0.29	0.03	0.53	0.52
Cotton	0.00	0.01	0.00	0.78	0.06	2.51
Drugs, Narcotics and Plantation Crops	0.33	2.08	1.95	2.68	0.03	1.25
Fodder Crops	1.72	72.96	4.45	14.06	9.74	22.78
Total	**100 (161735)**	**100 (567128)**	**100 (121524)**	**100 (1421438)**	**100 (403849)**	**100 (13926361)**
Wheat	28.18	8.43	32.58	31.77	63.43	33.71
Barley	0.12	0.06	0.18	4.96	8.56	3.05
Gram	1.17	18.02	1.22	7.26	11.36	13.29
Garlic	0.65	0.00	0.89	0.02	0.05	0.24
Coriander	14.08	0.00	8.91	0.00	0.02	1.72
Other Condiments and Spices	0.23	4.80	1.20	7.57	0.91	2.83
Fruits	0.19	0.09	0.04	0.36	0.09	0.33

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Vegetables	0.00	0.09	0.91	4.59	0.70	1.38
Castor seed	0.00	0.44	0.00	0.06	0.01	1.21
Rapeseed and Mustard	55.33	63.21	53.96	40.99	14.64	40.74
Other Oilseeds	0.05	4.86	0.09	2.42	0.22	1.50
Total	**100 (305097)**	**100 (154577)**	**100 (250314)**	**100 (240241)**	**100 (140155)**	**100 (7607448)**
Total Cropped Area	**466832**	**621605**	**371838**	**1421438**	**403849**	**21533809**

Table 4: Cropping pattern in the selected Districts of Rajasthan – 20015-16

Crops	**Year 2015-16**						
	Baran	**Jaisalmer**	**Kota**	**Nagour**	**Pratapgarh**	**Udaipur**	**Rajasthan**
Kharif							
Rice	4.76	0.00	8.14	0.00	0.44	2.00	1.09
Jowar	0.10	0.40	0.66	3.79	0.01	3.24	3.75
Bajra	0.33	11.67	0.02	28.64	0.00	0.01	24.21
Maize	3.04	0.00	0.89	0.01	22.93	71.29	5.23
Arhar	0.00	0.00	0.00	0.00	0.19	1.16	0.07
Other Pulses	6.47	2.30	8.54	41.49	7.72	3.90	17.30
Sugarcane	0.01	0.00	0.00	0.00	0.00	0.12	0.04
Chillies	0.01	0.00	0.01	0.01	0.04	0.31	0.07
Groundnut	0.18	2.17	0.07	1.18	0.19	0.84	3.09
Castor seed	0.00	0.68	0.00	0.01	0.00	0.03	1.14
Sesamum	1.36	0.59	3.14	0.91	0.23	0.80	2.18
Soyabean	83.35	0.00	77.26	0.00	65.44	5.23	7.16
Cotton	0.00	0.02	0.00	4.74	0.34	0.61	2.66
Fodder Crops	0.34	77.49	0.87	15.98	0.69	9.50	30.08
Drugs, Narcotics and Plantation Crops	0.05	4.67	0.41	3.25	1.79	0.96	1.94
Total	**100 (329237**	**100 (796932)**	**100 (251534)**	**100 (1232600)**	**100 (196255)**	**100 (243404)**	**100 (16836350)**
Rabi							
Wheat	47.82	5.42	45.65	25.12	57.12	69.77	38.02
Barley	0.08	0.01	0.10	3.89	1.37	9.24	3.13
Other cereals	0.00	0.00	0.00	0.00	0.02	0.52	0.17
Gram	2.59	57.03	0.82	3.36	14.14	8.14	11.52
Garlic	6.87	0.00	5.36	0.04	6.47	0.07	0.85
Coriander	13.48	0.01	20.87	0.04	0.81	0.01	2.60
Other Spices	0.59	17.22	2.52	35.15	8.66	0.85	8.92
Fruits	0.13	0.12	0.00	0.17	0.00	0.06	0.42
Rapeseed and Mustard	27.74	20.03	23.54	24.41	9.87	10.27	30.97
Linseed	0.09	0.00	0.01	0.16	0.57	0.01	0.02
Other Oilseeds	0.01	0.10	0.01	0.35	0.13	0.10	0.31
Vegetables	0.61	0.06	1.11	7.31	0.83	0.96	3.08
Total	**100 (333388)**	**100 (230930)**	**100 (263026)**	**100 (239970)**	**100 (99568)**	**100 (107236)**	**100 (8177354)**

