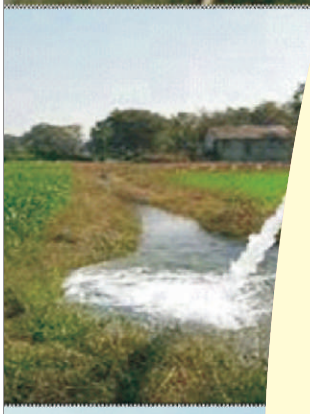

Study of Climate Change and its Adverse Effect on Forest Ecosystem and Adaptability of Villagers of Aravalli Hills of Rewari District of Haryana

Regional Centre
National Afforestation & Eco-development Board
Ministry of Environment & Forests (GoI) New Delhi

Agricultural Finance Corporation Ltd. New Delhi

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by

Regional Centre:
National Afforestation and Eco-Development Board
(Ministry of Environment & Forests, Government of India)

AGRICULTURAL FINANCE CORPORATION LTD.
Northern Regional Office, New Delhi

Phone : 011-45791190, 45791194-96 **Fax :** 011-45791189

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STUDY TEAM

Shri G. S. Yadav	-	Coordinator
Dr. N.P. Baduni	-	Team Leader
Dr. Gayatri Mahar	-	Young Professional
Shri R. B. P. Sinha	-	Project Assistant
Shri Aneesh Vijayan	-	Senior Consultant
Shri Aleen Mukherji	-	Senior Consultant
Shri Himanshu Dube	-	Senior Consultant
Prof. G. S. Paliwal	-	Overall Guidance
Shri Rajan Tyagi	-	Consultant
Shri Abhinav Arora	-	Consultant

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EXECUTIVE SUMMARY

As elsewhere in the world's mountain ecosystems, the Aravalli hills are also not untouched by the effects of climate change. The Aravalli region has come under severe stress and continuously degrading due to excessive felling of trees to meet the increasing demand for fuel, fodder and construction industry as well as extensive mining to meet the industrial demand for minerals. This has resulted in extensive soil erosion, loss of topsoil, silting up of river channels and reservoirs, reduced land fertility and lowering of the ground water table. The entire Aravali Range has become ecologically sensitive and critically fragile. The population resides in and around aravalli depends on climate sensitive sectors like agriculture and forestry for their livelihood. By adversely affecting freshwater availability and quality, biodiversity and desertification, climate change tends to disproportionately affect the poorest in the society, exacerbating inequities in access to food, water and health.

A number of initiatives have taken by various agencies to cope with the adverse effect of climate change. Several ongoing efforts to promote sustainable agriculture, forestry, providing sustainable livelihood and poverty alleviation are some of the measures which have been taken to address some of these vulnerability concerns. The Joint Forest Management programme, Social Forestry Project and Haryana Community Forestry Project are some of the initiatives taken up by the Govt. in recent past. In the current scenario it is important to assess and estimate the effect of climate change in Aravalli hills ecosystem and more importantly to identify how the local inhabitants adapt to them. Towards this end the study has been conducted in the Rewari district of Haryana with following objectives:

- *To document knowledge and experiences of the local people about the changes in forest ecosystem, agriculture, livestock, human and availability of water.*
- *To record peoples perception on phenological variations of species to predict the response of plants towards climate change.*
- *Propose mitigation strategies for conservation of natural resources of the study area.*

As per the 2001 Census, there are in all 399 revenue villages and 347 panchayats in the district. Block Rewari is the largest in terms of geographical area, whereas block Nahar is the smallest. Out of total 399 villages in the district, 41 villages across 3 blocks are located adjoining Aravalli Mountain Range. Among them a total of seven villages i.e. Harzipur, Khori, Khaleta, Manethi, Tankari, Kanuka, Gudiyaani from three forest ranges i.e. Rewari, Nahar and Bawal have been selected for the present study. The selection criteria are (i) representation of a wider and diverse geographical area within the district, (ii) size and forest cover available, (iii) dependence of forest fringe communities on the forest itself.

During the field work, efforts were made to cover the respondent of all the age groups including women. In each villages the respondent were categorized into: (a) age group 20-40 years (b) age group year 41-50 and above, (iii) women. Apart from these, other set of interaction was held with a group of 3-5 representatives of the Forest Department including Forest Guards, Foresters and Rangers. All interactions were conducted as Focus Group Discussions (FGD).

Apart from the Focus group discussions in each sample village a transect walk with village elders and forest officers were made to assess the composition of forest and assessing the natural regeneration prospectus in the adjacent forest area. A resource map of each selected village was prepared in a

participatory manner with an objective to understand the changes in status of natural resources over the past few decades. Village profiles including a comprehensive village wise list of physical resources, infrastructure facilities & services was prepared with the help of a structured questionnaire.

The study highlights present status of the water bodies in the district, mostly xerophytic vegetation, reduced supply of water for irrigation, changed agricultural patterns, changes in floral and fauna presence including phenological transformation in the trees. As a result of diminishing rainfall, the regeneration rate of the plant species has been adversely affected in the locality. This is one of the key factor for change in plant species composition in the area. With the growing arid climatic conditions each year, most of the traditional species are at the verge of becoming rare and even extinction in the district. According to the village inhabitants plantation drive under various afforestation programmes have changed the plant species composition in the region. The plantation drive has replaced traditional kikar (Acacia nilotica) with vilayati kikar (Prosopis chilensis). Some traditional species like khairi, siris, hingot, gugal, lasura, jhand, jaal, babul, bansa, kheef and kateli are now non-existent.

Phenological changes include delayed or early fruiting (jhand, lasura, kair), reduction in leaf size (jhaad beri, vilayati kikar) and bitter & inedilble fruit (neem). A major decline has been recorded in the population of wild life in the area. Some species like hyena, deer, wolf, vulture, leopard, black buck and fox are now non-existent in the region.

Based on the discussion with village inhabitants and forest officials, it was learnt that the amount of rainfall in the region has decreased and become more erratic. The average rainfall between 1978 and 2007 has been 498 mm. It has plunged from 596mm in the 1990s to 421mm during the last 7 years, a decrease of approximately 29%. This change has resulted in declining regeneration rate in forest species; decreased forest density; grazing land, meadows and forest fringe have deteriorated in terms of area and fodder production; depleting groundwater table, resulting in scarcity of water for irrigation and drinking; non-sowing of some major pulses crops like chana, moong, moth which require adequate rainfall; depleting traditional water bodies, like ponds, johads etc, resulting in scarcity of drinking water for livestock and decreased wild life.

Inadequate and erratic occurrence of rainfall has placed excessive pressure on groundwater for irrigation. The increased use of advanced irrigation equipments has further compounded the situation by fostering a water crisis. Over-drafting of groundwater has caused failure of shallow tube-wells in the region. Around 45 % of the geographical area falls with the 10-20m depth of water-table range. In the past three decades from 1974 to 2004, the water table is receding at an alarming rate of 30cm per annum in the district.

The average landholding pattern has witnessed a major paradigm shift. With the growing trend of nuclear families, agriculture land has fragmented into small pieces, which are economically non-available for farming at times. There has also been a marginal increase in the number of landless families. Also the region has witnessed a major shift in cropping pattern over the past few decades. The major cropping systems under the existing farming pattern are bajra-wheat, bajra-mustard, guar-wheat, and guar-mustard. Mustard and wheat are the major crops of Rabi, and bajra and guar are the main crops of Kharif. Cultivation of crops like gram, moong and moth has fallen significantly. Similarly, the district has witnessed major changes in productivity and area under different crops. These changes have been discussed in detail in the report.

The main source of irrigation in the district is underground water, which is largely brackish in nature and is drawn out through tube wells. It was learnt from the village inhabitants that until a few decades back, few surface water bodies were capable of supplying water for irrigation, which helped in reducing pressure on groundwater. Today no surface water bodies hold adequate water even for consumption by the cattle.

Next to irrigation, fertilizer is the second most important input for cultivating high-yielding varieties. Depleting rainfall and limited source of irrigation have triggered high fertilizer consumption in the district. During the past two decades fertilizer consumption in district has increased from 12.07 tons to 31.39 tons with the growth rate of 1.14 tons per year.

The animal husbandry practices have changed to a great extent over the past few decades. Decreasing availability of fodder and increased aridity in the district has resulted in changes as stall-feeding of cattle; use of tractors instead of bullocks for ploughing; use of camel carts initially and then tractors for transport and replacement of cow with buffalo as the main milch animal because of its high milk yield and hence higher commercial returns.

Grazing lands, meadows and forest fringe lands have deteriorated in terms of area and productivity over the past few decades. Only 2% of forage comes from common land today which was 10% in the year 1991. The remaining fodder requirement is met by cultivated fodder crops and crop residue of wheat and mustard and largely through purchases made in the open market. Decreasing availability of green fodder is a major challenge these days and it must be reiterated that the nutrient deficiency, due to reducing quantum of green fodder, has an adverse impact on animal health, a factor that needs serious attention.

Livelihood pattern in the region has changed to a great extent over the past few decades. Some major factors fostering this include fragmentation of agriculture land; shift from joint family to nuclear family; education and industrialization. In the early 1990s, families were large depending mainly on agriculture and labour work. Earning through rain fed agriculture and labour work was enough to manage their household expenses. Major part of livestock product was used for household consumption and a very little was sold.

Thus, some of the major findings of the study are as under:

- *Agriculture and allied activities are the major source of livelihood in rural Rewari, however a swift rise of employment in industrial sector has been registered in the region.*
- *Changing socio-economic status has resulted in loss of traditional knowledge of sustainable use and protection of forest.*
- *Scarce and erratic rainfall and deteriorating soil health has resulted in loss of essential plant nutrients and decreased regeneration rate. Loss of plant and animal productivity and diversity is a subsequent effect of the same.*
- *Overexploitation of forest for fuel wood and fodder coupled with scarce and erratic rainfall is a major reason for degradation of forest in the area.*
- *Degradation of forest results in a loss of essential environmental functions of forests including biodiversity, climate regulation, soil and water conservation including preservation of water catchment areas.*

- *Availability of fruits, fuel wood, fodder, medicinal plants and other forest products has reduced significantly during the past few decades.*
- *Grazing land, meadows and forest fringe lands have deteriorated in terms of area and total fodder production over the past few decades.*
- *Mining and industrial development in forest and fringe lands has improved access to potentially profitable mineral or other commercially valuable products; however less attention is being given to maintain environmental balance and forest sustainability.*
- *Increased use of tube wells in the region has resulted in overexploitation of groundwater resulting in rapid decline in groundwater level and reducing water quality.*
- *A significant change in plant and animal species composition has been witnessed in the region.*
- *A steady decrease in the population of traditional species of trees, herbs and shrubs has resulted in replacement of traditional plant species with others.*
- *Moong, moth are no more sown in the area and chna despite being one of the major crop of rabi is on the verge of extinction*
- *Increase in agriculture production is mainly due to introduction of additional land and wide availability of inputs.*

In order to suitably address the adverse impacts of climate change in the district, following recommendations has suggested:

- *Stringent implementation of rules and regulations for sustaining forests.*
- *Community involvement in afforestation*
- *Community level fodder plantation*
- *Controlled and sustainable industrialization and mining*
- *Encouragement/ Incentives to NGOs, Corporate Houses and other organizations to work on sustainable development in the region*
- *Community managed commercial plantations using Joint Forest Management Committees.*
- *Wide-scale implementation of rain water harvesting methods*
- *Use of Improved Irrigation Techniques*
- *Implementation of soil and moisture conservation initiatives*
- *Implementation of sustainable agriculture development initiatives*
- *Genetic Enhancement by development of appropriate genotypes suitable for the semiarid environment*
- *Balanced and scientific use of fertilizers*
- *Introduction of interventions emerging from National Action Plan on Climate Change.*

Chapter 1

INTRODUCTION

The crucial role of mountain and hill ecosystems to support the livelihood of about 10% of the world's population is well recognized. According to United Nations, 2001, the world's population depends directly on mountain resources such as water, forests, agricultural products and minerals. Intergovernmental Panel on Climate Change (IPCC) pointed out that climate change is causing serious damage to natural resources, socio-economic condition and livelihood of the people. It is assumed that the impact of global climate change in mountains will have profound effect not only on hill people but also those in the adjoining plains. The same not only directly affects human beings but also disturbs the entire eco-system of the forest. Therefore, there is an urgent need to assess the adverse effects of the climate change in forest ecosystem as well as to assess the adaptation of local inhabitants in the presently changed scenario.

Like other mountain ecosystems of the world, the Aravalli hills are also not untouched by the effects of climate change. The Aravalli Hills, in north-western India, separates the Thar Desert to the west and the sub-humid to humid Gangetic and Malwi plains to the east and have an important role in impeding desertification. In Haryana, the Aravalli range covers an area of about 1,46,000 hectares. The region was known as densely forested and rich in wildlife at the time of independence. Now the ecosystem of the region has come under severe stress and continuously degrading due to excessive felling of trees to meet the increasing demand for fuel, fodder and construction industry as well as extensive mining to meet the industrial demand for minerals. This has resulted in extensive soil erosion, loss of topsoil, silting up of river channels and reservoirs, reduced land fertility and lowering of the ground water table. The entire Aravali Range has become ecologically sensitive and critically fragile. The population resides in and around Aravalli depends on climate sensitive sectors like agriculture and forestry for their livelihood. By adversely affecting freshwater availability and quality, biodiversity and desertification, climate change tends to disproportionately affect the poorest in the society, exacerbating inequities in access to food, water and health.

To overcome with the adverse effect of climate change the government has been trying to mainstream climate change concerns into the relevant sector policies. Several ongoing efforts to promote sustainable agriculture, forestry, providing sustainable livelihood and poverty alleviation are some of the measures which have been taken to address some of these vulnerability concerns. The Joint Forest Management programme, Social Forestry Project and Haryana Community Forestry Project are some of the initiatives taken up by the Govt. in recent past. Besides a number of adaptation measures has been adopted and practiced by local populace to cope with the adverse effect of climate change.

