

IMPACT EVALUATION OF WATERSHED PROGRAMS IN JAISALMER DISTRICT OF RAJASTHAN



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Central Arid Zone Research Institute

ISO 9001 : 2008

(Indian Council of Agricultural Research)

Jodhpur - 342 003 (Rajasthan)

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Road block by wind deposited sand: Pre-project severity was more



Wind deposited sand in a branch of IGNP: Pre-project severity was more

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Preface

Post project evaluation of any intervention/technology is essential to understand the overall impact of the intervention/technology for the intended objectives *vis-a-vis* to learn lessons for the future actions. Impact evaluation in case of watershed technologies is imperative to know an overall impact of soil and water conservation measures adopted in a particular watershed. It also helps in learning of the appropriateness of the methods employed in carrying out the project activities and to estimate the medium and long-term social and economic benefits of the activities as well as their efficiencies and impact in the context of stated objectives of the project. Keeping in view the importance of post project evaluation, Ministry of Rural Development, Department of Land Resources, Government of India, vide letter no. M. 11011/1/2008-M&E dated 6/3/2009, requested the Director, Central Arid Zone Research Institute, Jodhpur for evaluation of the micro-watershed projects executed under Drought Prone Areas Program/Desert Development Program/Integrated Wastelands Development Program in different parts of the Rajasthan state. A team of experts was constituted by the Director, CAZRI to carry out the assignment. In all 76 watersheds executed under different programs were evaluated. Of the total 76 watersheds, 30 watersheds are in Jaisalmer District of Rajasthan. This bulletin pertains to impact evaluation report of watersheds of Jaisalmer district only. The team visited Jaisalmer in different phases during the year 2013. In the first phase team visited 18 micro- watersheds executed by the Forest Department, while in the second phase it covered 2 micro-watersheds executed by the forest department and 10 micro-watersheds executed by the *Zila Parisad*, Jaisalmer. Mr. Pankaj Gupta, Range Forest Officer, Jaisalmer coordinated the evaluation activities from the forest department side, while Mr. Bhagirath Bishnoi, Executive Engineer (LR), *Zila Parisad*, Jaisalmer coordinated from *Zila Parisad* side. Mr. S.K. Saini, Range Forest Office (RFO)-Chhayan; Mr. Jagmal Singh, RFO-Lathi and Pokaran; Mr. Nakta Ram, RFO-Jaisalmer; Mr. Ram Dhan Meena, RFO-

Bharewala and their staff accompanied the CAZRI team to the spots of their respective micro-watersheds including the beneficiary villages. Mr. Jaimal Singh, Assistant Engineer; Shri Mahesh Gautam, Junior Engineer; Mr. Sukhwinder Singh, Assistant Engineer accompanied the team to spots of their respective watersheds executed by *Zila Parisad*, Jaisalmer including the beneficiary villages. The team interacted with Mr. Chhoga Ram Bishnoi, BDO Pokaran and other officers too. Besides physical evaluation of the watersheds, the team, using the structured questionnaire, additionally collected salient information by interviewing randomly but carefully selected sample beneficiary households representing differential patterns of caste, land holding and the disadvantageous group of the population in the micro-watersheds. The team was provided excellent support by the project officials and full cooperation by the beneficiary villages. Mr. S.P. Seth, Mr. S.K. Sankhla, Mr. Naveen Singh, Mr. M.S. Mertia, Mr. B.K. Soni and Mr. Hukam Singh of CAZRI provided the technical support.