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Total Cropped Area	**662661**	**1027862**	**514560**	**1472570**	**295823**	**350640**	**25013704**

Table 5: Composition of livestock in selected districts of Rajasthan- 2003

(Percent)

	Baran	**Jaisalmer**	**Kota**	**Nagaur**	**Udaipur**	**Rajasthan**
Cattle	41.84	13.72	35.13	13.72	35.02	22.07
Buffalo	24.18	0.12	29.01	15.88	17.89	21.18
Sheep	1.59	50.20	3.76	28.24	6.90	20.45
Goat	30.46	33.16	28.82	40.94	39.27	34.26
Horse	0.05	0.04	0.06	0.04	0.05	0.05
Donkey	0.26	0.60	0.16	0.16	0.21	0.29
Camel	0.13	2.08	0.41	0.65	0.31	1.01
Pig	1.50	0.08	2.66	0.36	0.37	0.69
Total Livestock	**100 (786338)**	**100 (1773323)**	**100 (655935)**	**100 (2645047)**	**100 (2965023)**	**100 (49175238)**

Table 6 Composition of livestock in selected districts of Rajasthan- 2012

(Percent)

Type	**District**						**Total Rajasthan**
	Baran	**Jaisalmer**	**Kota**	**Nagaur**	**Pratapgarh**	**Udaipur**	
Cattle	42.83	13.60	34.54	15.92	43.11	34.96	23.08
Buffalo	31.25	0.13	36.70	17.67	19.66	19.91	22.48
Sheep	1.20	37.09	2.84	18.57	2.86	5.06	15.73
Goat	22.91	47.36	23.21	47.14	33.95	39.81	37.53
Horses & Ponies	0.06	0.03	0.05	0.07	0.04	0.03	0.07
Mules	0.02	0.00	0.01	0.00	0.01	0.00	0.01
Donkeys	0.11	0.18	0.07	0.06	0.04	0.09	0.14
Camel	0.10	1.56	0.29	0.34	0.01	0.10	0.56
Pig	1.50	0.04	2.29	0.24	0.31	0.05	0.41
Total Livestock	**100 (800806)**	**100 (3195213)**	**100 (644466)**	**100 (3150011)**	**100 (765557)**	**100 (2780566)**	**100 (57732204)**

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Table 7: Average Rainfall and Rainy days in Selected Districts

District	Normal Rainfall (in mm)	Rainy days	
		1957	2018
Baran	828.8	27	41
Jaisalmer	146.9	14	7
Kota	732.3	35	34
Nagaur	354.8	23	16
Partapgarh	872.9	33	46
Udaipur	575	29	31