In the current scenario it is important to assess and estimate the effect of climate change in Aravalli hills ecosystem and more importantly to identify how the local inhabitants adapt to them. Towards this end the study has been conducted in the Rewari district of Haryana. The District Rewari is likely to prove as an eye-opener for the vast climatic changes that have taken place during the past six decades. This is reflected in several indicator parameters including the present status of the water bodies in the district, prominence of xerophytic vegetation, reduced supply of water for irrigation, phenological changes in the plants etc. The objective of the study is to assess the adverse effect of climate change on forest ecosystem and adaptability of villagers residing in the Aravalli hills area which includes:

- To document knowledge and experiences of the local people about the changes in forest ecosystem, agriculture, livestock, human and availability of water.
- To record peoples perception on phonological variations of species to predict the response of plants towards climate change.
- Propose mitigation strategies for conservation of natural resources of the study area.

STUDY AREA

District Rewari lies between 27° 57' 17'' to 28° 27' 47'' N latitude and 76°17' to 76° 51' E longitude **(Figure 1)**. The district has an area of 1,559 sq km and is divided into two Sub-divisions i.e. Rewari and Kosli which are further divided into 3 revenue tehsils i.e. Rewari, Bawal and Kosli with five Development Blocks namely, Rewari, Jatusana, Khol, Bawal and Nahar. Rewari is predominantly a rural district with, 74.18% of its population living in rural areas (Census, 2011). The literacy rate of the district is 82.20 with the male literacy of 92.90%. The district has a total of 63,744 land-holdings with an area coverage of 1,24,707 ha. Besides, there are as many as 71,816 landless families in the district. The total cultivable area in the district is about 1.43 lakh ha of which 1.25 lakh ha (87.4%) is cultivated. The major source of the district income originates from the agriculture sector (73.25%) which is followed by animal husbandry (16.5%) and horticulture (9.1%). Mustard and wheat are the main crops in rabi and, bajra is of kharif. The main source of the irrigation in the district is tube-well, which provides water to the major part of the irrigated area. However their desperate use has depleted the groundwater to the level of over-exploited category.

Two types of forests are witnessed in the states i.e. tropical dry deciduous forests in northern districts in the Shiwaliks ranges and tropical thorn forests of Aravalli in the southern districts. The tropical thorn forests are predominant in the district covering 3,970 hectares constituting merely 2.33% of the total geographical area of the district. The forests confer manifold ecological benefits to the economy along with great bearing on ground water occurrence, soil erosion, floods and environment and are a source of raw materials and shelter for fauna.

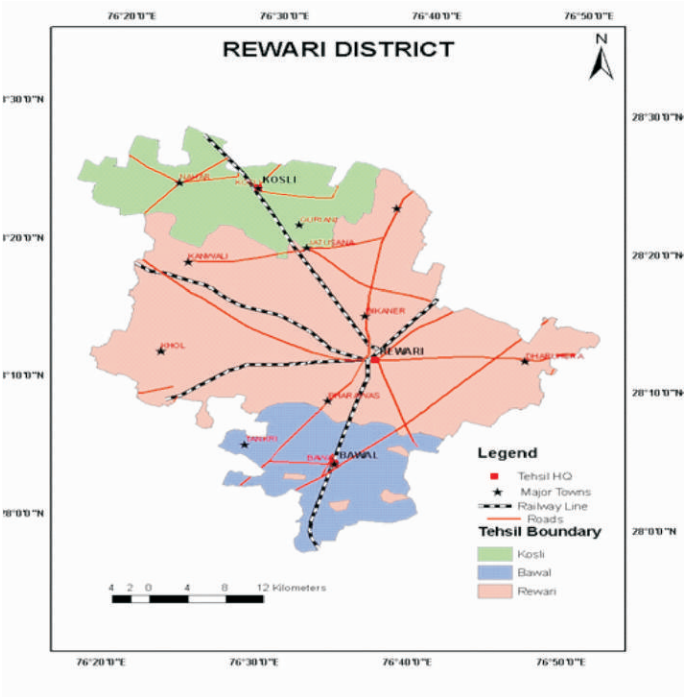


Figure 1: Map of Rewari District with the Boundaries of Tehsils

SELECTION OF VILLAGE

As per the 2011 Census, there are in all 399 revenue villages and 347 panchayats in the district. Block Rewari is the largest in terms of geographical area, whereas block Nahar is the smallest. Out of total 399 villages in the district, 41 villages across 3 blocks are located adjoining Aravalli Mountain Range. Among them a total of seven villages i.e. Harzipur, Khori, Khaleta, Manethi, Tankari, Kanuka, Gudiyaani from three forest ranges i.e. Rewari, Nahar and Bawal have been selected for the present study. The selection criteria were (i) representation of a wider and diverse geographical area within the district, (ii) size and forest cover available, (iii) dependence of forest fringe communities on the forest itself.

Chapter 2

APPROACH AND METHODOLOGY

The data generated here are based on primary as well as secondary sources. The former has been collected by conducting Focus Group Discussions (FGD) which concentrated on understanding the knowledge and experiences of the local people and the officials of Forest Department about the pattern of change in climatic conditions and its effect on forest ecosystem as well as other livelihood resources in the selected villages. Efforts were made to cover the respondent of all the age groups including women. In each villages the respondent were categorized into: (a) age group 20-40 years (b) age group year 41-50 and above, (iii) women. Apart from these, other set of interaction was held with a group of 3-5 representatives of the Forest Department including Forest Guards, Foresters and Range Officers.

Figure 2: Focus Group Discussion with villagers of age group 50 years and above

Figure 3: Focus Group Discussion with Women group drawn from various age groups

Figure 4: Focus Group Discussion with Forest Department Staff at Bawal

Besides, conducting FGD, in each sample village a transect walk with village elders and forest officers were made to assess the composition of forest and assessing the natural regeneration prospectus in the adjacent forest area. A resource map of each selected village was prepared in a participatory manner with an objective to understand the changes in status of natural resources over the past few decades. Village profiles including a comprehensive village wise list of physical resources, infrastructure facilities and services was prepared with the help of a structured questionnaire. Brief village profiles and resource maps have been presented in ***Annexure II*** and ***Annexure III*** respectively.

Figure 5: Preparation of Village Profile and Resource Mapping

Besides the primary data, significant amount of secondary information was collected from various sources which include the State and District Statistical Department, Forest Department, Agriculture Department, Department of Revenue/Land Records, Haryana Agricultural University, Regional Research Station, Bawal.

LIMITATIONS OF THE STUDY

The study met with two major limitations which are reflected in the findings and conclusions as well, viz.

- Rewari district was created only 20 years back. Thus, adequate secondary data spliced for the district in its current area is not available
- The changes in the phenological aspects were brought from observations of respondents in the Focus Group Discussions and not through scientifically recorded techniques. Thus, only a limited set of changes have been captured in this report.

Chapter 3

FINDINGS OF THE STUDY

This section documents the findings drawn from the knowledge and experiences of the local people and relevant secondary data from various sources to study the changes in forest eco-system, climate, agriculture, livestock, water and human lives in Rewari District.

3.1 CHANGES IN FOREST ECO-SYSTEM

3.1.1 Changes in Composition of Plant Species

Forest degradation has taken different shapes, particularly in the open forest, chiefly based on outcome of the human activities such as overgrazing, over-exploitation (for firewood or timber), repeated fires, or natural causes as attacks by insects, diseases, plant parasites and the declining annual rain. In most instances, degradation not only shows a decrease in the area of forest vegetation but also results in a gradual reduction of the total biomass, change in species composition and soil degradation. Unsustainable logging practices have also contributed to this phenomenon since removal of the mature trees has not been accompanied by their regeneration and replanting and continued drought like situation persists.

As per the Forest Survey of India (2007) the district has 2.92% of total forest cover distributed in moderately dense (8 sq km) and open forest (43 sq km). Besides, 4 sq km areas fall under scrub forest. Due to constant lopping for fulfillment of fuel demand of locals, over grazing and extensive logging, the forests have deteriorated, particularly those within reach of settlements. Apart from ecological deterioration, there is growing shortage of fire-woods, timber, fodder and other raw materials while the demand is increasing.

Another estimate based on remote sensing application shows that the district nearly 14.21% to total forest area is closed forest and 85.79 per cent of total forest area is block plantation. Jabua and Nahar are the only two closed forests in the district. Main species in these closed forest area are *Acacia nilotica/arabica, Prosopis cineraria, Ziziphus nummularia,* Eucalyptus spp and shrubs (Chaudhary et.al., 2003).The block plantation are the lands, which contain plantation outside notified or reserve forest area and are either naturally grown or raised under social/agro-forestry programme. Block plantations are largely located in village panchayat/common land, institutional land and are distributed all through the districts. These block plantations are occupied by tree species of *Acacia nilotica, Acacia tortilis, Prosopis juliflora, Salvadora oleoides* and *Prosopis cineraria.*

The species composition and regeneration rate of the plant species of the District, has been

adversely affected due to diminishing rainfall. This is one of the key factors for change in plant species composition in the area. With the growing arid climatic conditions each year, most of the traditional species are at the verge of becoming rare and even extinction in the district.

The local community has also observed changes in composition of plant species which has emerged from Focal Group Discussion (FGD) and micro plan of Forest Department**.** Further, the plantation drives conducted during the implementation of various afforestation projects brought about change in the plant species composition in the District. According to the villagers, it has replaced traditional Kikar (*Acacia nilotica*) with Vilayati kikar (*Prosopis chilensis*) **(Figure 6)**. According to FAO (2006) the canopy of *Prosopis* spp. takes over the ground cover, making it difficult for other grasses to grow. Pods of this leguminous plant have high sugar content, which causes teeth decay in animals ingesting them. *Prosopis juliflora* foliage has allelopathic effects on seed germination and seedling growth of Bermuda grass *(Cynodon dactylon*) cultivars of *Zea mays,* four cultivars of *Triticum aestivum* and *Albizia lebbeck*. Further, specimens of several timber-yielding species have died out in the area; a few which have been left out are either diseased or infected by termites and other insects exhibiting coppice deforestation and stunted growth. The observation of sample villagers collected through FGD on changes in composition of plant species during the past six decades is presented in **Table 2.**

Figure 6: Vilayati Kikar (*Prosopis chilensis*)

Table : Change in composition of plant species during the past 6 decades

S. N.	Scientific Name	Local Name	Habit	Uses	1950[1]	1991[2]	Current Status[1]
1.	*Acacia jacquemontii* Benth.	Babul	Tree	Medicine	Rare	Very rare	Not found
2.	*Acacia leucophloea* Willd.	Ronj	Tree	Fuel-wood, medicine	Common	Rare	Very rare
3.	*Acacia nilotica* (Linn.) Delile	Kikar, Babool	Tree	Fodder, Fuel-wood	Common	Common	Rare
4.	*Acacia Senegal* Willd.	Khairi	Tree	Edible (Gum), fodder	Common	Rare	Not found

5.	*Adhatoda vasica* Nees	Bansa	Shrub	Medicine	Common	Rare	Not found
6.	*Aerva javanica* Juss. Ex Schult	Dhouli Mundi, Bui	Herb	Medicine	Rare	Very rare	Not found
7.	*Ailanthus altissima* (Mill.) Surngle	Ailanthus	Tree	Fuel-wood, Fodder	Non-existent	Very rare	Common
8.	*Ailanthus excelsa* Roxb.	Ullu Neem	Tree	Fodder, Fuel-wood, Medicine	Common	Common	Rare
9.	*Albizzia lebbek* Benth.	Siris	Tree	Fodder, Fuel-wood, medicine	Common	Rare	Not found
10.	*Anogeissus pendula* Edgew	Dhok	Tree	Fuel-wood and edible (Gum)	Common	Rare	Very rare
11.	*Asparagus racemosus* Willd.	Ollakata/ Shatavar	Herb	Medicine	Common	Very rare	Not found
12.	*Azadirachta indica* A. Juss.	Neem	Tree	Fodder, fuel-wood, medicine	Common	Common	Rare
13.	*Balanites aegyptiaca* (Linn.) Delile	Hingot	Small tree	Fodder	Rare	Very Rare	Not found
14.	*Butea monosperma* (Linn.) Kuntze	Dhak	Tree	Fuel-wood, fodder, medicine, Dye	Common	Rare	Very rare
15.	*Calligonum polygonoides* Linn.	Phogalo	Shrub	Edible	Rare	Very rare	Very rare
16.	*Capparis deciduas* Edgew.	Karir, Kair	Shrub	Edible (vegetables and pickles)	Common	Common	Rare
17.	*Cassia fistula* Linn.	Amaltas	Tree	Medicine	Common	Rare	Very rare
18.	*Commiphora wightii* Arnott	Gugal	Small Tree	Medicine	Common	Very rare	Not found
19.	*Cordia dichotoma* Forst	Lasura	Small Tree	Edible(vegetable and Pickle)	Common	Very rare	Not found
20.	*Dalbergia sissoo* Roxb.	Shisham	Tree	Timber, fuel-wood	Common	Common	Rare
21.	*Holoptelea integrifolia* Planch.	Papri/Kanju	Tree	Medicine, fuel-wood, fodder	Common	Rare	Very rare

22.	*Leptaedenia pyrotechnica* (Forsk.) Decne	Kheef	Shrub	Fodder	Common	Very rare	Not found
23.	*Pongamia pinnata* Pierre	Karanji /Kanji	Tree	Uses for making shades	Common	Common	Very rare
24.	*Prosopis chilensis* Stuntz	Vilayati Kikar	Tree	Fuel-wood	Non-existent	Very rare	Common
25.	*Prosopis cineraria* Druce	Jand/Saingri	Tree	Medicine	Common	Common	Not found
26.	*Salvadora oleoides* Decne	Jaal	Tree	Veterinary medicine for camels	Common	Very rare	Not found
27.	*Solanum surattense Burm.F.*	Kateli	Shrub	Veterinary Medicine	Common	Very rare	Not found
28.	*Tribulus terrestris* Linn.	Gokhru	Herb	Medicine	Common	Rare	Very rare
29.	*Urgenia indica* Kunth.	Ranpyaz	Herb	Medicine, veterinary medicine	Common	Very rare	Very rare
30.	*Ziziphus mauritiana* Lam.	Ber	Shrub/small tree	Fruits	Common	Rare	Very rare
31.	*Ziziphus nummularia* Burn. Wight & Arh.	Jhar Ber, Mallah, Beri	Shrub	Fruits	Common	Rare	Very rare

Source – [1]Focus Group Discussion, [2] Aravalli Micro-Plan

3.1.2 Phenological Changes

The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the influence of environment and seasonal variation on flowering and fruiting behaviour (Zhang *et al*., 2006). Singh & Kushwaha (2005) have suggested that the climate change forces deviations in the length of growing period, and competition among species may change the resource use patterns in different species. Karmer (1997) has concluded that differences in that and phenological responses to temperature changes of tree species can and do have long-term consequences on their geographic distribution. He further suggests that the phenology and climate relationship can also reveal the potential impacts of future climate changes. The initiation of growth in plants and changes in phenology are controlled by a series of environmental factors and the influence of temperature and moisture has been studied by several workers (Dewald & Steiner 1986; Walter 1973).