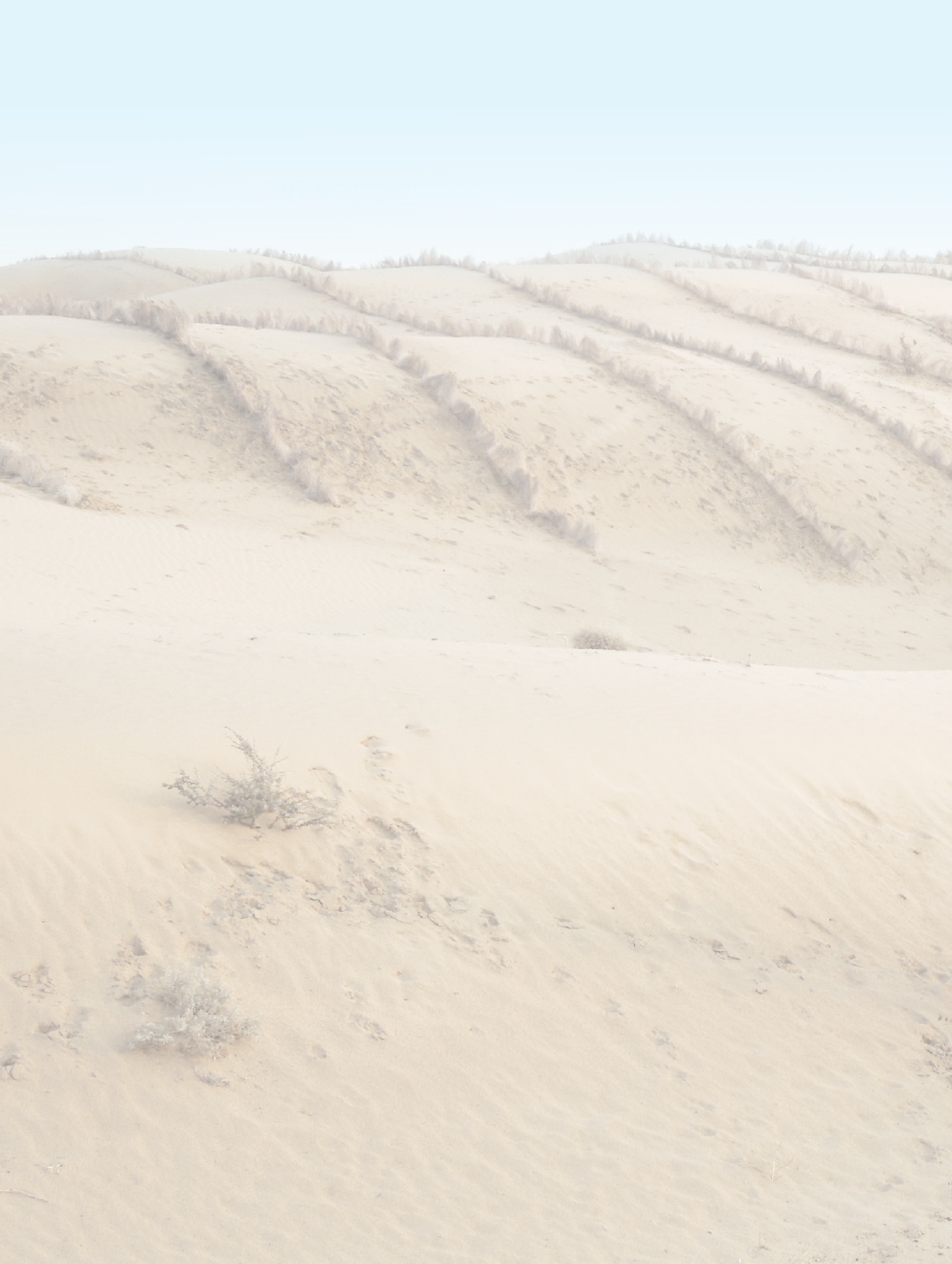
This work has received full support of Director CAZRI and with his approval the report was prepared and submitted to the Ministry of Rural Development, Department of Land Resources Government of India, New Delhi.

Authors

September, 2014
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JAISALMER DISTRICT AT A GLANCE

Origin

Jaisalmer was founded by King Jaisa or Jaisal. The word Jaisalmer is said to have been derived from a combination of words, Jaisal and Meru - A local name for Jaisal's fort. The present district is largely composed of the former Jaisalmer state, which was among the last Rajputana states to go under British protection. From 1844 to 1949, prior to merging of Jaisalmer into the state of Rajasthan, there was no important change in the area of the state. On October 6, 1949, the region was given the status of an independent district in Jodhpur division. At that time the district was divided into two sub-divisions namely, Jaisalmer and Bap, comprising five tehsils viz. Jaisalmer, Ramgarh, Sam, Fatehgarh and Bap. Both the sub-divisions were subsequently reduced to one and the five tehsils to two; the tehsils of Ramgarh, Sam and Fatehgarh were amalgamated with Jaisalmer tehsil.

In 1953, as a measure of economy and administrative convenience, the status of Jaisalmer was reduced from a district to that of a sub-division and was made a part of Jodhpur district. However, the district status was restored in 1954. At that time the district was divided into six tehsils viz., Jaisalmer, Pokaran, Ramgarh, Sam, Nachna and Fatehgarh. In 1962, Fatehgarh tehsil was abolished while in 1963 Ramgarh, Sam and Nachna tehsils were reduced to the status of sub-tehsils. The total number of villages in the district in 1991 was 578, which increased to 637 in 2001 census. After 1991 census, a new tehsil named Fatehgarh was formed by transfer of 25 *Patwar* circles from Jaisalmer tehsil. For the purpose of administration, the district is currently divided into two sub-divisions and three tehsils as given below:

Table 1. Administrative setup of Jaisalmer district

Name of sub-division	Name of tehsil	Total No. of villages in the tehsil
Jaisalmer	Jaisalmer	312
	Fatehgarh	110
Pokaran	Pokaran	215

Location and Size

Jaisalmer district lies along the International border on the western part of India and forms the major part of the Great Indian Desert. It lies between 26° 01' and 28° 02' north latitudes and 69° 29' and 72° 20' east longitudes. It is bounded on the west, north

and north-west sides by Pakistan and on the north-east side by Bikaner district. On the south lies the district of Barmer and on the east the district of Jodhpur. The area of the district is 3840100 km² and in terms of area it ranks first among the other districts in the state; it comprises 11.2% of the total area of the state and has an International boundary running to 471 km.

Physiography

The Jaisalmer district being a large part of the *Thar* Desert is almost sandy and arid. However, in the neighbourhood of Jaisalmer town within a radius of about 64 km the soil is stony containing numerous rocky ridges, and hard undulating plains with this exception the general nature of land in the district looks like a sea of sand dunes of different shapes and varying sizes. The biggest sand dunes are found in Ramgarh and Sam sub-tehsils. Most of these are stabilized and look like sandy hills. It is, however, interesting to note that even a little rain turns this waste area into greenery and good pasture. On the contrary in the sub-division of Pokaran the land is gravel stony and is locally known as '*Magra*'. There are also few low-lying hills in Pokaran tehsil. The height of these hills varies between 61 to 107 m above mean sea level and they are usually covered with *Ziziphus nummularia* (*Bordi*) and *Prosopis cineraria* (*Khejri*) trees.