Table8: District wise Block wise status of Groundwater - 2017

District/Blocks	Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Recharge	All Usage			Stage of Ground Water	Categorization
				Irrigation Use	Domestic Use	Total Extraction		
ANTA	10947.14	1094.71	9852.43	7178.07	1255.13	8433.2	85.6	Semi-critical
ATRU	5252.43	525.25	4727.18	6568.09	855.97	7424.06	157.05	OE
BARAN	6337.07	633.71	5703.36	9845.04	1033.55	10878.59	190.74	OE
CHHABRA	6254.19	625.42	5628.77	6459.36	643.49	7102.85	126.19	OE
CHHIPABARO D	6019.11	601.91	5417.2	8901.96	717.7	9619.66	177.58	OE
KISHANGANJ	10607.9	1060.79	9547.11	7860.6	466.65	8327.25	87.22	Semi-critical
SHAHBAD	8512.77	554.41	7958.36	5402.24	782.28	6184.52	77.71	Semi-critical
BARAN Total	**53930.61**	**5096.2**	**48834.41**	**52215.36**	**5754.77**	**57970.13**	**118.707547**	
JAISALMER	2083.93828	208.3938	1875.54448	6480.45072	744.165	7224.61572	385.2	OE
SAM	3300.0626	330.0063	2970.0563	4707.516	1021.205	5728.721	192.88	OE
SANKRA	1380.23942	138.0239	1242.21552	4132.9872	741.8825	4874.8697	392.43	OE
JAISALMER Total	**6764.2403**	**676.424**	**6087.8163**	**15320.9539**	**2507.2525**	**17828.2064**	**292.850598**	
ITAWA	15689.3962	1568.94	14120.4562	11489.75	822.34	12312.09	87.193288	Semi-critical
KHAIRABAD	4754.74	475.48	4279.26	6429.62	993.9	7423.52	173.476723	OE
LADPURA	10574.5036	1057.44	9517.06364	6869.585	2537.82	9407.405	98.8477682	Critical
SANGOD	8738.17011	724	8014.17011	9646.595	1140.02	10786.615	134.594285	OE
SULTANPUR	17562.3747	1756.24	15806.1347	12513.496	1070.55	13584.046	85.9416058	Semi-critical
KOTA Total	**57319.1846**	**5582.1**	**51737.0846**	**46949.046**	**6564.63**	**53513.676**	**103.433884**	
DEGANA	4400.55701	440.0557	3960.50131	7472.362	1246.4	8718.762	220.14	OE
DIDWANA	2928.17107	202.5638	2725.60727	1667.4375	1092.8	2760.2375	101.27	OE
JAYAL	4815.05928	466.434	4348.62528	3330.325	1556.8	4887.125	112.38	OE
KHINVSAR	5360.59755	536.0598	4824.53775	9311.5	1523.2	10834.7	224.57	OE
KUCHAMAN	4497.91301	449.7913	4048.12171	12132.6783	567.2	12699.8783	313.72	OE

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LADNU	4697.68931	444.0916	4253.59771	2332.34129	1536.832	3869.17329	90.96	Critical
MAKRANA	3699.76228	269.5037	3430.25858	3053.00625	1520.8	4573.80625	133.34	OE
MERTA	5139.75536	503.3189	4636.43646	14862.8094	1173.6	16036.4094	345.88	OE
MOLASAR	3078.4486	153.9224	2924.5262	5255.25	988.8	6244.05	213.51	OE
MUNDWA	4035.81464	403.5814	3632.23324	12160.75	1431.2	13591.95	374.2	OE
NAGAUR	3363.15791	336.3157	3026.84221	1675.2133	533.6	2208.8133	72.97	Semi-critical
NAWA	2545.73518	127.2868	2418.44838	3904	272.8	4176.8	172.71	OE
PARBATSAR	3433.93873	343.3938	3090.54493	2991	758.4	3749.4	121.32	OE
RIYAN	5358.01403	535.8014	4822.21263	6424.6376	376.32	6800.9576	141.03	OE
NAGAUR Total	**57354.614**	**5212.1203**	**52142.4937**	**86573.3106**	**14578.752**	**101152.063**	**193.991609**	
ARNOD	4300.8392	215.042	4085.7972	5507.44	111.24	5618.68	137.517349	OE
CHHOTI SADRI	3669.5771	366.9578	3302.6193	4651.02	48.76	4699.78	142.304625	OE
DHARIAWAD	2684.6987	268.4698	2416.2289	2187.77	126.38	2314.15	95.7752802	Critical
PEEPALKHOONT	2943.6192	235.0997	2708.5195	1761.01	88.28	1849.29	68.2767837	Safe
PRATAPGARH	7064.7896	405.2733	6659.5163	8869.7	144.85	9014.55	135.363435	OE
PRATAPGARH Total	**20663.5238**	**1490.8426**	**19172.6812**	**22976.94**	**519.51**	**23496.45**	**122.551717**	
BADGAON	1050.7312	105.0731	945.6581	1100.57	91.72405	1192.29405	126.08088	OE
BHINDER	5155.4046	515.5405	4639.8641	5488.51	264.44	5752.95	123.989623	OE
GIRWA	3881.633	388.1633	3493.4697	3125.45	173.663	3299.113	94.4365712	Critical
GOGUNDA	2531.7246	253.1725	2278.5521	2057.41	91.58	2148.99	94.3138408	Critical
JALLARA	3005.3069	300.5307	2704.7762	1909.77	91.97	2001.74	74.0076018	Semi-critical
JHADOL	1528.2285	152.8229	1375.4056	1174	145.63	1319.63	95.9447889	Critical
KHERWARA	1839.6779	183.9678	1655.7101	1405.62	240.28	1645.9	99.4074989	Critical
KOTRA	3044.6446	304.4645	2740.1801	2293.36	149.59	2442.95	89.1528991	Semi-critical
KURAWAD	1548.3406	154.8341	1393.5065	1254.84	117.98	1372.82	98.5155075	Critical
LASADIYA	1821.5774	182.1577	1639.4197	1526.61	96.94	1623.55	99.0319928	Critical
MAVLI	6012.9303	601.293	5411.6373	6691.6	264.59315	6956.19315	128.541378	OE
PHALASIYA	1547.592	154.7592	1392.8328	1119.53	236.68	1356.21	97.3706248	Critical
RISHABHDEV	1519.8619	151.9862	1367.8757	1240.36	105.38	1345.74	98.3817462	Critical
SALUMBAR	2608.7761	260.8776	2347.8985	1752.52	157	1909.52	81.328899	Semi-critical
SARADA	2925.0907	292.509	2632.5817	2172.1	182.58	2354.68	89.4437578	Semi-critical
SAYARA	2448.2236	244.8224	2203.4012	2093.4	94.28	2187.68	99.2865031	Critical
SEMARI	1243.2126	124.3212	1118.8914	852.38	111.97	964.35	86.1879893	Semi-critical
UDAIPUR Total	**43712.9565**	**4371.2957**	**39341.6608**	**37258.03**	**2616.2802**	**39874.3102**	**101.353907**	