In the current study, the scope was limited to capturing phenological variations as observed by village residents and forest functionaries through the past few decades. In order to make the study comprehensive, the team compared the information emerging from results and papers focused on capturing phenological variation in plant species. Towards the end the team reviewed a relevant study focusing on observations on the phenology of woody species of Sariska Tiger Reserve in north-eastern Rajasthan by Yadav & Gupta (2009). Major findings of the study are also presented in this section, as the study was carried out in the Slopka Forest and the adjacent Kalighati forest areas which also fall under the Aravalli range and have similar composition of plant species.

Thus, the findings are broadly classified into the following two sections:

- Local knowledge on phenotypic variation, as observed by village residents and forest functionaries through the decades.
- Comparison with the major findings which emerged from the study of tree species of the Sariska Tiger Reserve in north-eastern Rajasthan.

3.1.2.1 Local knowledge on phenotypic variation

The observation of local people on phenotypic changes in plants behaviour at the bud initiation stage, foliage formation flowering, fruiting, colouring, Leaf-fall and size variation of leaves, etc. in a few common plant species are presented below:

Species	Phenological Variations Observed
Prosopis cineraria (Jhand)	The tree currently bears fruit in August and September as against its fruiting in May and June a few decades back. There are more thorns on the trees now as against their more leafy nature earlier with dense canopy.
Cordia dichotoma (Lasura)	Fruiting in August and September as against April-May earlier.
Capparis deciduas (Kair)	Nearly 40% of the plant population now fruits twice a year in April-May and October -December. Earlier, *Kair* fruits were only seen in April-May.
*Ziziphus nummularia (*Jhaad Beri*)*	Leaf has become perceptibly smaller in size.
Azadirachta indica (Neem)	The fruit of the tree *(Nimbori)* presents an increasingly bitter taste rendering it inedible.
Prosopis chilenses (Vilayati Kikar)	Leaf has become perceptibly smaller in size.

3.1.2.2 Major Findings from study of Sariska Tiger Reserve

Similar types of findings have been reported by the Yadav and Gupta (2009) on their study conducted on 39 woody species in Sariska Tiger Reserve over one year period. As per Yadav and Gupta (2009) the phenological pattern of the species indicated that 30 per cent species are evergreen whereas 70 per cent are deciduous **(Table 3)**. Most of the species exhibited extended leaf fall activity whereas leaf flushing was a short duration activity in all the species. Flowering was a short period activity in 50 per cent species. Forty-three per cent species exhibited lengthy periods of fruit-bearing activity whereas 57 per cent species showed rapid fruiting activity.

Table 3. Phenological pattern of selected woody species in the Sariska Tiger Reserve Forest

Species	Type	Leaf fall	Leaf flushing	Flowering	Fruit initiation and maturity
Acacia catechu (L.f.) Wiled	Tree	Ds	S	S	L
Acacia leucophloea (Roxb.) Wiled*	Tree	Es	S	E	L
Acacia senegal (L.) Wiled*	Tree	Ds	S	E	R
Albizia odoratissima (L.f.) Benth	Tree	Ee	S	E	L
Anogeissus latifolia (Roxb.ex DC.) Wall. ex Guill. & Perr.	Tree	De	S	E	L
Anogeissus pendula Edgew.*	Tree	De	S	E	L
Balanites aegyptiaca (L.) Del.*	Tree	De	S	E	L
Bauhinia racemosa Lam.	Tree	Ee	S	E	L
Boswellia serrata Roxb. Ex Coleb.	Tree	De	S	S	R
Butea monosperma Taub.*	Tree	De	S	S	R
Capparis sepiaria Linn	Shrub	Ee	S	S	R
Cordia vestita (DC.) Hook. f. & Thoms.	Small Tree	De	S	S	R
Diospyros melanoxylon Roxb.	Tree	Ee	S	S	L
Ehretia laevis Roxb.	Shrub	De	S	S	R
Euphorbia neriifolia Linn.	Shrub	De	S	E	R
Ficus glomerata Roxb.	Small Tree	Ee	E	E	L
Grewia flavescens A. Juss.	Shrub	Ds	S	S	R
Lannea coromandelica (Houtt.) Merr.	Tree	De	S	S	R

Mallotus philippensis (Lamk.) **Muell. – Arg.**	Tree	Ee	S	E	L
Phoenix sylvestris Roxb.	Tree	Ee	S	S	R
Sterculia urens Roxb.	Tree	Ds	S	S	R
Ziziphus mauritiana Lamk.*	Shrub	De	S	E	L

** Common species in Rewari and around the Rewari Forest Division*

D= deciduous; E= evergreen, S= short one month per episode; E= extended > 1 month per episode; Fruit maturation, R= rapid and L= Lengthy

The soil moisture and photoperiod play an important role in the phenology of the woody species of the Sariska Tiger Reserve (Yadav & Gupta 2009). Leaf fall begins in late September in *Boswellia serrata, Lannea coromandelica* and *Sterculia urens* with the retreat of monsoon. The plants occurring on the hill slopes are the first to shed leaves which support the view that decline in soil moisture is responsible for this phenomenon in these species. This is also supported by the decline in rainfall and temperature from October to January. Leaf fall due to low soil moisture and low temperature in tree species has been reported by other workers (Jakson, 1978; Khan, 1999; Reich & Borchert, 1982; Sundriyal, 1990). Singh and Singh (1992) and Khan (1999) also suggested that the initiation of Leaf fall coincides with the onset of the post-monsoon low temperature dry period and can be a mechanism for maintaining turgidity of shoots. However, the leaf fall in other species, growing in the valley may not be in response to decrease in soil moisture since these can absorb water from the deeper layers of the soil. For instance in *Holopetea integrifolia* the leaf fall begins in October which may be in response to decrease in photoperiod. This is in conformity with the findings of Borchert *et al.* (2002) who suggested that in Agrentina leaf-shedding in several species is probably caused by a combination of increasing leaf age and declining photoperiod, rather than increasing drought.

3.1.3 Changes in Wildlife Composition

The change in plant species composition has also changed the wildlife composition of the region. Animals and birds like hyena, deer, wolf, vulture, leopard, fox and black buck are almost becoming extinct from the area. As per the villager's observation, during 1950s to 1970s the area was frequented by tigers, panthers, leopards, black bucks, chinkaras, rabbits, eagles, fox and deer. These animals were sometimes even spotted in the vicinity of the villages. The villages were also inhabited by a number of birds. The then dense forest cover played an important role in providing sufficient food, water and shelter to the animals and birds. Increased human interference for mining, industrialization, farming and exploitation for fodder and changes in climatic conditions has affected the wildlife population in the region to a great extent. The forest density has reduced significantly over the past few decades which have adversely affected the natural food chain. Furthermore, the shrinking water bodies have resulted in inadequate drinking water for animals,

resulted in decline of wild life in the area. As per the villagers observation as a result of diminishing rainfall during last 30-40 years, major water bodies in the region have dried out due to the shrinking source of drinking water for animals and forced them to permanently migrate from the area. Human-wildlife conflict is a fast growing serious threat to the survival of several endangered species in the Aravalli hill forests. In adjoining Aravalli villages the conflicts become more intense since livestock-holding practices of local community create a competition between livestock and wild animals over natural resources like edible leaves and grass, drinking water, forcing them to evacuate the area. The swift pace of development in the area has increased the anthropogenic interference in forest for their various needs such as fodder, fuel-wood, timber, NTFP and mining etc. It has been largely responsible for disturbing the animal food chain in the area. In several Aravalli villages farmers encroached forest land for cultivation, which was later taken away from them by the Forest Department. However that left the land free of vegetation, making the forest unfavorable for wild life. As per perception of the elderly people of the villagers, the changes observed by them in status of major animal and bird species in the area over the past few decades has been presented in **Table 4.**

Table 4: Change in Wildlife Composition in the Area

S. N.	Names of Species	Local Names	Binominal Names/ Families	Status		
				1950	1991	Current Status
1.	Hyena	Geedar	*Hyaenidae* canis aureus	Common	Very rare	Not found
2.	Deer	Hiran	*Cervidae muntiacus muntjak*	Rare	Very rare	Not found
3.	Wild Cat	Bidhav	*Felis silvestris*	Common	Rare	Very rare
4.	Wolf	Bhedia	*Wild Canid Canis lupus*	Rare	Extinct	Not found
5.	Blue Bull	Nilgai	*Boselaphus tragocamelus*	Common	Common	Rare
6.	Rabbit	Jangli Khargosh	*Leporidae lepus nigricollis*	Common	Common	Very rare
7.	Porcupine	Sheh	*Hystrix indica*	Common	Very rare	Very rare
8.	Snakes	Saanp	*Snakes*	Common	Rare	Very rare
9.	Eagle	Cheel	*Aquila rapax*	Common	Common	Very rare
10.	Vulture	Giddh	*Accipitridae (Aegypii nae) Cathartidae*	Common	Common	Not found

11.	Wild Dog	Jarak	*Cuon alpinus*	Common	Rare	Very rare
12.	Leopard	Cheeta	*Panthera pardus*	Very Rare	Extinct	Not found
13.	Wild Boar	Jangli Suar	*Sus scrofa*	Common	Rare	Very rare
14.	Fox	Lomri	*Canidae vulpes bengalensis*	Common	Very rare	Not found
15.	Black Buck	Kala hiran	*Antilope cervicapra*	Rare	Extinct	Not found
16.	Crow	Kaowa	*Corvus corvus*	Common	Common	Very rare

Source: Data available from Aravalli Micro-Plan prepared in 1991 by the Forest Department, However the data of 1950 and current status is based on FGD

3.1.4 Change in dependency on forest

In Rewari, the tree cover is more in protected forest areas than in the natural forest areas. The forest is being utilized as a source of fodder, fruits, fuel-wood, NTFPs etc. A few decades back major dependency on forest was for fodder and fuel-wood, when agriculture was not as sound as today. Each household had average 10-12 cattle and they were dependent on community land and forest for fodder, as agriculture residues were not adequate to feed livestock throughout the year. With the commercialization of livestock rearing practice, livestock feeding habits have also changed.

Similarly, dependence for fuel wood has also reduced due to advancement of agriculture and introduction of LPG. In the two decades 80's - 90's agriculture residues constituted a major part of household fuel requirement. Today, with the introduction of LPG, dependence on forest has minimized.

Figure presents the changes in the fuel sources in sample villages during the last two decades.

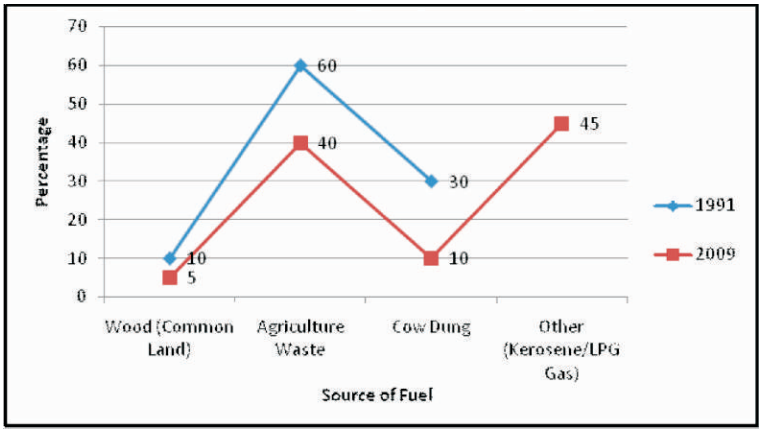


Figure 7: Changes in sources of fuels utilized by the inhabitants of the Sample Villages

Source: Aravalli Micro Plan prepared in 1991 by the Forest Department

3.1.5 Impact of changing climate on availability of Forest Products

Like other forest dependent community the people of Rewari are also dependent on the Non Timber Forest Produce for their survival. These include common wild fruits, seeds, bark, horns, feather, flowers, and medicinal plants. The present study has recorded a total of 36 species of which different parts are being used by the inhabitant both for household consumption and commercial use**.** These species are facing threats with the change in the climatic conditions and degradation of forest with the result availability of such NTFP's has reduced drastically. The inhabitant of different studied villages has noticed that many of these species are now rarely available or not available in the forest as compared to the past situation. Due to these families involvement in collection and quantity of NTFP collection has come down significantly. The list of NTFP available in the region along with the uses has been given in **Table 6**.