Drainage

There is no perennial river in the district. However, among the few streams which flow around Jaisalmer, one is called '*Kakni*' which rises near village *Kotri* about 22 km south of Jaisalmer. It flows first towards the north and then turns west. Near *Rupsi* village it forms a lake known as '*Bhujjhil*'. However, during heavy rainfall, it deviates from its natural course and flows towards north for about 20 km where its water is harnessed by the '*Daiya*' dam. There are no natural lakes in the district. During the rainy season the water accumulates in several low lying areas and this is used for drinking and other domestic purposes. The underground water level in the district is very low with depth varying from 38 m to 46 m.

Climate

The district has an arid climate characterized by extreme dryness of air, large extremes of temperature and erratic meagre rainfall. The winter season from November to middle of March is followed by the hot season which extends up to the end of June. The south-west monsoon season is from July to the middle of September. The second

half of September to October end constitutes the post monsoon season. The annual average rainfall of the district is 212 mm. January is the coldest month with an average maximum temperature 21.7°C and the average minimum temperature 2.5°C. The western disturbances passing across north India in the cold season affect the weather of the district, which then experiences cold waves and the minimum temperature often goes 3-4°C below the freezing point. The summer season runs from April to June with peak maximum temperature 45°C. The Table 2 below gives average temperature and rainfall of the district during the past 50 years.

Table 2. Climatic features of Jaisalmer district

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C	21.7	25.1	30.6	36.2	39.6	38.8	35.7	34.0	34.4	34.1	29.0	23.5	31.89
Average low °C	2.6	5.5	11.4	16.9	20.6	22.0	21.5	20.4	19.2	15.2	8.4	3.5	13.93
Precipitation mm	1.5	3.0	2.7	21.0	8.9	15.1	60.1	75.8	17.6	2.4	1.5	2.4	212
Avg. precipitation days (≥ 0.1 mm)	0.6	0.8	0.7	0.8	0.9	1.3	3.5	2.8	1.5	0.5	0.4	0.6	14.4

Soil

Jaisalmer district has an immense variability of soil. Sediments from different rock sources and varied history of landscape evolution have given rise to a wide range of soils, like coarse aeolian sandy soils, the dune soils, interdune soils, the moderately fine textured clay soils, the gravelly skeletal soils and bare rocky outcrops. Generally most of the soils are prone to wind erosion/deposition and hence the surface at many places is highly hummocky. About 74.1% area of the Jaisalmer district is covered by coarse textured soil followed by medium textured soil (10.53%) and medium to moderately fine textured soil (5.32%). Other soils of the district include soils of *Khadin* area (0.7%), shallow gravelly/rocky soils of piedmont zone (3.17%), salt affected soils (0.51%) and soils of rocky hills and plateaus (5.71%).

Geology and Minerals

The important minerals of the Jaisalmer district are fuller's earth, clay, gypsum, limestone, yellow and red ochre and phosphorite. Though fairly large deposits of fuller's earth are available in the district, its quarrying is limited to *Mandau*, *Manda*, *Nadai* and *Ramgarh*. Gypsum is excavated at *Mohangarh*. Jaisalmer limestone is extensively used

for exquisite artistic work. Recent finds of phosphorite have also been reported near *Beermania*. This important mineral may prove to be of great value in the manufacturing of super phosphate fertilizers. Test drilling for oil and gas by the Oil and Natural Gas Commission is also in progress. The rock formation is mostly of granite and dolomite type. The main minerals found in the district are gypsum, bentonite, fuller's earth, clay, lime stone, dolomite and yellow clay. The district is also famous for its yellow marble.

Forest and Flora

The forest area cover in the district was 22408 hectares in the year 2000-2001, which increased to 23277 hectares in 2001-2002. There are not much forests in the district because of the dry climatic conditions. Due to the arid conditions prevailing in the district vegetation is very scarce. The vegetation in this area can be included in tropical thorn forest. Most of the flowering plants found in the area are shrubs and wild grasses, which however do not survive for more than a few months after the rains. The main plant species of trees are *Acacia nilotica*, *Acacia senegal*, *Azadirachta indica*, *Capparis aphylla*, *Capparis decidua*, *Commiphora mukul*, *Prosopis spicigera*, *Salvadora oleoides*, *Salvadora persica*, *Tecomella undulata* and *Ziziphus mauritiana*.

The shrubs include *Aerva tomentosa*, *Calotropis procera*, *Calligonum polygonoides*, *Euphorbia tirucalli*, *Gynandropsis pentaphylla*, *Haloxylon salicornicum*, *Mimosa rubicaulis* and *Trianthema monogyna*.

Immediately after good showers the area turns into green pasture where wild grasses grow in abundance. Important among these are *Aristida depressa*, *Pennisetum cenchroides*, *Cynodon dactylon*, *Cyperus longus*, *Chloris virgata*, *Chloris roxburghiana*, *Cenchrus catharticus*, *Dactyloctenium aegyptium*, *Panicum crusgalli* and *Panicum frumentaceum*.