Table 9: Land Utilization as Percentage of Total Geographical Areain Sample Villages

(Percent)

Districts	Villages	Forest Area	Area under Non-Agricultural Uses	Barren & Un-cultivable Land	Permanent Pastures and Other Grazing Land	Culturable Waste Land	Fallows Land other than Current Fallows	Current Fallows	Net Area Sown	Total Geographical Area
Nagaur	Todas	0.00	3.28	0.00	3.17	0.00	7.77	2.52	83.26	100.0 (914.0)
	Karnoo	0.00	5.82	0.00	15.15	0.00	17.52	1.51	60.00	100.0

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										(3680.3)
Jaisalmer	Fatehgarh	0.00	9.84	0.74	7.59	33.28	0.00	3.55	45.00	100.0 (3441.6)
	Keeta	0.00	0.11	12.55	2.59	62.08	0.70	4.30	17.67	100.0 (11717.0)
Kota	Khani	9.18	0.74	0.74	0.00	3.47	0.00	2.98	82.88	100.0 (403.0)
Baran	Bakanpura	61.66	0.72	4.53	9.82	1.02	0.00	2.08	20.16	100.0 (2166.3)
	Ranwasa	81.29	1.76	0.35	2.81	0.00	3.86	1.93	7.99	100.00 (1139.2)
Udaipur	Gejvi	64.91	3.80	3.65	1.02	1.61	0.00	6.43	18.57	100.0 (684.0)
	Rawatpura	27.25	7.98	28.28	17.79	3.88	0.68	0.23	13.91	100.0 (438.5)
Pratapgarh	Devgarh	53.24	6.41	0.00	0.00	11.36	0.00	0.00	28.98	100.0 (570.6)

Note: Figures in parenthesis are geographical area in hectares.