Table 6: Status of Non-Timber Forest Products (including Medicinal Plants)

S. N.	Local Names	Types of Products	Approximate Quantity Collected (per family/ day)
1.	Teet	Fruit	4 - 5 Kg
2.	Peel	Fruit	
3.	Ber	Fruit	20-25 Kg
4.	Khair	Gaund	Need based
6.	Kurund	Medicinal	Need based
7.	Sadahaari	Medicinal	Need based
8.	Gokhru	Medicinal	Need based
9.	Fasad Ketli	Medicinal	Need based
10.	Neem-ka Bakkal	Medicinal	Need based
11.	Hari Dhuti	Medicinal	Need based
13.	Hingot	Medicinal	Need based
14.	Dhak	Medicinal, Fodder, Fuel -wood	Need based
15.	Amaltas	Medicinal	Need based
16.	Lasura	Fruit	Need based
17.	Papri/Kanju	Medicinal	Need based
18.	Jhand	Medicinal	Need based
19.	Bansa	Medicinal	Need based
20.	Kheef/Kheep	Fodder	Need based
21.	Jhojru	Medicinal, Fertilizer	Need based
22.	Katheli	Medicinal	Need based
23.	Nakad Bavari	Medicinal	Need based
24.	Ghagharani	Fruit	Need based
25.	Ollakata/ Shatavar	Medicinal	Need based
26.	Dholphullia	Fruit	Need based
27.	Khaff	Raw material for rope	Need based

28.	Raanpyaz	Medicinal and Veterinary	Need based
29.	Hadzod	Medicinal	Need based
30.	Nakchhikni	Medicinal	Need based
31.	Gudan	Medicinal	Need based
32.	Gwarpatha	Medicinal	Need based
33.	Garmunda	Medicinal	Need based
34.	Ailanthas (Ardu)	Fruit	Need based
35.	Sangri	Fodder, Fuel -wood	Need based
36.	Dhok	Fuel-wood	Need based

Some NTFPs with medicinal values are collected by village inhabitants, which are commonly used for treatment of human-beings as well as livestock. Since majority of these medicinal plants are rarely available, dependence on allopathic medicines has grown over the past few decades. Medicinal plants such as: Nakad Bavari, Gokhru, Sangri, Amaltas, etc. are no longer available in Aravali hills forest. Unlike medicinal plants which are collected for personal use, even today some fruits like teet (Rs. 10-15 /kg), peele (Rs. 10-15 /kg) and ber ((Rs. 15-20 /kg), are collected for commercial use i.e. they sold in the local market by few landless families.

3.2 CLIMATIC VARIATION

3.2.1 Rainfall

The district experiences extreme arid to semi-arid climate, characterized by hot-dry and windy summers, cold winters and humid-warm monsoon months. In addition to low quantum, the erratic rainfall aggravates the problem to a much higher degree. About 80-85 percent of total annual rainfall is brought about by the south-western monsoon, which is spread over between July to September. Weather remains almost dry throughout October and March, except a few occasional light showers. The rainfall pattern is most vulnerable to climate change. It has plunged from 596 mm in the 1990s to 421 mm during the last 7 years, a decrease of approximately 29%. However, average rainfall in the past 30 years was around 498mm, which is much lower than the average rainfall of 1990s (Figure 8).

The local inhabitant viewed that the ill effects caused by erratic and decreasing rainfall are: (i) declining regeneration of native species in forest, (ii) decreased forest density, (iii) depleting groundwater table, resulting in scarcity of water for irrigation and drinking, (iv) non-sowing of some major pulses crops like chana, moong, moth which require adequate rainfall, (v) depleting traditional water bodies, like ponds, johads etc., resulting in scarcity of drinking water for the cattle, (vi) depleting water bodies and forest density has also resulted in decreased wild life.

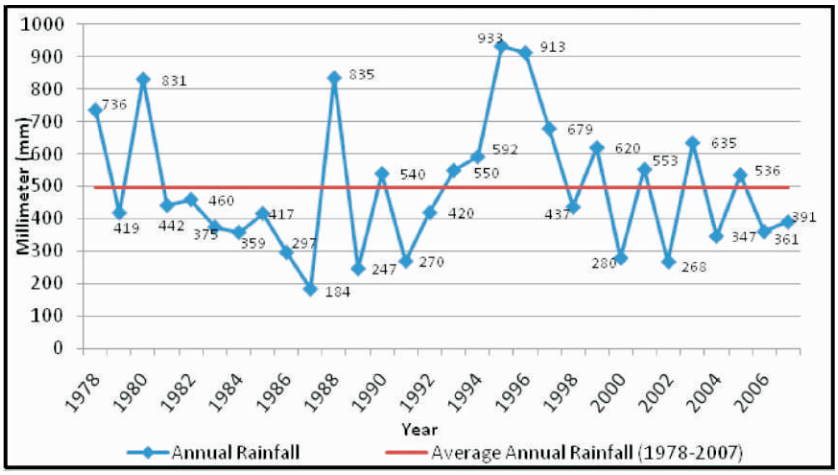


Figure 8: Rainfall in the Rewari District (in Millimeter)

Source: Aravalli Micro-plan and District Statistical Handbook

3.2.2 Month-wise distribution of average rainfalls in the district

The data for the past 26 years demonstrate an average rainfall of 157mm in the month of July and August. However, it is 25 mm less that the average rainfall in the 1990's (1990 – 1999). **Figure 9** represents monthly average rainfall in the district for the period 1978 to 2003:

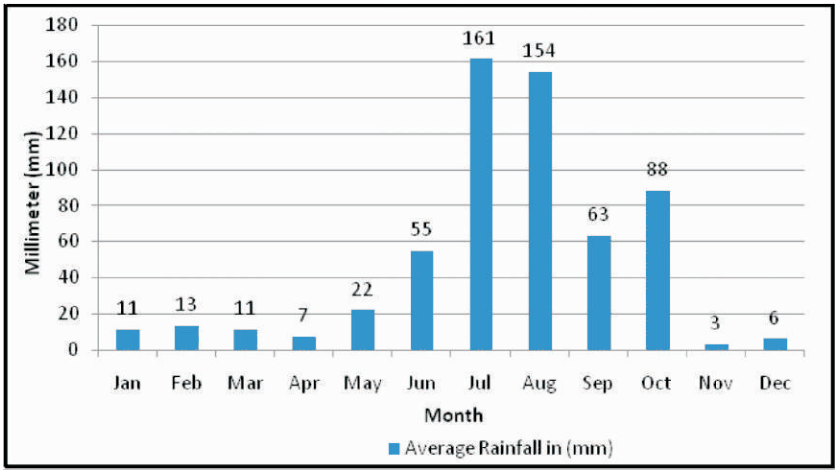


Figure 9: Distribution of Average Rainfall

Source: Aravalli Microplan and Rewari District Plan

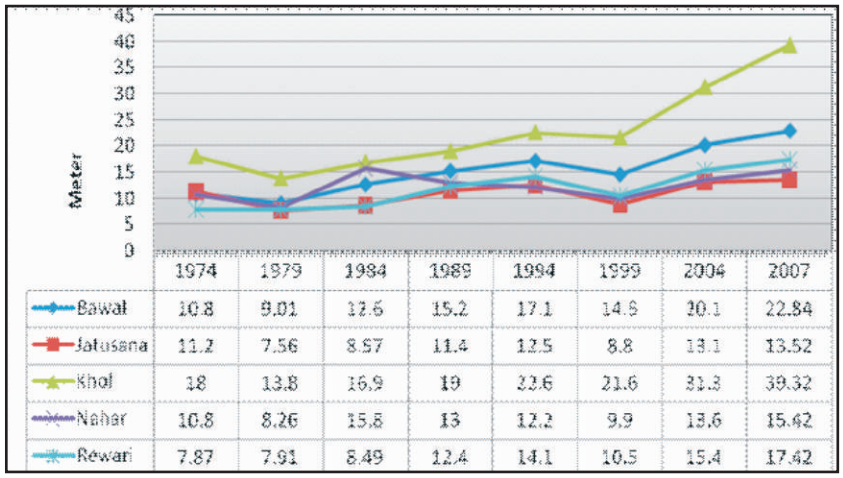
Based on the discussion with the local villagers, it has been deduced that the monsoon rains sets off quite late since the past 2-3 decades, accounting to major changes in agriculture practices and

cropping patterns. The sowing period of monsoon crops has been shifted significantly. More than 90% village inhabitants have reported a steep decline in cultivation of pulses, which is one of the major impact witnessed in the cropping pattern. Further, the per-acre productivity of pulses is remarkably low when irrigated by the groundwater as compared to crop grown under rainfed condition earlier.

3.3 AVAILABILITY OF WATER

3.3.1 Groundwater

Around 45% of the geographical area falls with the 10-20m depth of water-table range. In the past three decades (June 1974 - June 2004), the water table is receding at an alarming rate of 30cm per annum in the district. Looking at 2007 figures, the depth of water table varies from 13.52m in the Rewari Block to 39.32m in Khol Block. The variation is around 26m, approximately 200 per cent, reflecting a huge disparity in the groundwater table within the district. The decline in water level is much drastic (62 cm / annum) in Khol Block of the district due to over-exploitation of water, being good in quality and lesser recharge due to low quantum of rains in the block, and minimum in Jatusana (6.0cm per annum) due to recharge by seepage of Jawahar Lal Neharu canal in the area **(Figure 10)**. The water table decline between1994-2007 is less than 45 cm per annum in the district as a whole and 1.29 m/annum in the Khol Block of the district.



	1974	1979	1984	1989	1994	1999	2004	2007
Bawal	10.8	9.01	12.6	15.2	17.1	14.9	20.1	22.84
Jatusana	11.2	7.56	8.97	11.4	12.5	8.8	13.1	13.52
Khol	18	13.8	16.9	19	23.6	21.6	31.3	39.32
Nahar	10.8	8.26	15.8	13	12.2	9.9	13.6	15.42
Rewari	7.87	7.91	8.49	12.4	14.1	10.5	15.4	17.42

Figure 10: Block-Wise Level of Groundwater Table (in Meter)

Source: Comprehensive District Agriculture Plan, Rewari

In the 33 year period (1974-2006), the average depth of groundwater (pre-monsoon) has receded to 22m below ground level from 12m below ground level **(Figure 11)**. Thus, the average groundwater depth has plunged almost 10m in the last two decades. There was a respite from the

constant decline during 1995-1999, when sufficient quantum of rainfall was received to recharge groundwater in the area. The water table declined from 1994-2007 less than 45cm per annum in the district. The situation in some part of Jatusana Block is comparatively better; due to recharge by seepage from JLN canal.

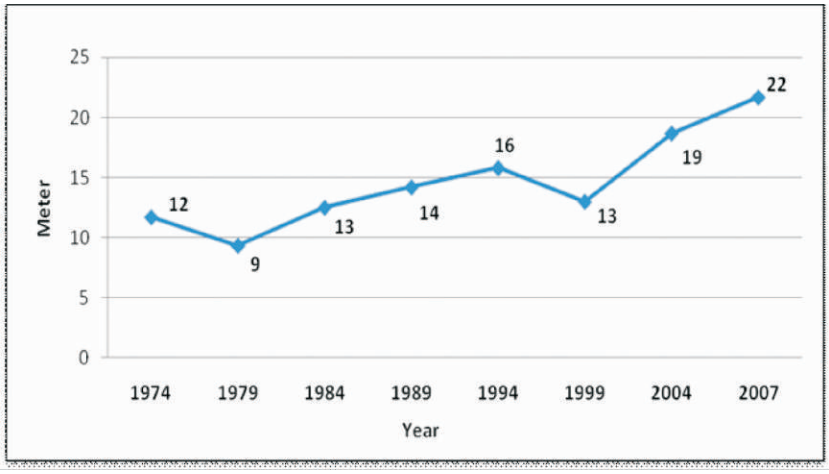


Figure 11 Average Depth of Groundwater in the District (in Meter)

Source: Comprehensive District Agriculture Plan, Rewari

Due to heavy rainfall in the years 1995-1999, there was a swift rise in groundwater table. A rise of more than 5m was recorded in groundwater level during that period. ***Considering depletion of ground water the villagers responded that inadequate and erratic occurrence of rainfall has placed excessive pressure on groundwater for irrigation. The increased use of advanced irrigation equipments has further compounded the situation by fostering a water crisis. Over-drafting of groundwater has caused failure of shallow tube-wells in the region. Plunging rainfall has the dual effect on groundwater i.e. (i) inadequate groundwater recharge, (ii) increased drawl of groundwater for irrigation and other uses.***

3.3.2 Groundwater Balance in Rewari

The annual rainfall of the district is nearly 498mm (past 30 years average). However, this rainfall occurs in short spell of high intensity. Because of such intensities and short duration of heavy rain, most of the rain falling on surface tends to flow away rapidly, leaving very little for the recharge of groundwater. This highlights the need to implement measure to ensure that the rain falling over a region is tapped as fully as possible through water harvesting, either by recharging it into the groundwater aquifers or storing it for direct use.

As per the study of Agriculture Department conducted in year 2004 in different blocks of the district reveals that the net groundwater available is much less than the total draft **(Figure 12)**. The availability of water was highest (170 per cent) in Khol Block followed by Rewari (151 per cent), Jatusana (113 per cent), Bawal (105 per cent) categorized as over-exploited zones. It was 88 per cent in Nahar Block putting it in a semi-critical zone is recharged by seepage of JLN canal and is exploited to a lesser degree due to poor quality of underground water. The higher degree of over-exploitation in Khol Block may be due to progressive increase in number of minor irrigation units, due to good quality underground water, whereas, over-exploitation of groundwater in Rewari Block may be ascribed to highest density of Minor Irrigation units in the blocks. Nahar Block falls under semi-critical zone.