Land Use Pattern

Land use in the district is typical to that found in an arid region. Most of the area is sandy and there is a high proportion of cultivable waste, which accounts for 66% and is scantily covered by desert shrubs. Sand dunes are common sight, which keep shifting due to the sandstorms. The forest cover in the district is at a very low level. Due to deficient rainfall and lack of water resource the forest area is only 1.17%; also the net area sown is only 14.24% of the total area of the district. The land use pattern of the district is given in Table 3.

Table 3. Land utilization pattern of Jaisalmer district

Land use	Geographical area (%)
Forest	1.17
Land not available for cultivation	13.21
Other uncultivated land	66.00
Fallow lands	5.38
Area under agriculture	14.24

Cropping Pattern

In *kharif* season, clusterbean is the major crop and during 2009-10 it occupied 50.7% of total cropped area with total production of 2576 tonnes. Second important crop of *kharif* season is pearl millet. During 2009-10 it shared 25.82% of total cropped area. Other important *kharif* crops are groundnut, mungbean and castor. During *rabi* season cropping pattern is dominated by cereals, oil seeds and pulses. Among cereals wheat is the major crop and in 2009-10 it occupied 1.72% of the cropped area. Among oil seeds, rapeseed and mustard are the major crops with 5.54% of the cropped area. In case of pulses, gram is the major crop of the *rabi* season and during 2009-10 it occupied 8.41% of the cropped area. Other crops of *rabi* season though of less significance are taramira, isabgol, cumin, barley etc. During 2009-10, total food grain production of the district was 33347 tonnes. Gram (19044 tonnes) was main contributor followed by wheat (12725 tonnes) and bajra (1115 tonnes). Among oil seeds, rapeseed and mustard and groundnut are the important crops and contributed 70.32 and 27.27% respectively to total oil seed production.

Irrigation

Due to absence of perennial streams and the depth of water table in wells too deep to be economically utilized for irrigation purposes, artificial irrigation on any significant scale is impracticable in the district. The agricultural production in the district therefore, completely depends on seasonal rains. However, *rabi* crops can be taken under conserved moisture in the *khadins*. On the completion of the *Indira Gandhi Nahar Pariyojna* (IGNP) large part of Jaisalmer district is expected to be covered by a canal irrigation network. On the completion of this project the existing pattern of economy in this desert region is expected to be completely transformed. During 2009-10, net irrigated area was 80020 ha, of this 55.63% was irrigated by canal (IGNP) and 32.8% by electric tube wells.

Animal Husbandry

The district is rich in cattle wealth. According to livestock census of 2007, total livestock population was 2838214 of which 12.29% were cattle, 45.93% sheep, 39.88% goats, 1.38% camel and the rest were buffaloes, horses and donkeys. In the absence of suitable conditions for agricultural operations, cattle breeding provides the single most important alternative source of livelihood for a majority of the rural population of the district even under normal conditions. The herds of cattle, camels, sheep and goats serve as the sole wealth of these people. These animals possess such traits that they can thrive in spite of the arid nature of the region.

The cow serves as a source of milk and its products like curd and ghee are supplied to the other districts. Bullocks are used for ploughing the harder type of land. The important breed of cattle found in the district is *Thar* locally known as Tharparkar and is predominantly bred in the eastern parts of the district. It is a dual-purpose breed, bullocks are good draught animals and cows have a high milk yield potential. The other purely milch breed is *Rathi*, and it is mostly found in the north-eastern parts. Camels are among the most useful domestic animals in the district. The Jaisalmer camels, forming a specific breed, are famous for their speed, hardiness, endurance and easy paces. They can go long distances without food and water.

Sheep rearing is the most important occupation of the maximum number of inhabitants. Sheep is reared mostly for the wool. Average type of sheep has a fairly good hump and generally medium grade of wool, though some flocks produce fine grade as well. The *Jaisalmeri* sheep also gives excellent mutton. Goats are also extensively bred in the district for milk and meat. *Marwari* and *Lohi* are the two important breeds of goat found in the district.

Population and Literacy

As per census of the year 2011, Jaisalmer district had a population of 672008, of which male population was 363346 and female 308662, with sex ratio of 849 females for every 1000 males. The district had population density of 17 inhabitants per km². Its population growth rate during the decade 2001-11 was 32.22%. The overall literacy rate of the district according to 2011 census was 58.04%. The literacy rate of rural and urban areas was 56.61 and 78.91%, respectively.