Table 10: Land Utilization as Percent of Total Geographical Areain Sample Villages

Villages	Forest Area	Area under Non-Agricultural Uses	Barren & Un-cultivable Land	Permanent Pastures and Other Grazing Land	Culturable Waste Land	Fallows Land other than Current Fallows	Current Fallows	Net Area Sown	Total Geographical Area
Todas	0.00	3.28	0.00	3.17	0.00	7.77	2.52	83.26	100.00 (914.00)
Karnoo	0.00	5.82	0.00	15.15	0.00	17.52	1.51	60.00	100.00 (3680.31)
Fatehgarh	0.00	9.84	0.74	7.59	33.28	0.00	3.55	45.00	100.00 (3441.6)
Keeta	0.00	0.11	12.55	2.59	62.08	0.70	4.30	17.67	100.00 (11717.00
Khani	9.18	0.74	0.74	0.00	3.47	0.00	2.98	82.88	100.00 (403.00)
Alod	3.70	6.31	3.02	8.09	3.29	0.00	1.23	74.35	100.00 (729.00)
Bakanpura	61.66	0.72	4.53	9.82	1.02	0.00	2.08	20.16	100.00 (2166.35)
Ranwasa	81.29	1.76	0.35	2.81	0.00	3.86	1.93	7.99	100.00 (1139.16)
Gejvi	64.91	3.80	3.65	1.02	1.61	0.00	6.43	18.57	100.00 (684.00
Rawatpura	27.25	7.98	28.28	17.79	3.88	0.68	0.23	13.91	100.00 (438.48)
Devgarh	53.24	6.41	0.00	0.00	11.36	0.00	0.00	28.98	100.00 (570.63)

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Kulmipura	0.00	2.84	4.66	19.83	14.44	1.42	1.31	55.51	100.00 (459.38)

Table 11: Percentage of Total Geographical Areain Sample Villages

Villages	Net Area Sown	Unirrigated Area	Irrigated Area	Total Geographical Area
Todas	83.26	39.87	43.39	914.00
Karnoo	60.00	60.00	0.00	3680.31
Fatehgarh	45.00	45.00	0.00	3441.60
Keeta	17.67	17.67	0.00	11717.00
Khani	82.88	55.20	27.68	403.00
Alod	74.35	37.75	36.60	729.00
Bakanpura	20.16	0.19	19.97	2166.35
Ranwasa	7.99	4.94	3.05	1139.16
Gejvi	18.57	15.33	3.24	684.00
Rawatpura	13.91	8.25	5.66	438.48
Devgarh	28.98	21.41	7.57	570.63
Kulmipura	55.51	19.66	35.85	459.38

Table 12: Percentage Distribution of Population in Sample Villages

Villages	**Male**	**Female**	**Family size**
Todas	0.52	0.48	5.89
Karnoo	0.53	0.47	5.74
Fatehgarh	0.53	0.47	5.31
Keeta	0.53	0.47	5.54
Khani	0.51	0.49	4.52
Alod	0.51	0.49	5.30
Bakanpura	0.52	0.48	4.93
Ranwasa	0.55	0.45	5.53
Gejvi	0.55	0.45	4.66
Rawatpura	0.51	0.49	4.63
Devgarh	0.48	0.52	4.96
Kulmipura	0.52	0.48	4.79

Table 13: Percentage irrigated area of Total Geographical Area in Sample Villages

Districts	Villages	Net Area Sown (%)	Unirrigated Area (%)	Irrigated Area (%)	Total Geographical Area (Ha.)
Nagaur	Todas	83.26	39.87	43.39	914.00
	Karnoo	60.00	60.00	0.00	3680.31
Jaisalmer	Fatehgarh	45.00	45.00	0.00	3441.60
	Keeta	17.67	17.67	0.00	11717.00
Kota	Khani	82.88	55.20	27.68	403.00
Baran	Bakanpura	20.16	0.19	19.97	2166.35

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	Ranwasa	7.99	4.94	3.05	1139.16
Udaipur	Gejvi	18.57	15.33	3.24	684.00
	Rawatpura	13.91	8.25	5.66	438.48
Pratapgarh	Devgarh	28.98	21.41	7.57	570.63

Table 14: District wise distribution of size of land holding. (Percent)

District	**Marginal**	**Small**	**Semi-Medium**	**Medium**	**Large**	**All**	Average size of holding (Ha.)
Baran	37.5	26.6	22.4	12.0	1.6	100 (163771)	2.13
Kota	30.0	27.1	25.4	15.5	2.0	100 (111241)	2.47
Jaisalmer	2.9	8.0	12.6	52.1	24.4	100 99342)	8.72
Nagaur	12.1	20.7	29.7	28.7	8.9	100 (336098)	4.38
Paragraph	19.5	21.3	25.0	26.0	8.3	100 (710452)	1.5
Udaipur	59.4	22.3	12.8	4.9	0.6	100 (324181)	1.29

Note: Figures in the parenthesis are total number of land holdings.