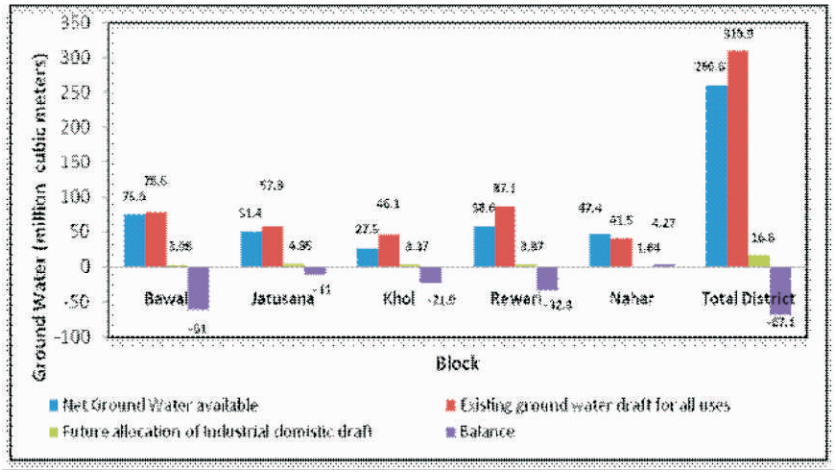


Figure 12: Block-Wise and total Groundwater Balance in the District

Source: Comprehensive District Agriculture Plan, Rewari

Thus it becomes imperative for the farmers not only to adopt techniques for efficient water use but also pay attention towards rainwater harvesting and its recharging, preferably to be taken up at the community level. Out of the several methods of rainwater harvesting, open well method is more appropriate under the present conditions. This proposed recharge measure will not only check decline in water level, but will result in rise of water level. It will also bring additional land under irrigation.

3.3.3 Water Quality

According to District Plan, Rewari based on quality of water Rewari has been divided into five zones i.e., fresh groundwater, marginal groundwater, shallow fresh deep/marginal, shallow marginal/deep fresh, and shallow marginal/deep saline. Freshwater zones near in the south;

Figure 13: White patches on soil due to salinisation of soil

eastern parts of district where Aravalli hills act as groundwater recharging zones and absence of canal irrigation has rendered the groundwater quality as fresh. Major zones of marginal groundwater occur in vast areas of the district. The shallow marginal–deep fresh zones are found associated with fresh-water. Shallow saline and deep/marginal zones are found at a few places in the northern–western fringes of the district. Rewari is among the districts where the groundwater exploitation is highest, which forms a broad zone of groundwater decline.

The district has witnessed mushrooming growth of tube-wells and poor water management practices which has resulted in falling of water level with the rate of 45cm per annum in the last 15 years. Block-wise area under different quality of water in Rewari district during June 2007 has been presented in **Table :**

Table 8: Statement of water quality in the district (Block-wise)

Blocks	Total Geographical Area (sq.km)	Hilly Area (sq. km.)	Area (sq. km)			
			Quality of Groundwater (Electrical conductivity)			
			0-2000	2000-4000	4000-6000	>6000
Bawal	312.85	7.20	50.28	152.16	52.93	50.28
Jatusana	351.25	--	168.30	153.68	29.27	---
Khol	275.24	15.58	153.26	43.62	62.48	---
Nahar	285.32	--	103.62	130.70	51.00	---
Rewari	334.34	--	77.04	218.05	31.98	7.27
Total	**1559**	**23.08**	**552.50**	**698.21**	**227.66**	**57.55**
%	100	1.5	35.4	44.8	14.60	3.70

Based on the water samples received in the State Testing Laboratory at Bawal, only 24% of the tubewell water is of good quality and remaining 76% waters are affected with varying degrees of salinity and sodicity in the district. Comparatively speaking, the Khol Block, followed by Jatusana has the highest percentage of good quality water in contrast to the other blocks. Nahar and Bawal Blocks are affected with sodicity, whereas salinity is highly perceivable in waters of Rewari and Jatusana **(Table).**

Table 9: Water Categories in the District

Blocks	Percentage			
	Good	Saline	Sodic	Highly Sodic
Rewari	26.0	43.0	25.6	5.4
Khol	46.9	27.9	21.8	3.4
Jatusana	35.8	40.5	20.0	3.6
Bawal	16.7	33.2	45.0	5.1
Nahar	20.6	25.2	50.9	3.3
Total for the District	**24.1**	**34.8**	**36.5**	**4.6**

Source: State Testing Laboratory at Bawal

The quality of groundwater plays a significant role in agricultural productivity and maintenance of soil health. As per survey of groundwater cell, the highly brackish water is available in 16% part of Bawal Block, whereas good quality water is available in 56% part of Khol Block. On an average, in June 2007, around 35% water in the district could be ranked of good quality, whereas 65% are affected with varying degree of salinity /sodicity.

3.4 CHANGE IN AGRICULTURAL PRACTICES

3.4.1 Land-holding Pattern

The average landholding pattern has witnessed a major paradigm shift with the growing trend of nuclear families, agriculture land has fragmented into small pieces, which are economically not viable for farming at times. The major downturn in number of families with land-holdings of 2 ha and more and major upturn in number of families with less than 2 ha are mutually complemented to a great extent **(Figure 14)**. The figures clearly indicate fragmentation of land. Percentage of landless families is also very high in the area. Decreasing size of land-holdings has a direct impact on cropping patterns and household income from agriculture. This also results in encroachment of community land, meadows and forest fringe land for the purpose of agriculture. As a result meadows and forest fringe land is decreasing in terms of area.

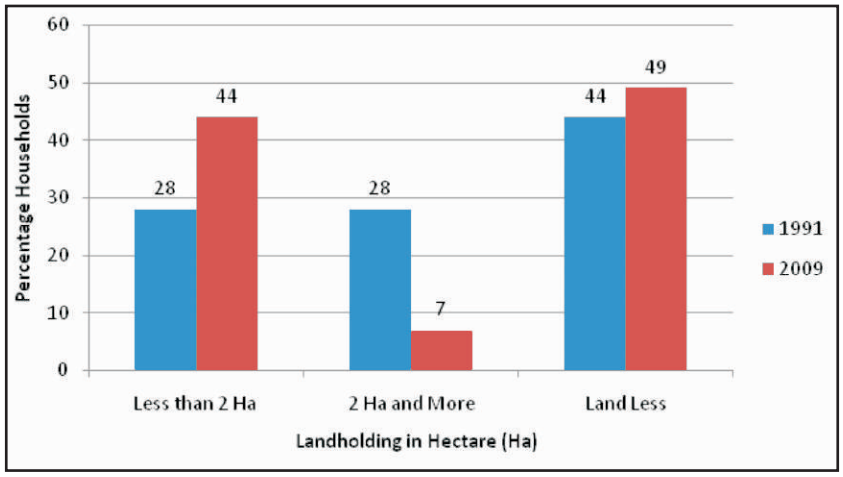


Figure 14: Change in Landholding Pattern in the Sample Villages (in percentage)

Source: Aravalli Micro-plans 1991, Forest Department

3.4.2 Cropping Pattern

As discussed in the earlier sections, the region has witnessed a major shift in cropping pattern over the past few decades. The major cropping systems under the existing farming pattern are bajra-

wheat, bajra-mustard, guar-wheat, and guar-mustard. Mustard and wheat are the major crops of Rabi, and bajra and guar are the main crops of Kharif. Cultivation of crops like gram, *moong* and *moth* has fallen significantly. Similarly, the district has witnessed major changes in productivity and area under different crops. This section has elaborate the changes observed in cropping intensity, area under major Rabi and Kharif crops; area, productivity (yield) and production of major crops like wheat, mustard, gram and vegetables in the district.

3.4.3 Cropping Intensity

Out of the net sown area in the State, 82.5% per cent area was sown more than once in 2005-06 as compared to 34.4% in the year 1966-67. The same trend follows in Rewari as well; cropping intensity in the district is 145% **(Figure 15)**. In the sample villages almost hundred per cent cultivable land is put to use, leaving no land for open grazing. Factors fostering cropping intensity are improved irrigation facilities, High-Yielding-Variety seeds, fertilizers, growing number of nuclear families, inadequate alternate source of income and decreasing land-holding. A family with small land-holding has no other option than making maximum use of available piece of land. Increased land use is also creating an imbalance in nature, fostering climate change.

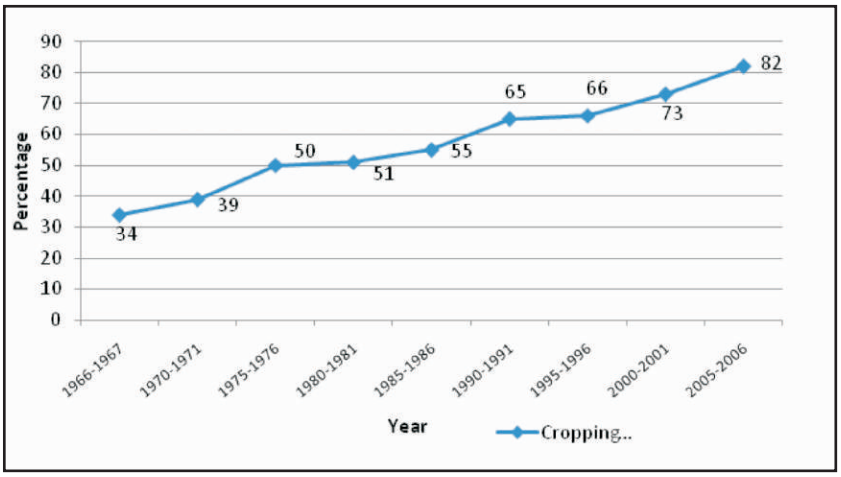


Figure 15: Trends in Cropping Intensity in Haryana State

Source: Statistical Handbook, Haryana

3.4.3.1 Block Wise Cropping Intensity

As mentioned earlier that average crop intensity of the district is 145%. However there is a block wise deviation in average, dependent on availability of irrigation resources and quality of groundwater in the block. In **Table**, Nahar and Jatusana demonstrates an above average cropping intensity, reason being JLN Canal and higher water table compared to other blocks.

Table 10: Block-wise Cropping Intensity

Name of the Blocks	Geographical Area (ha)	Net Sown Area (ha)	Gross Cropped Area (ha)	Cropping Intensity (%)
Rewari	32,213	27,080	37,580	138.7
Bawal	31,329	23,158	31,489	135.9
Khol	28,927	23,167	29,937	129.2
Nahar	26,782	20,114	33,372	165.9
Jatusana	31,679	26,342	42,054	159.6
Total	**1,50,930**	**119,869**	**174,432**	**145.5**

Source: Comprehensive District Agriculture Plan, Rewari

3.4.4 Changes in Area, Productivity and Yield of Wheat

During 2006-07 wheat occupied 47,000 ha with an average productivity of 42.2 q/ha in the district. The significant increase in the area under wheat cultivation is chiefly due to technological improvements/interventions backed by effective price support and public stocking policies. ***The village inhabitants opinioned that high commercial value, availability of high-yielding variety seeds, limited options in terms of commercial crops, it is only crop that can be used for household consumption, technological improvements/ interventions, effective price support and public stocking policies, residue from wheat is a good fodder etc. are some of the key reasons of increase of area under wheat crop.***

In 1990-91 the area under wheat crops was 39.4 thousand ha, which augmented to 47 thousand ha, with a growth of 19.3 per cent since 1991 **(Figure 16)**. The average yield per hectare has augmented by 12.5 per cent since 1991. Major boost (34.2 per cent) is production has been due to additional land brought under this crop.

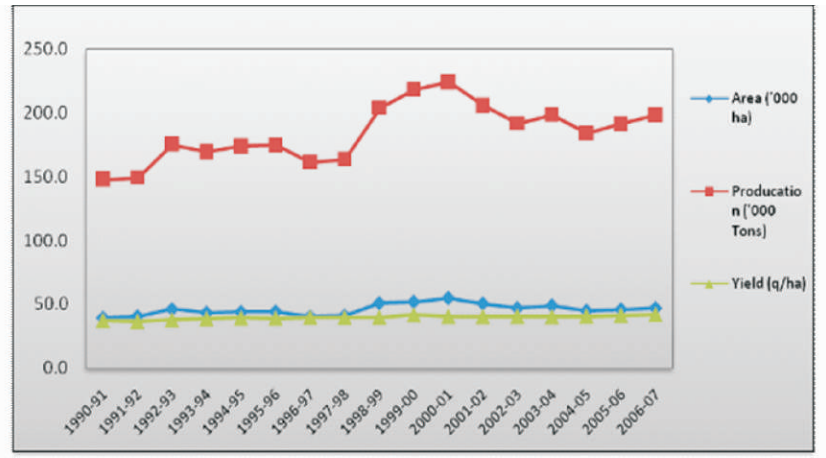


Figure 16 : Changes in area, production and yield of wheat in the district

Source: Comprehensive District Agriculture Plan, Rewari

3.4.5 Change in Area, Productivity and Yield of Mustard

The green revolution provided strong motivation to diversify crops with the use of high-yielding cultivars of wheat and mustard in the district during 1970s and 1980s. Area under mustard cultivation has increased by 31.5 per cent (71 thousand ha.) since 1991. ***According to the village inhabitants key factors fostering mustard cultivation in the district are (i) It needs less irrigation as compared to other crops, (ii) High commercial value, (iii) Intensification of mustard-intercropping of mustard with potato, and multiple cropping with karonda (Carissa carandas) interspersed, (iv) Horticultural crops on bunds can prove to be an economic cropping system with this crop, (v) Technological improvements/ interventions, (vi) Effective price support and public stocking policies, (vii) Suitable agro-climatic conditions in the area, (viii) Easy availability of improved seeds***

As per the available data since past 17 years average yield during mustard is around 14.63 quintals/hectare. However the figure demonstrates a below average yield in 1991-92, 92-93 95-96, 2002-03, 2005-06 mainly due variation in climatic conditions. In the year 1996-97 yield was 18 quintals/hectare which is much higher than the 17 year average 14.63 (1991-2007) **(Figure 17)**.