BRIEF HISTORY OF WATERSHED PROGRAMS

The idea of conservation of natural resources, land and water on watershed basis is not new. However, focused efforts on watershed management were started after 1983 when GOI launched model watershed projects with involvement of ICAR. Under this program 47 model watersheds were identified in different agro-climatic zones all over the country. Rajasthan state got its first model watershed during 1986-87 as *Jhanwar* model watershed (Distt. Jodhpur). The planning commission while emphasizing the role of local level planning in VIII Five Year Plan highlighted the role of drought prone and dryland areas in augmenting the food production of the country by adopting the watershed approach. Later to cover major dryland areas, National Watershed Development Program for Rainfed Area (NWDPPRA) was launched as a centrally sponsored program by GOI in 1990-91. This scheme covered all blocks where less than 30% area was irrigated. Two hundred four watersheds in 190 *Panchayat Samities* in the state have been covered under the scheme. The approach has been adopted as a national strategy for integrated and comprehensive development of drought prone and rainfed areas. Watershed Development Fund (WDF) has been established at NABARD with the objective of integrated watershed development in 100 priority districts of 18 states through participatory approach. To involve village communities in the implementation of watershed projects under all area development programs namely, Integrated Wastelands Development Program (IWDP), Drought Prone Areas Program (DPAP) and Desert Development Program (DDP), the guidelines for watershed development were adopted w.e.f. 1.4.1995, and subsequently revised in August 2001. The watersheds evaluated in Jaisalmer district were sanctioned under IWDP, DPAP and DDP. All these three programs had different objectives and strategies.

Integrated Wastelands Development Program

Integrated Wastelands Development Program (IWDP) has been under implementation since 1989-90. From 1st April 1995, the program is being implemented through watershed approach under the common guidelines for watershed development. The development of wastelands and degraded lands under the program was expected to promote the generation of employment in the rural areas besides enhancing the participation of people at all stages.

Objectives

The program was to fulfil the following objectives:

Developing wastelands/degraded lands on watershed basis, keeping in view the capability of land, site conditions and local needs.

Promoting the overall economic development and improving the socio-economic condition of the resource poor and disadvantaged sections inhabiting the program areas.

Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover.

Employment generation, poverty alleviation, community empowerment and development of human and other economic resources of the village.

Promoting the overall economic development and improving the socio-economic condition of the resource poor and disadvantaged sections inhabiting the program areas.

Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover.

Drought Prone Areas Program

Drought Prone Areas Program (DPAP) is the earliest area development program launched by the Central Government in 1973-74.

Objectives

The basic objective of the program was to minimize the adverse effects of drought on the production of crops and livestock and productivity of land, water and human resources thereby ultimately leading to the drought proofing of the affected areas. The program aimed at promoting overall economic development and improving the socio-economic condition of the resource poor and disadvantaged sections inhabiting the program areas through creation, widening and equitable distribution of the resource base and increased employment opportunities. The objectives of the program were addressed in general by taking up development works through watershed approach for land development, water resource development and afforestation/pasture development.

Strategy

The main features of the strategy were:

Area development programs to be implemented exclusively on watershed basis.

Program activities to be confined to the identified watershed of about 500 hectares and to be executed on a project basis spanning a period of four to five years.

Watershed project to be, as far as possible, co-terminus with village boundary.

Direct participation of the people in planning and development of watershed areas and maintenance of assets in the post project period.

Panchayati Raj Institutions have the right to monitor and review the program at district, block and village levels. They can also function as Project Implementation Agencies if they so desire.

Voluntary agencies to be given effective role in the implementation of the program particularly in motivating people, community organisation and training.

Desert Development Program

The Desert Development Program (DDP) was started both in hot desert areas of Rajasthan, Gujarat and Haryana and the cold deserts of Jammu & Kashmir and Himachal Pradesh in 1977-78. From 1995-96, the coverage has been extended to a few more districts in Andhra Pradesh and Karnataka. In hot sandy desert areas, sand dune stabilization and shelterbelt plantations were given greater weightage. On the other hand, in cold desert areas, since rainfall is negligible, crop cultivation and afforestation were taken up only through assured irrigation. In these areas the main activity was development of water resources by construction of channels for diversion of water flow from glaciers and springs to the fields and lift irrigation works in the valleys.

The program was reviewed in 1994-95 by a Technical Committee. The main reason identified by the Committee for below satisfactory results under the program was that area development was not taken up on watershed basis and the involvement of the local people was virtually non-existent, both in planning and execution of the program. Besides inadequacy of funds, non-availability of trained personnel and taking up of too many activities, which were neither properly integrated nor necessarily related to the objectives of the program, were also identified as contributory factors towards reducing the impact of the program.

Based on the recommendations of the Committee, new Blocks/Districts were included under the program. Comprehensive Guidelines for Watershed Development commonly applicable to different area development programs were issued in October 1994 and made applicable with effect from 1.4.1995. Subsequently, based upon the feedback received from the various stakeholders, revised guidelines were circulated in September, 2001. These guidelines are applicable for projects sanctioned during 2000-2001 and thereafter.

Rajasthan has distinct problems because of large tracts of hot arid (sandy) areas. In view of the problem of mobile sand dunes and their stabilization in ten districts of the state, special projects are under implementation under DDP since 1999-2000 for combating desertification by way of shelterbelt plantation, sand dune fixation and silvi-pasture development. These ten districts are Barmer, Bikaner, Churu, Jaisalmer, Jalor, Jhunjhunu, Jodhpur, Nagaur, Pali and Sikar.

Objectives

The major objectives of the program were:

To mitigate the adverse effects of desertification and adverse climatic conditions on crops, human and livestock population and combating desertification.

To restore ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover and raising land productivity.

To implement developmental works through the watershed approach, for land development, water resources development and afforestation/ pasture development.