Table 15: Rural and Urban population in the selected districts. (Number)

Item	**Baran**			**Kota**		
	Total	Rural	Urban	Total	Rural	Urban
Households (No.)	241428	191526	49902	396501	151351	245150
Total Population	1222755	968541	254214	1951014	774410	1176604
Total Male	51.8	51.9	51.8	52.3	51.8	52.7
Total Female	48.2	48.1	48.2	47.7	48.2	47.3
Population-SC	18.1	17.3	21.2	20.8	23.5	19.0
Male-SC	9.4	9.0	11.0	10.8	12.2	9.9
Female-SC	8.7	8.3	10.2	10.0	11.3	9.1
Population-ST	22.6	27.3	4.9	9.4	16.4	4.9
Male-ST	11.7	14.1	2.6	4.9	8.5	2.6
Female-ST	10.9	13.2	2.3	4.5	7.9	2.2
Population-LIT	56.7	53.8	67.6	66.5	58.9	71.6
Male-LIT	35.4	34.3	39.3	39.2	36.6	41.0
Female-LIT	21.3	19.5	28.3	27.3	22.4	30.6
Population-ILL	43.3	46.2	32.4	33.5	41.1	28.4
Male-ILL	16.5	17.5	12.5	13.1	15.3	11.7
Female-ILL	26.8	28.6	19.9	20.3	25.8	16.8

(Percent)

Item	**Nagaur**			**Jaisalmer**		
	Total	Rural	Urban	Total	Rural	Urban

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Households (No.)	578809	476736	102073	117171	100427	16744
Total Population (No.)	3307743	2670539	637204	669919	580894	89025
Total Male	51.3	51.3	51.4	54.0	53.8	55.3
Total Female	48.7	48.7	48.6	46.0	46.2	44.7
Population-SC	21.2	23.0	13.6	14.8	15.4	10.9
Male-SC	10.9	11.8	7.0	7.9	8.2	5.9
Female-SC	10.3	11.1	6.6	6.9	7.2	5.1
Population-ST	0.3	0.3	0.2	6.3	6.4	5.8
Male-ST	0.2	0.2	0.1	3.4	3.4	3.1
Female-ST	0.1	0.2	0.1	3.0	3.0	2.7
Population-LIT	53.2	51.5	60.1	46.1	42.9	66.7
Male-LIT	33.3	32.8	35.7	31.4	29.8	41.6
Female-LIT	19.8	18.7	24.4	14.7	13.1	25.1
Population-ILL	46.8	48.5	39.9	53.9	57.1	33.3
Male-ILL	17.9	18.5	15.7	22.6	23.9	13.7
Female-ILL	28.9	30.0	24.2	31.3	33.1	19.6

(Percent)

Item	**Pratapgarh**			**Udaipur**		
	Total	**Rural**	**Urban**	**Total**	**Rural**	**Urban**
Households (No.)	178726	163810	14916	623531	495973	127558
Total Population(No.)	867848	796041	71807	3068420	2459994	608426
Total Male	50.4	50.4	50.9	51.1	50.9	51.9
Total Female	49.6	49.6	49.1	48.9	49.1	48.1
Population-SC	7.0	6.3	13.9	6.1	5.0	10.9
Male-SC	3.5	3.2	7.1	3.2	2.6	5.6
Female-SC	3.4	3.1	6.8	3.0	2.4	5.2
Population-ST	63.4	68.5	7.0	49.7	60.3	6.9
Male-ST	31.9	34.4	3.6	25.2	30.5	3.6
Female-ST	31.5	34.1	3.3	24.5	29.8	3.3
Population-LIT	46.3	43.7	74.4	51.6	45.1	77.9
Male-LIT	28.8	27.7	41.0	31.7	29.0	42.9
Female-LIT	17.4	16.0	33.4	19.9	16.1	35.0
Population-ILL	53.7	56.3	25.6	48.4	54.9	22.1
Male-ILL	21.6	22.7	9.9	19.3	21.9	8.9
Female-ILL	32.1	33.6	15.7	29.1	33.0	13.2

Table 16: Workers Population in selected districts.