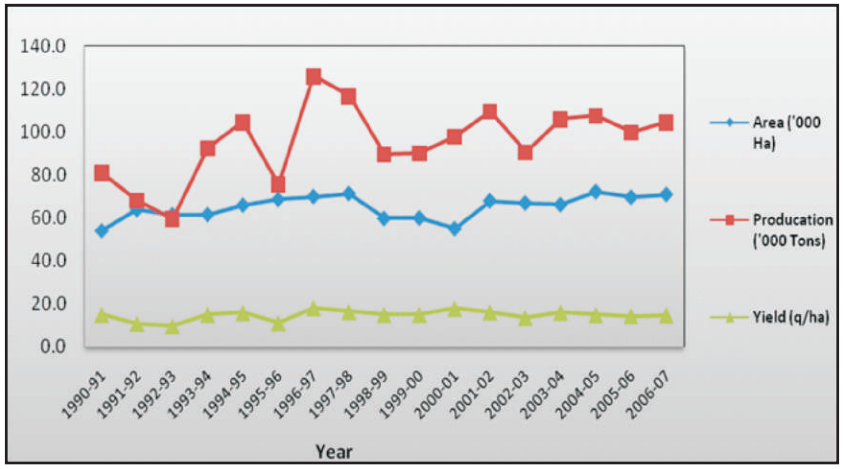


Figure 17: Changes in area, production and yield of Mustard in the district

Source: Comprehensive District Agriculture Plan, Rewari

Since 1990-91 the overall productivity has decreased by two per cent, although production has increased by 28.9 per cent; chiefly due to bringing in additional land under mustard cultivation.

3.4.6 Change in Area, Productivity and Yield of Gram

Couple of decades ago barley, gram, moong and moth were the chief crops Rabi crops in the region. Low rainfall with its erratic distribution, scarce water resources for irrigation, poor groundwater quality coupled with arid and semi-arid conditions resulted in relatively less production during Rabi season, fostering a major shift in the cropping pattern. After 1996 Rewari has witnessed a major downfall in gram cultivation.

Villagers of Rewari also noticed that area under moong and moth has also witnessed a steep downturn over the past few decades and these crops are very rarely sows in the area. ***Based on discussion with the villagers some key reasons for this decline in cultivation are:***

- ***Low and erratic rainfall with erratic distribution***
- ***Depleting water table***
- ***Increasing deficiency of micronutrients in soils, resulting in poor soil fertility***
- ***Light-textured soils with poor retention of water and nutrients***
- ***Lack of water-harvesting and management practices***
- ***Inadequate soil health management practices***

A survey conducted by Department of Agriculture reveals that during the years 1990-1991 to 1991-

92 gram cultivation declined by 75 per cent. Only 5,000 ha land was brought under gram cultivation in the district, which was 20 thousand ha in the preceding year. ***It has witnessed a regular downturn through 1998-99. In the year 2002 - 2003 the area under this was only 500 ha. Thus, although one of the major Rabi crops in the area, a few decades back, Gram is now on the verge of becoming an extinct crop in the district.*** The area under gram cultivation was nearly non-existent during the year 2004-05. **(Figure 18)**

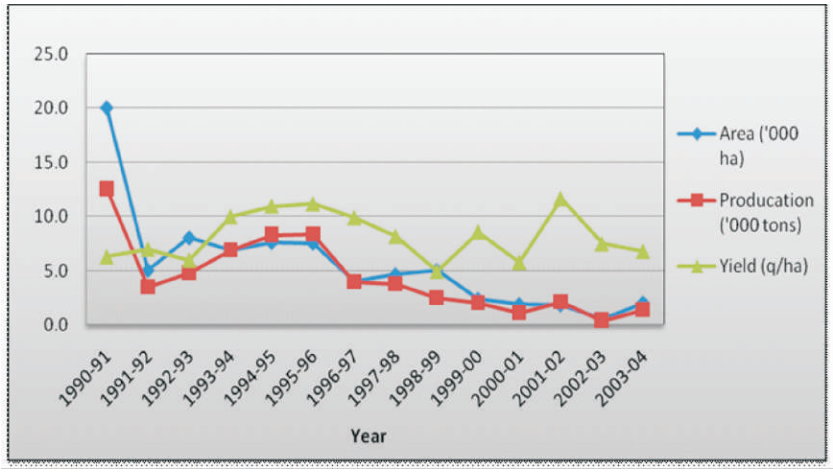


Figure 18: Changes in area, production and yield of Gram Crop in the district

Source: Comprehensive District Agriculture Plan, Rewari

The above figure demonstrates a steep decline in the area under gram cultivation and production, although the yield per hectare shows an undulated trend even after use of excessive fertilizers. The above figure also shows a rise in productivity, from 6.3 q/ha in 1990 - 91 to 11 q/ha (74.60 per cent) in the subsequent five years, which is a positive trend that needs to be pursed more intensively.

3.4.7 Changes in Area, Productivity and Yield of Vegetables

The following figure presents the trends in vegetable crops in growth of area under cultivation and production during the past seven years. However, per hectare yield has remained almost static, around 14 tons per hectare. The current study also shows that the fertilizer consumption has also grown over 150% in the last few years in the district **(Figure 19).** A growth trend is visible in area under vegetable cultivation since this is economically viable as compared to the traditional crops in relatively small land holdings.

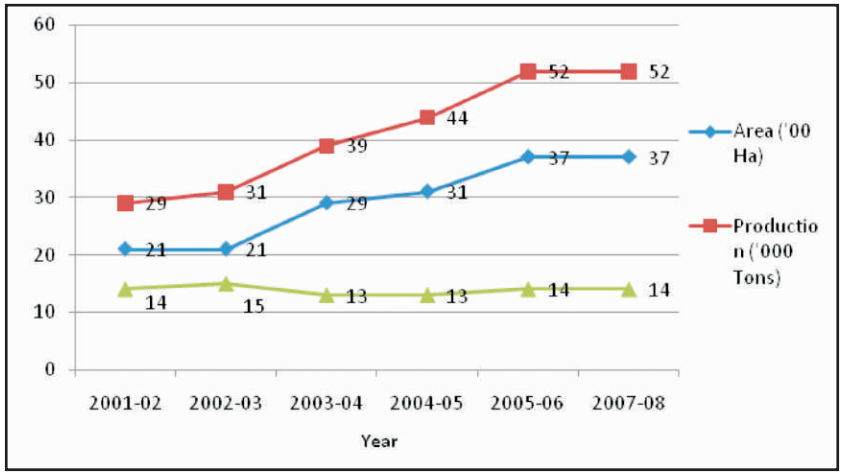


Figure 19: Changes in Area, Production and Yield of Vegetable Crops in the district

Source: Comprehensive District Agriculture Plan, Rewari

3.5 Changes in Irrigation Pattern

The main source of irrigation in the district is underground water, which is largely brackish in nature and is drawn out through tube wells. ***It was learnt from the village inhabitants that until a few decades back, few surface water bodies were capable of supplying water for irrigation, which helped in reducing pressure on groundwater. Today no surface water bodies hold adequate water even for consumption by the cattle.***

Figure 20: Irrigation through Sprinklers

Figure 21: Flood Irrigation

Since early 1970s, the tube wells run by electricity or diesel became a common sight, facilitated by rural electrification. This was followed by introduction of sprinkler systems in late 1980s, which have become widespread with even, uneven fields now being irrigated, with their use. The increased use of tube wells and sprinkler systems have resulted in the irrigated area augmenting from 72.3% in 1990-91 to 88% during 2003-04 leading to a remarkable progress in agricultural productivity.

The irrigation water forms a very scarce input and has become a major hurdle in the growth of agriculture. The major source of irrigation is tube well which has overexploited groundwater during recent years, which has resulted in secondary salinisation and sodification in the agriculture fields. Tube wells now irrigate nearly 98% of the irrigated area whereas the remaining agriculture land receives water from the Government Canal System. The normal rainfall in the district is not enough to recharge the depleted groundwater. Therefore, it is essential to manage groundwater efficiently with the use of advance irrigation innovations like drip irrigation system.

The number of tube wells has rapidly increased in the Haryana State since 1970s **(Figure 22)**. The figure below presents the trends of electricity and diesel run tube wells in the State. Whereas the electricity run tube wells continue to grow with increased availability of power in rural areas, the number of diesel sets has reached a plateau since mid 1990s.

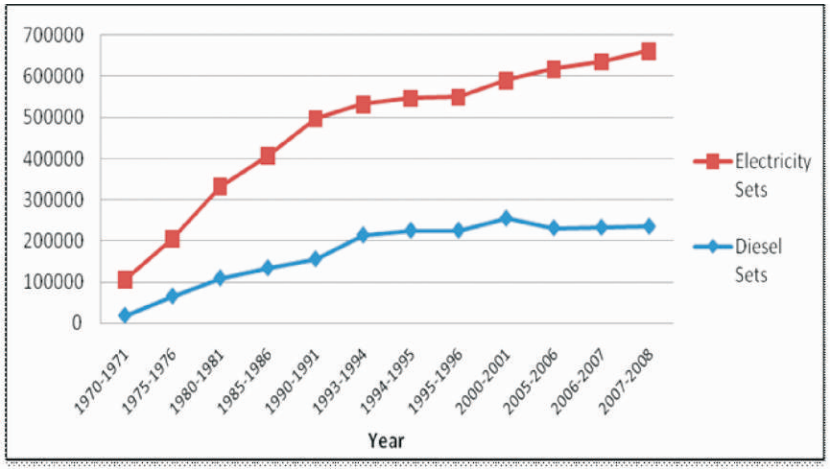


Figure 22: Trends in categories of tube wells run by electricity and diesel

Source: District Statistical Handbook

However, through the respondents were aware about the alarming rate of groundwater depletion and excessive pressure on groundwater for irrigation, they did not highlight any concern to take constructive measures to recharge groundwater and use advanced irrigation techniques which would utilize less water. This lack of sensitivity seems reinforced by successful change over from traditional rain-fed crops like gram and pulses to irrigated crops like wheat, mustard and vegetables.

3.6 CHANGE IN USE OF FERTILIZERS

Next to irrigation, fertilizer is the second most important input for cultivating high-yielding varieties. Depleting rainfall and limited source of irrigation have triggered high fertilizer consumption in the district. During the past two decades fertilizer consumption in district has to

augmented from 12.07 tons to 31.39 tons with the growth rate of 1.14 tons per year, refer **Figure 23 and Figure 24.**

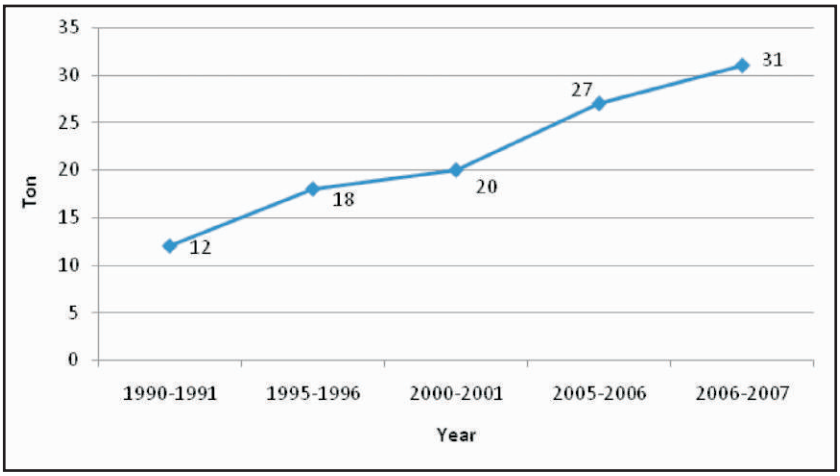


Figure 23: Change in Fertilizer Consumption in the District

Source: District Statistical Handbook

Based on the discussion with farmers, it is evident that farmers are not very concerned about balanced use of fertilizers, although they are aware that non-judicious use of inorganic fertilizers is increasing dependability of soil on them. Unplanned fertilizer application has also resulted in problems related to soil health and nutrient imbalance. This also indicates that no effective attempts are being made for soil testing and nutrient restoration. The situation is further compounded by the incidence of double-cropping that does not allow cultivable land to regain its nutrient balance naturally.

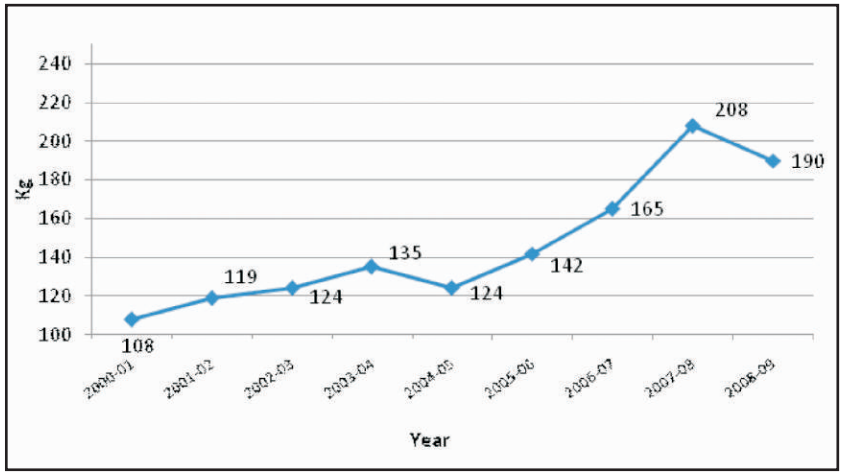


Figure 24: Fertilizer Consumption per Hectare in the State (in Kg)

3.7 CHANGE IN ANIMAL HUSBANDRY PRACTICES

3.7.1 Changes in livestock rearing practice

Like rainfall, irrigation practices and fertilizers, livestock is an integral part of farming systems in the traditional farming system. Arable farming in combination with animal husbandry or animal husbandry alone is one of the main farming systems here. The main milch animal in the district is buffalo and drought animal is camel. Good entrepreneurship qualities in residents, particularly landless families are basic factors for the development of animal husbandry in the district.