Strategy

Prior to 31-3-95, the impact of the program was felt only in the areas actually treated by core activities. Growing population and poverty compounded the problem by increasing pressure on fragile ecosystems. Based on the recommendations of the Hanumantha Rao Committee, the major elements of the new strategy w.e.f. 1.4.95 were:

Area development under the program to be taken up on watershed basis only and a watershed development project of about 500 hectares would be the field unit for implementation over a period of four to five years. A watershed development project to cover a village, as far as possible.

However, in some sandy areas where it was not physically feasible to demarcate a watershed, program was to be implemented by adopting either a cluster of villages or an Index Catchment as the unit of planning.

Direct participation of the local people in planning and development of watershed project areas as well as in the maintenance of assets after the project is completed.

The Panchayati Raj Institutions were responsible for monitoring and reviewing the programme at district, block and village levels up to 2002-03. Under new HARYALI Guidelines applicable w.e.f. 1.4.2003, the Panchayati Raj Institutions would function as Project Implementation Agencies (PIA) for the Watershed Development Projects sanctioned during 2003-04 and thereafter.

Keeping in view the problem of sand dune stabilization in 10 districts of Rajasthan, special projects would be taken up for three activities namely sand dune stabilization, shelterbelt plantation and afforestation.

IMPACT EVALUATION OF WATERSHEDS IN JAISALMER

Methodology

Impact assessment study of micro-watershed project was carried out in Jaisalmer district of western Rajasthan. Twenty micro-watersheds executed by forest department and 10 micro-watersheds executed by *Zila Parisad* were selected randomly from 128 and 61 executed micro-watersheds, respectively. Thus, total 30 micro-watersheds were covered under the study. From each micro-watershed one village and from each village 5 beneficiaries were selected randomly. Thus total 150 samples beneficiary households were covered representing various castes/communities, land holding sizes etc.

Data were collected from the head of each household through a specially designed interview schedule supplied by the Ministry, focused group discussion, in depth interview etc. Besides primary data collection, block level and district level officials involved in the project were also contacted for detailed information in connection with the implementation of the programme. The selected watersheds are described below in Table 4 and 5 and their locations are shown in Fig. 1.

Table 4. Watersheds selected under forest department, world food program and desert national park

Range/Division	No. of watersheds selected	Name of watershed
Sam	2	Lunnar, Dabri
Chhayyan	4	Chhayyan-I, Loharki, Didoo-I, Tota
Dabla	2	Amarpura, Dhanwa-II
Pokaran	4	Sankdia, Padroda, Hajiron-ki-Dhani, Balad
Jaisalmer	3	Ramgarh, Bandha, Kalyanghat
Lathi	3	Chandan-I, Karmo-Ki-Dhani, Chandan-II
Desert National Park	1	Ramdeora
World Food Program	1	Nachna
Total	20	

Table 5. Watersheds selected under *Zila Parisad*

Panchayat samiti	No. of watersheds selected	Name of watershed
Jaisalmer	3	Bramsar, Kathori, Lanelmokala
Sam	3	Rahuka par (Dhanana), Kanoi-II, Loono-ki-Basti
Sankara	4	Narsinghpura, Baghthal, Sankara-I, Sankara-II
Total	10	