Item	**Baran**			**Kota**		
	Total	Rural	Urban	Total	Rural	Urban
Households (No.)	241428	191526	49902	396501	151351	245150
Total Population (No.)	1222755	968541	254214	1951014	774410	1176604
Total Worker	45.2	48.3	33.2	38.4	46.1	33.3
Main Worker	29.4	30.0	27.2	29.6	29.9	29.4
Main Cultivator	14.5	17.6	2.3	5.9	13.6	0.8
Main Agriculture Labourer	6.2	7.4	1.6	3.0	6.5	0.7

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Main Household worker	0.8	0.5	2.1	1.0	0.5	1.3
Main other worker	7.9	4.4	21.3	19.8	9.2	26.7
Marginal Worker	15.8	18.3	6.0	8.8	16.3	3.8
Marginal Cultivators	3.3	4.0	0.3	1.3	3.2	0.1
Marginal Agriculture Labourer	8.9	10.9	1.6	3.9	9.1	0.5
Marginal Household Worker	0.4	0.4	0.4	0.3	0.3	0.3
Marginal Other Workers	3.2	3.0	3.7	3.2	3.7	2.9
Non-Worker	54.8	51.7	66.8	61.6	53.9	66.7

Workers Populationcont… (Percent)

Population	**Nagaur**			**Jaisalmer**		
	Total	Rural	Urban	Total	Rural	Urban
Households (No.)	578809	476736	102073	117171	100427	16744
Total Population (No.)	3307743	2670539	637204	669919	580894	89025
Total Worker	43.1	46.4	29.4	43.1	44.4	34.7
Main Worker	29.8	30.9	25.4	26.2	25.5	30.7
Main Cultivator	15.3	18.6	1.5	11.5	13.1	0.4
Main Agriculture Labourer	3.7	4.3	1.5	2.2	2.4	0.8
Main Household worker	0.7	0.5	1.2	0.7	0.5	1.6
Main other workers	10.1	7.5	21.2	11.8	9.4	28.0
Marginal Workers	13.3	15.5	4.1	16.9	18.9	3.9
Marginal Cultivators	6.9	8.4	0.5	8.3	9.6	0.2
Marginal Agriculture Labourer	4.2	5.0	0.9	4.3	4.9	0.6
Marginal Household Worker	0.2	0.2	0.3	0.3	0.3	0.3
Marginal Other Workers	1.9	1.8	2.4	3.9	4.1	2.8
Non-Worker	56.9	53.6	70.6	56.9	55.6	65.3

	Pratapgarh			**Udaipur**		
	Total	Rural	Urban	Total	Rural	Urban
Households (No.)	178726	163810	14916	623531	495973	127558
Total Population (No.)	867848	796041	71807	3068420	2459994	608426
Total Worker	55.5	57.1	36.7	44.5	47.0	34.5
Main Worker	37.7	38.2	32.2	26.8	25.6	31.8
Main Cultivator	27.3	29.5	2.6	11.1	13.7	0.8
Main Agriculture Labourer	4.6	4.8	2.3	2.8	3.4	0.5
Main Household worker	0.4	0.3	1.9	0.7	0.5	1.7
Main other workers	5.4	3.6	25.3	12.2	8.0	28.9
Marginal Workers	17.7	18.9	4.6	17.7	21.4	2.7
Marginal Cultivators	8.0	8.7	0.3	6.4	8.0	0.2
Marginal Agriculture	6.6	7.0	1.2	7.1	8.8	0.3

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Labourer						
Marginal Household Worker	0.2	0.2	0.4	0.4	0.4	0.2
Marginal Other Workers	2.9	3.0	2.6	3.8	4.3	2.0
Non-Workers	44.5	42.9	63.3	55.5	53.0	65.5

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