The livestock practices have changed to a great extent over the past few decades. Decreasing availability of fodder and increased aridity in the district has resulted stall-feeding of cattle, use of tractors instead of bullocks for ploughing, use of camel carts initially and then tractors for transport and replacement of cow with buffalo as the main milch animal because of its high milk yield and hence higher commercial returns.

With higher income, tractors have become the preferred investment for both farm work and transport. This in turn has decreased reliance on cattle except for milch purposes. **Figure 25** clearly demonstrates drastic fall in population of cow and a rise in population of buffalo in the State. With the commercialization of livestock rearing in the area, villagers have replaced cows with buffaloes. Normally a cow yields 10-16 liter milk per day in contrast to a buffalo (15-25liter). Buffalo milk is also rich in fat as compared that of cow. Thus, since the mid 1980s, buffalos have become the preferred milch animal as would be clear from the graph below.

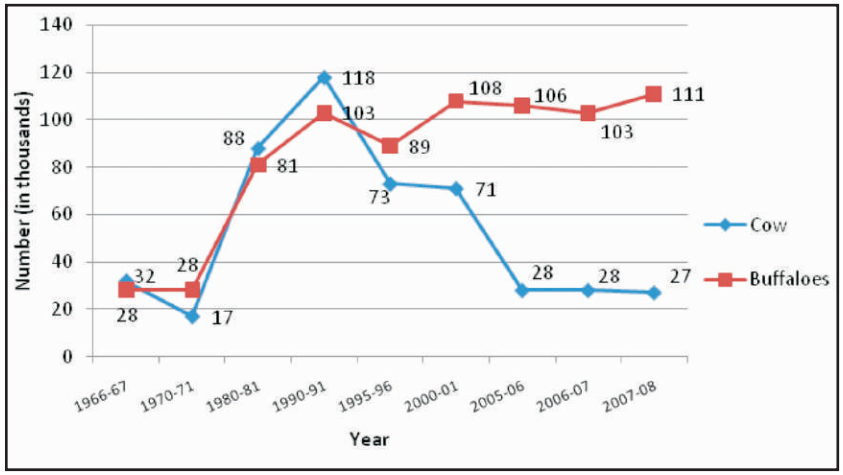


Figure 25: Population of Cows and Buffaloes in the State (in thousands)

Source: District Statistical Handbook

Village habitants also reported major changes in goat and sheep-rearing practices. Normally, landless poor families are involved in rearing goats and sheep as their main source of income. However, this reliance has also decreased significantly due to reduced availability of fodder and a wider job market. The above discussed changes are also reflected in the study of sample villages, which is presented in **Figure 26** below:

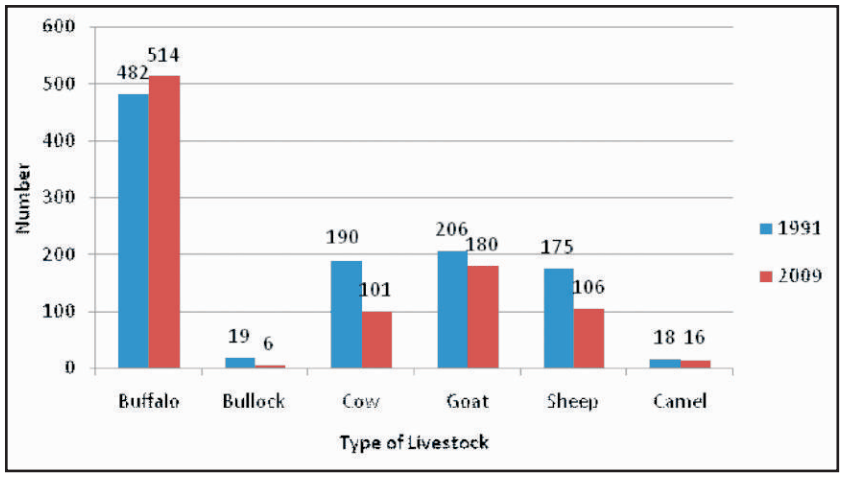


Figure 26: Average Livestock Population in Sample Villages

Source: Aravalli Micro Plan prepared in 1991 by the Forest Department

Given the commercial importance of buffalo as a milch and drought animal, it is stall-fed with fodder fortified with nutrients to improve its milk yield.

3.7.2 Sources of fodder

As indicated in previous sections, grazing lands, meadows and forest fringe lands have deteriorated in terms of area and productivity over the past few decades. A perusal of brings out that only 2% of forage comes from common land today which was 10% in the year 1991, clearly demonstrating a downfall of 80% during the past 18 years **(Figure 27)**. The remaining fodder requirement (almost 65%) is met by cultivated fodder crops and crop residue of wheat and mustard. Cropping pattern and livestock feeding habit have changed over the years. The past 17 years have witnessed a 43.5% addition in the fodder purchase from open market. Decreasing availability of green fodder is a major challenge these days and it must be reiterated that the nutrient deficiency, due to reducing quantum of green fodder, has an adverse impact on animal health, a factor that needs to be seriously attended to.

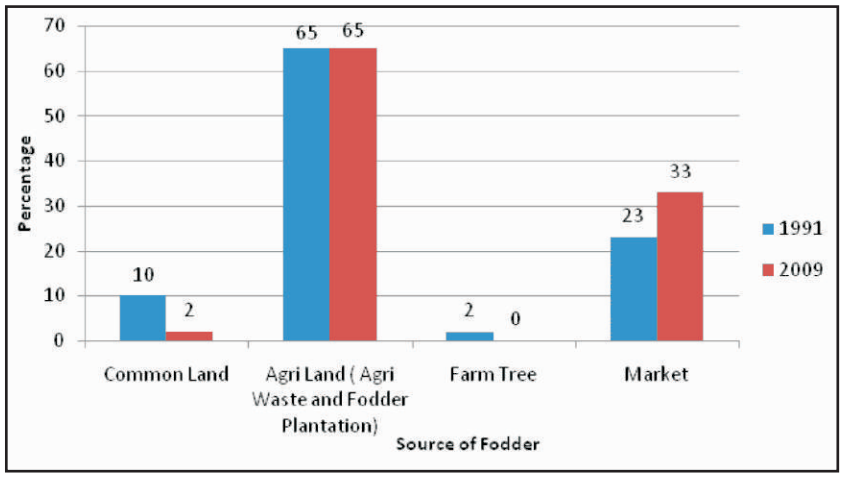


Figure 27: Sources of Fodder in Sample Villages

Aravalli Micro-Plan prepared in 1991 by the Forest Department

3.8 CHANGE IN HUMAN LIFESTYLE

3.8.1 Changes in Livelihood Pattern

The agriculture and allied activities are the major source of livelihood in rural Rewari. Other supplementary sources of income are livestock rearing, agriculture and other labour work including, employment in the local industries. Livelihood pattern in the region has changed to a great extent over the past few decades. The major factors fostering this are fragmentation of agriculture land, shift from joint family to nuclear family, education and industrialization. In the

early 1990s, families were large depending mainly on agriculture and labour work. Earning through rainfed agriculture and labour work was enough to manage their household expenses. Major part of livestock product was used for household consumption and a very little was sold.

Agriculture land is fragmenting with the growing trend of nuclear families. Small pieces of agriculture land force people to strive for alternate/ supplementary sources of income. The growth of mines and industries in the area gave an opportunity for the local people to earn additional income. Rewari district has tremendous employment opportunities as Aravalli hills are rich in mineral resources and Bawal Block is a major industrial areas of the State. shows a swift rise of employment in registered factories in the State. Having Bawal industrial area in the neighborhood, this trend is more intense in Rewari.

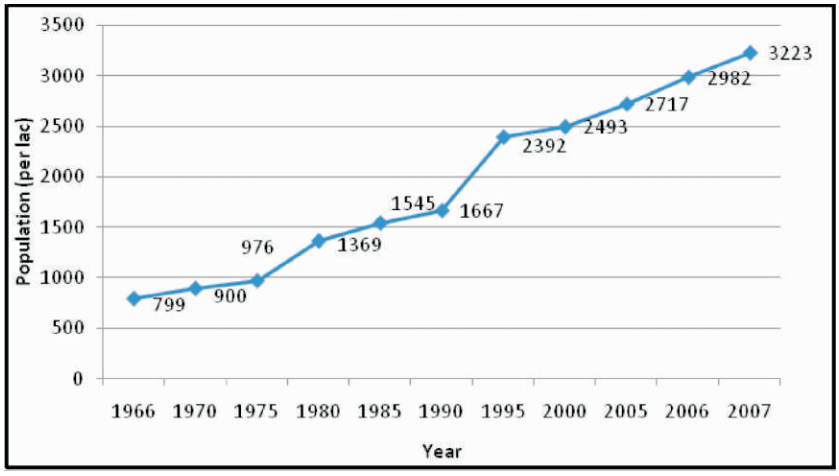


Figure 28: Employed Population in Registered Factories in the State (Per lakh)

Source: District Statistical Handbook

In Manethi, one of the seven sample villages, the dependence on mining and allied activities was more than that on agriculture. Similarly, in Tankri, Kanuna and Harzipur, proximity to Bawal industrial area has resulted in the residents getting employed with the industries.

A major change in migration pattern has been witnessed in the region. Land-less and small farmers migrate to nearby cities to earn their livelihood during lean seasons. They also migrate to UP, Punjab for agriculture labour work during the harvest season of wheat and cotton. The average wage earned during this span is around 100-150 per day, and people migrate once or twice in a year depending on their economic needs. Education is also playing a major role in changing the livelihood pattern. Rewari being close to Gurgaon and Delhi has better opportunities to study and work. Many young men in the area are working in Gurgaon and Delhi, after completion of their studies.

3.8.2 Changes in Health Issues

The change in climatic conditions has resulted in an adverse impact on human health in many ways. Some major findings from the discussions are presented below:

- Extreme weather conditions and fluctuating temperature are contributing to minor illness like cold, fever etc.
- Incidence of malaria has also resurfaced over the past few decades.
- Changing water quality is a one of the major issues in the area causing major illness in both adults and children. Fluoride content in water is considered high in some sample villages.
- Surprisingly, cardiac diseases are on an increase due to following reasons:
- Decreasing physical labour due to use of modern agriculture equipments like tractors, sprinklers etc.
- Unbalanced diet, low nutrient intake due to changing cropping pattern.
- Increasing alcohol consumption in the area, due to changing income pattern.

Chapter 4

CONCLUSION

The study indicates that the changing climatic conditions have a direct impact on forest ecosystem, agriculture, livestock and lifestyle of human-being. Forest ecosystem and agriculture is most vulnerable to climate change. In this Section we have presented the major learning/conclusions drawn out of the study:

- Agriculture and allied activities are the major source of livelihood in rural Rewari, however a swift rise of employment in industrial sector has been registered in the region.
- Moong, moth are no more sown in the area and gram despite being one of the major crop of Rabi is on the verge of extinction.
- Increase in agriculture production is mainly due to introduction of addition at land and inputs.
- Increased use of tube-wells in the region has resulted in overexploitation of groundwater resulting in rapid decline in groundwater level and reducing water quality.
- Scarce and erratic rainfall and deteriorating soil health has resulted in loss of essential plant nutrients and decreased regeneration rate. Loss of plant and animal productivity and diversity is a subsequent effect of the same.
- Overexploitation of forest for fuel-wood and fodder coupled with scarce and erratic rainfall is a major reason for degradation of forest in the area.
- Degradation of forest results in a loss of essential environmental functions of forests including biodiversity, climate regulation, soil and water conservation including preservation of water catchment areas.
- Availability of fruits, fuel-wood, fodder, medicinal plants and other forest products has reduced significantly during the past few decades.
- Grazing land, meadows and forest fringe lands have deteriorated in terms of area and total fodder production over the past few decades.
- Mining and industrial development in forest and fringe lands has improved access to potentially profitable mineral or other commercially valuable products, however less attention is being given to maintain environmental balance and forest sustainability.
- Continuing forest destruction is accelerating global warming with potentially negative consequences for human welfare and survival.
- A significant change in plant and animal species composition has been witnessed.
- A steady decrease in the population of traditional species of trees, herbs and shrubs has resulted in replacement of traditional plant species with others.
- Incidence of cardiac disease has increased in the region.
- Changing socio-economic status has resulted in loss of traditional knowledge of sustainable use and protection of forest.

Chapter 5

SUGGESTIVE MITIGATION STRATEGY

Increased dependence on technological innovations including the farming equipments, irrigation systems (tube-wells and sprinkler systems), hybrid seeds and fertilizers has significantly changed the rural economy and environment. This change has clearly shown a dwindling tree cover and lower groundwater levels. The following section presents the recommendations/ mitigation strategy based on the discussion with village inhabitants, forest department staff and scientist of Agriculture University.