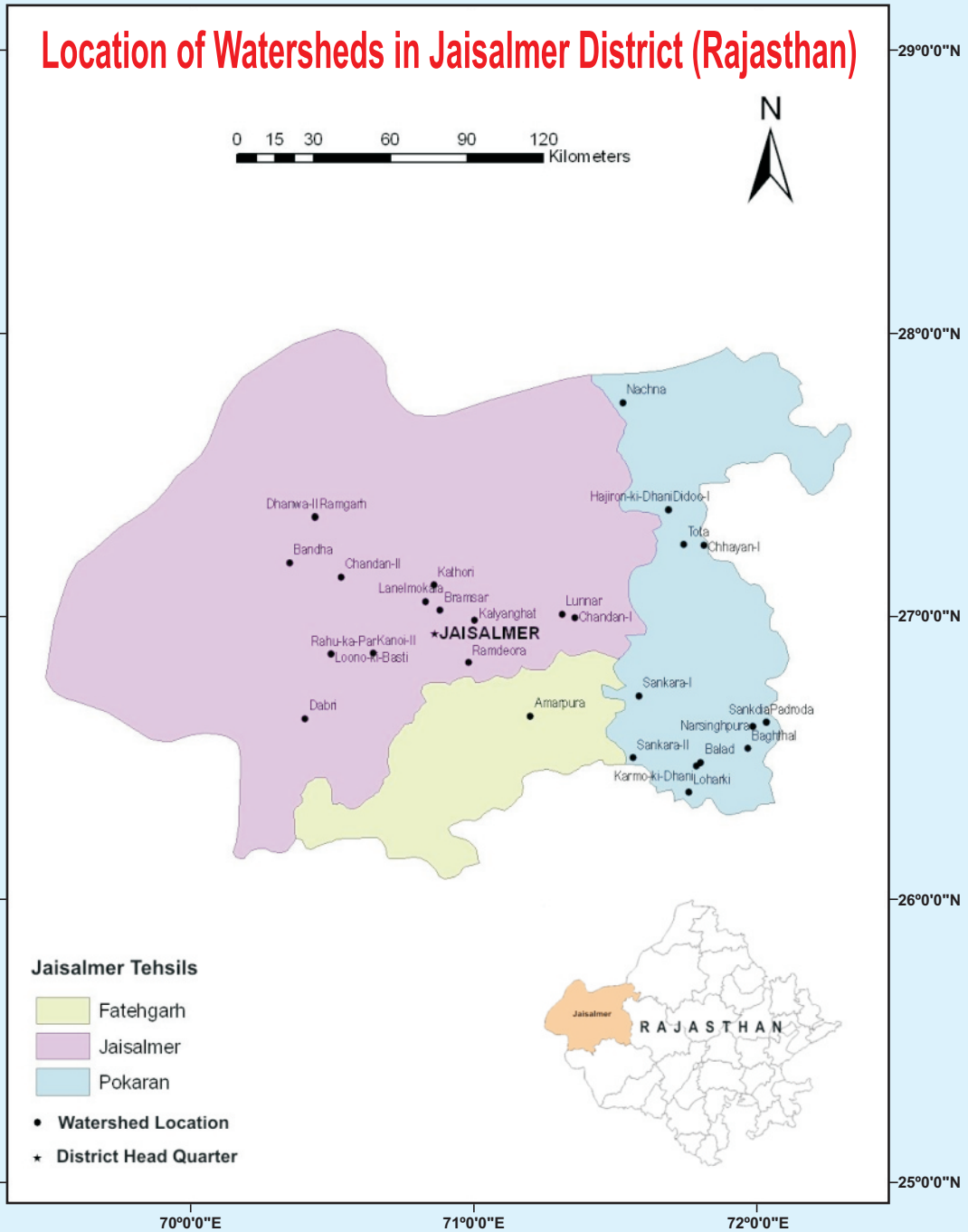


Fig. 1. Location of selected micro-watersheds in Jaisalmer district

Results and Discussion

Demographic and social status

Analysis of primary household level data revealed that 77.33% of the respondent households were headed by males and 22.67% by females (Table 6).

Table 6. Composition of population

Category	Respondents	
	Number	Percentage
Male	116	77.33
Female	34	22.67

Data regarding social status indicated that 34% of the households belonged to general category followed by muslims (28%), scheduled castes (14%), scheduled tribes (12%) and other backward castes (12%).

Educational status

Analysis of educational standard of the sample respondents revealed that 48% households were illiterate. The primary, middle, and secondary and above educated were 26.67, 12.66 and 12.67%, respectively (Fig. 2). Thus, maximum number of illiterate persons were in farming.

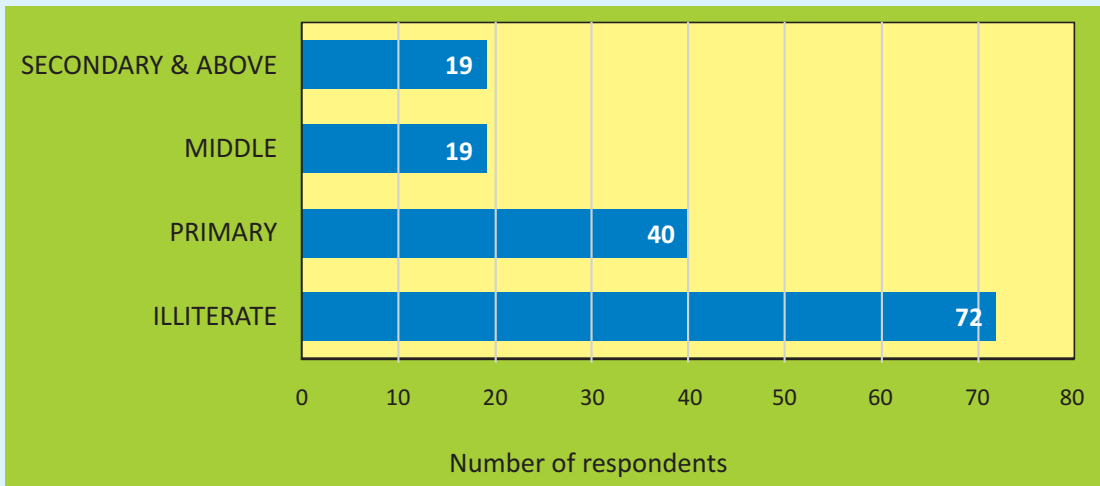


Fig. 2. Educational status of respondents

Distribution according to age

All the respondents were categorized in 3 age groups i.e. up to 30 years, between 31 to 50 years and above 50 years. Data presented in Table 7 showed that majority (46.67%) of the respondents were in the age group of 31 to 50 years followed by below 30 years (30%) and above 50 years (23.33%) respectively. Thus, maximum number of respondents belonging to middle age group were involved in farming.

Table 7. Distribution of respondents in different age groups

Age group (years)	Respondents	
	Number	Percentage
Up to 30	45	30.00
31 to 50	70	46.67
51 and above	35	23.33
Total	150	100.00

Occupational structure

Majority of the population irrespective of caste/community and land holdings was engaged in agriculture and allied activities. About 82.6% of the respondents were engaged in cultivation indicating that there was no other significant source of livelihood except agriculture. Thus economy of the district due to absence of industries and other employment opportunities was by and large based on agriculture only (Fig. 3).