- *Stringent Rules and Regulations:* People involved in cutting of trees or destruction of forest in any other way should be prosecuted. The judiciary system should be strengthened to punish such people on a fast track basis.
- *Community Involvement in Afforestation:* Since forest fringe community is responsible for overexploitation of forest for their need, it is advisable to involve them in reforestation and forestry.
- *Community Fodder Plantation:* Cultivation of fodder in Panchayat land/ village common land can reduce pressure on forest for fodder.
- *Controlled Industrialization/ Mining:* Infrastructures development/mining should be managed properly and not be done on the cost of forest. Proper care should be taken in order to maintain enough green cover.
- *Encouragement/ Incentives to NGOs, Corporate Houses and other organizations*: Government/ Forest Department should encourage and facilitate NGOs, and corporate houses to work in the region for sustainable development. Corporate could play major roles for environment sustainability under Corporate Social Responsibilities (CSR), if government offers tax deduction and other facilities.
- *Commercial Plantations:* Forest department can involve community in cultivation of medicinal plants and other commercially viable plants. On a profit sharing basis community can be involved in plantation, irrigation and protection of plants. This will help in increasing green cover and reducing human pressure on forest.
- *Rain Water Harvesting:* With depleting ground water level and scarce rainfall, there is an emergent need to propagate rain water harvesting practice in the region. Government should provide the technical and financial to farmers for creation of new farm ponds and

renovation of old water bodies. It can also provide even broader environmental benefits especially in arid and semiarid regions.

- *Use of Improved Irrigation Techniques:* Use of improved irrigation techniques like drip irrigation can help in optimum utilization of water resource. Government should promote drip irrigation by subsidizing the cost and providing adequate technical support.
- *Soil and Moisture Conservation:* Government should provide adequate financial support for soil and moisture conservation activities on forest land, forest fringe land and land of individuals.
- *Sustainable Agriculture Development:* According to agricultural researchers, policy makers and other key stakeholders actively involved in improving agricultural productivity in semiarid areas agree that the solution to this challenge lies in sustainable agricultural development. This concept of sustainable agricultural development entails improved management of the available resources and use of improved crop production technologies that can enhance sustainable production in semiarid areas. Improved use of the limited resources can be achieved by managing the natural resources sustainably, for example, use of soil and water conservation measures to prevent land degradation (mainly through soil erosion) and conserve soil fertility and improved use of the water resources through rainfall harvesting.
- *Genetic Enhancement:* Development of appropriate genotypes suitable for the semiarid environment through appropriate Genetic Enhancement will go a long way in increasing agricultural productivity while ensuring sustainable agricultural production. For example uses of genetically enhanced early maturing genotypes or genotypes tolerant to salinity are likely to be more productive in semiarid areas where water deficits and salinity respectively, are more severe.
- *Balance use of fertilizers: Government should establish* soil testing centers in every block and facilitate the process of regular soil testing. This should further be supported by technical input of balanced use of fertilizers.

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145. Documentation of good work done by FDA where composite pilot project on Bamboo are going on in Pratapgarh, Rajasthan. RC-146, 2010.
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Annexure I – List of people met for the purpose of the study

The meetings were held with the following officials for the purpose of the study:

Mr. T. Satya Prakash, District Magistrate, Rewari

Forest Department

- Dr. D. Hembram, DFO, Rewari
- Mr. Brahm Prakash, RFO, Rewari & Nahar
- Mr. Dharam Singh, RFO, Bawal
- Mr. Rampratap, BFO, Nahar
- Mr. Prem Kumar, Forester

Agriculture Department

- Mr. Chaitram Mor, DD Agriculture, Rewari
- Researchers from CCS Agriculture University, Bawal

Statistical Department

- Mr. Yadav, Statistical Officer, Rewari

Points Discussed

With DFO, Rewari

- Area under forest cover
- Classification of forest types of the forest cover
- Change in condition over the past few decades, especially due to climate change.
- Various programs/ schemes implemented by Forest Department
- Dependency of villagers on forest
- Stock-taking of relevant data available with Forest Department for the study
- Identification of other data sources
- Invited comments and suggestions on proposed methodology of study

With District Statistical Officer, Rewari

- Stock-taking of relevant data available with DSO for the study
- Identification of other data sources
- Invited comments and suggestion on proposed methodology of study

With DD Agriculture, Rewari

- Change in status of agriculture in Rewari over the last few decades, especially due to climate change
- Stock taking of relevant data available with the Agriculture Department for the study
- Identification of other data sources
- Invited comments and suggestions on proposed methodology of study

Annexure II - Profile of Sample Village

1. **Village Profile Kanuka**			2. **Village Profile Gudayani**	
Distance from the District	18 Km		**Distance from the District**	25 Km
No of Households	280		**No. of Households**	1235
Population	1310		**Population**	6045
Male	458		Male	2200
Female	392		Female	1745
Children	460		Children	2100
Education Status			**Education Status**	
Illiterate	20%		Illiterate	10%
Primary	20%		Primary	10%
High School	25%		High School	30%
Higher Secondary	20%		Higher Secondary	30%
Graduation	10%		Graduation	15%
Technically Educated	5%		Technically Educated	5%
Occupation (House-hold)			**Occupation (House-hold)**	
Agriculture	55%		Agriculture	50%
Agriculture Labourers	41%		Agriculture Labourers	30%
Other Labour			Other Labour	
Govt. job	6%		Govt. job	20%
Pvt. Job			Pvt. Job	
Business			Business	
Land-holdings			**Land-holdings**	
Marginal Farmers (Less than 5 Acre)	52%		Marginal Farmers (Less than 5 Acre)	38%
Small Farmers (5 to 10 Acre)	4%		Small Farmers (5 to 10 Acre)	7%
Large Farmers (Above 10 Acre)	2%		Large farmers (Above 10 Acre)	3%
Landless Households	42%		Landless households	51%
Sources of Irrigation			**Sources of Irrigation**	
Bore Wells/ Open Wells	30		Bore Wells/Open Wells	60
Cropping Pattern			**Cropping Pattern**	
Rabi	Mustard, Wheat		Rabi	Mustard, Wheat
Kharif	Bajra, Gwar, Gwari		Kharif	Bajra, Gwar, Gwari
Animal Husbandry			**Animal Husbandry**	
Cows	100		Cows	100
Buffalos	300		Buffalos	550
Bullocks	6		Bullocks	4
Sheep	100		Sheep	-
Goat	300		Goat	150
Camel	5		Camel	30

Infrastructure Facilities			Infrastructure Facilities	
Roads	Average		Roads	Average
Bus Services	No		Bus Services	Good
Railway Services	13 Km., Bawal		Railway Services	4 Km, Jatusana
Panchayat Office	Good		Panchayat Office	Good
Anganvadi	2		Anganvadi	5
Houses			***Houses***	
Hutments/Thatched	10%		Hutments/Thatched	5%
Concrete/Pucca	90%		Concrete/Pucca	95%
School	1 - Govt. Primary School		***School***	1 - Govt. Senior Sec. School, 1- Govt. Higher Sec. School, 1- Govt. Girls Higher Sec School,
Post-Office	Yes		***Post-Office***	Yes
Health & Sanitation			***Health & Sanitation***	
Hospital/Clinics	No		Hospital/Clinics	1 - PHC, 7 - Clinics
Veterinary Hospital	No		Veterinary Hospital	1

1. **Village Profile Manethi**			2. **Village Profile Khaleta**	
Distance from the District	25 Km		**Distance from the District**	23 Km
No. of Households	1350		**No. of Households**	700
Population	10000		**Population**	5000
Male	3500		Male	1200
Female	3000		Female	1070
Children	3500		Children	2730
Education Status			**Education Status**	
Illiterate	15%		Illiterate	20%
Primary	10%		Primary	10%
High School	25%		High School	20%
Higher Secondary	25%		Higher Secondary	30%
Graduation	20%		Graduation	15%
Technically Educated	5%		Technically Educated	5%
Occupation (House-hold)			**Occupation (House-hold)**	
Agriculture	50%		Agriculture	70%
Agriculture Labourers	24%		Agriculture Labourers	26%
Other Labour			Other Labour	
Govt. job	26%		Govt. job	4%
Pvt. Job			Pvt. Job	
Business			Business	

Land-holdings			**Land-holdings**	
Marginal Farmers (Less than 5 Acre)	37.04%		Marginal Farmers (Less than 5 Acre)	66.43%
Small Farmers (5 to 10 Acre)	1.48%		Small Farmers (5 to 10 Acre)	2.86%
Large farmers (Above 10 Acre)	0.74%		Large farmers (Above 10 Acre)	2.14%
Landless households	60.74%		landless households	28.57%
Sources of Irrigation			**Sources of Irrigation**	
Bore Wells/Open Wells	50		Bore Wells/Open Wells	160
Cropping Pattern			**Cropping Pattern**	
Rabi	Mustard, Wheat		Rabi	Mustard, Wheat
Kharif	Bajra, Gwar, Gwari		Kharif	Bajra, Gwar, Gwari
Animal Husbandry			**Animal Husbandry**	
Cows	200		Cows	100
Buffalos	1500		Buffalos	500
Bullocks	10		Bullocks	5
Sheep	150		Sheep	150
Goat	300		Goat	200
Camel	50		Camel	5
Infrastructure Facilities			**Infrastructure Facilities**	
Roads	Average		Roads	Average
Bus Services	Average		Bus Services	Good
Railway Services	3 Km, Kund		Railway Services	13 Km, Kund
Panchayat Office	Good		Panchayat Office	Good
Anganvadi	5		Anganvadi	3
Houses			***Houses***	
Hutments/Thatched	15%		Hutments/Thatched	20%
Concrete/Pucca	85%		Concrete/Pucca	80%
School	1- Govt. Senior Sec. School, 1- Govt. Girls Mid School, 1 – Pvt. School		***School***	1- Govt. Middle School 2 - Pvt. School
Post-Office	Yes		***Post-Office***	Yes
Health & Sanitation			***Health & Sanitation***	
Hospital/Clinics	1 - Ayurvadic Clinic, 2 - Pvt. Clinic		Hospital/Clinics	1 - PHC
Veterinary Hospital	1		Veterinary Hospital	1

1. **Village Profile Tankari**	
Distance from the District	22 Km
No. of Households	1101
Population	6505
Male	2090
Female	2008
Children	2407
Education Status	
Illiterate	5%
Primary	10%
High School	30%
Higher Secondary	30%
Graduation	15%
Technically Educated	10%
Occupation (House-hold)	
Agriculture	56%
Agriculture Labourers	28%
Other Labour	
Govt. job	15%
Pvt. Job	
Business	
Land-holdings	
Marginal Farmers (Less than 5 Acre)	51.32%
Small Farmers	3.63%
Small Farmers (5 to 10 Acre)	3.63%
Large farmers (Above 10 Acre)	1.36%
landless households	43.69%
Sources of Irrigation	
Bore Wells/ Open Wells	150
Cropping Pattern	
Rabi	Mustard, Wheat
Kharif	Bajra, Gwar, Gwari
Animal Husbandry	
Cows	150
Buffalos	300
Bullocks	4
Sheep	300
Goat	150
Camel	5

2. **Village Profile Khori**	
Distance from the District	13 Km
No. of Households	439
Population	4115
Male	2080
Female	2035
Children	-
Education Status	
Illiterate	5%
Primary	10%
High School	30%
Higher Secondary	30%
Graduation	15%
Technically Educated	10%
Occupation (House-hold)	
Agriculture	30%
Agriculture Labourers	35%
Other Labour	
Govt. job	35%
Pvt. Job	
Business	
Land-holding	
Marginal Farmers (Less than 5 Acre)	14.89%
Small Farmers	17.02%
Small Farmers (5 to 10 Acre)	17.02%
Large farmers (Above 10 Acre)	4.26%
landless households	63.83%
Sources of Irrigation	
Bore Wells	60
Cropping Pattern	
Rabi	Mustard, Wheat
Kharif	Bajra, Gwar, Gwari
Animal Husbandry	
Cows	100
Buffalos	300
Bullocks	4
Sheep	300
Goat	100
Camel	5

Infrastructure Facilities			Infrastructure Facilities	
Roads	Average		Roads	Average
Bus Services	Good		Bus Services	Good
Railway Services	10 Km., Bawal		Railway Services	1 Km, Khori
Panchayat Office	Good		Panchayat Office	Good
Anganvadi	2		Anganvadi	1
Houses			***Houses***	
Hutments/Thatched	15%		Hutments/Thatched	20%
Concrete/Pucca	85%		Concrete/Pucca	80%
School	1 - Govt. Senior Secondary School 3 - Pvt. School		***School***	1 – Govt. Primary School 1 - Govt. Senior Secondary School 1 - Pvt. School
Post-Office	Yes		***Post-Office***	Yes
Health & Sanitation			***Health & Sanitation***	
Hospital/Clinics	1 - PHC, 2 - Clinics		Hospital/Clinics	No
Veterinary Hospital	1		Veterinary Hospital	1

1. Village Profile Harzipur	
Distance from the District	15 Km
No. of Households	310
Population	1067
Male	307
Female	304
Children	465
Education Status	
Illiterate	20%
Primary	10%
High School	40%
Higher Secondary	15%
Graduation	10%
Technically Educated	5%
Occupation (House-hold)	
Agriculture	39%
Agriculture Labourers	
Other Labour	84%

Govt. job	
Pvt. Job	
Business	32%
Land-holding	
Marginal Farmers (Less than 5 Acre)	41.94%
Small Farmers (5 to 10 Acre)	9.68%
Large farmers (Above 10 Acre)	3.23%
landless households	45.16%
Sources of Irrigation	
Bore Wells/ Open Wells	30
Cropping Pattern	
Rabi	Mustard, Wheat
Kharif	Bajra, Gwar, Gwari
Animal Husbandry	
Cows	30
Buffalos	300
Bullocks	6
Sheep	20
Goat	10
Camel	10
Infrastructure Facilities	
Roads	Average
Bus Services	No
Railway Services	4 Km., Khori
Panchayat Office	Good
Anganvadi	No
House-holding	
Hutments/Thatched	30%
Concrete/Pucca	70%
School	1- Govt. Primary School, 1 – Pvt. School
Post-Office	No
Health & Sanitation	
Hospital/Clinics	No
Veterinary Hospital	No