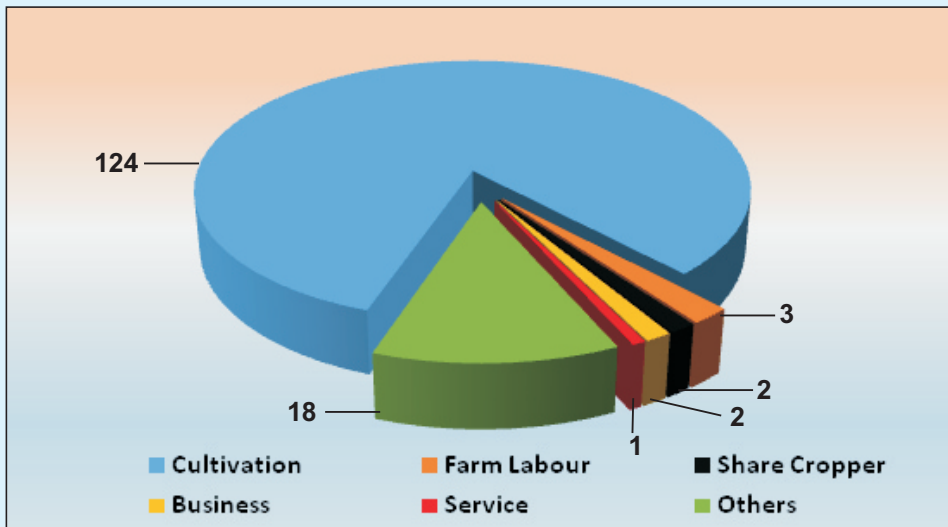


Fig. 3. Occupational structure of respondents

Micro-watershed and peoples' participation

Membership pattern in watershed activities presented in Table 8 revealed that 13.33% of the respondents considered as user groups were benefited with watershed activities. It was learnt that both the interest of farmers to form the self-help groups (SHGs) through micro-finance as well as the efforts made by the officials entrusted with the watershed activities had contributed to joining of SHG's by 19.33% respondents. The representation of BPL families in watershed committee was 10.66% only. The watershed committee had participation of 7.33% respondents and they were generally involved in decision making process of various activities.

Table 8. Type of membership of the respondents (multi response)

Membership type	Respondents	
	Number	Percentage
Users group	20	13.33
SHGs	29	19.33
Watershed committee	11	7.33
BPL	16	10.66

Land holding pattern

Analysis of data revealed that the average land holding that was 6.08 ha in pre-project period increased to 6.33 ha in post-project period (Table 9). In case of irrigated land holdings there was a slight increase only from 1.80 ha in pre-project to 1.84 ha in post-project period. The increase in land area was attributed to reclaiming effects of various measures taken through watershed activities.

Table 9. Land holding (ha) status

Type of land	Pre-project		Post-project	
	Total area	Average holding per respondent	Total area	Average holding per respondent
Agricultural land (A)	882.24	6.08	917.76	6.33
Non-agricultural land	397.76	2.74	401.12	2.76
Irrigated land (B)	261.92	1.80	267.68	1.84
Un-irrigated land (A-B)	620.32	4.28	650.08	4.48

Groundwater status

Though the number of wells did not change but there was a rise in water table by 23 ft, the depth changed from 262.5 ft to 239.5 ft from pre- to post-project period due to conservation measures adopted in the watershed area (Table 10).

Table 10. Water depth in wells

Features	Pre-project	Post-project
Number of wells in 30 villages	28	28
Average number of wells per village	0.93	0.93
Average water depth (foot)	262.5	239.5

Irrigation sources

There was no improvement in sources of irrigation especially the number of dug wells, tube wells, ponds etc. Rather, the number of dug wells and tube wells declined from pre- to post-project period. However, the number of *nallah* doubled from 7 to 14 (Table 11).

Table 11. Sources of irrigation

Source in thirty villages	Pre-project		Post-project	
	Number	Average per village	Number	Average per village
Dug well	8	0.27	7	0.24
Tube well	22	0.75	20	0.69
Pond	1	0.03	1	0.03
<i>Nallah</i>	7	0.24	14	0.48

Awareness of watershed program and its objectives

Majority of the respondents (64.10%) were aware about the watershed program. Regarding the objectives of watershed programs out of 193 responses 68 expressed that the main objective of the watershed program was to improve the availability of green fodder (Table 12). Thirty one respondents said that the objective was to improve the availability of wood for fuel. Checking soil erosion, storing water in reservoir, wood for making household furniture, increasing agriculture production and labour employment were the other objectives mentioned by the respondents, responses ranged in numbers from 20 to 11. We view that plantation by forest department on sand dunes which provided shade and fodder to animals, fuel to households and checked wind erosion has influenced the opinion of the respondents to a great extent. However, the respondents had expressed also that due to less interaction with the project staff and time constraints faced by them they could not gather in-depth knowledge about the objectives of the watershed program.

Table 12. Objectives of watershed (multi response)

Objectives	No. of respondents
Increasing agricultural production	11
Improving availability of fodder	68
Improving availability of drinking water for animals	13
Labour employment	11
Checking soil erosion	20
Shadow for animals	8
Wood for fuel	31
Wood for making household furniture	13
Check dam	1
Storing water in reservoir	17

Training

Training as a whole was an important component in micro-watershed activities for updating the knowledge about integrated development of the area. It was observed that the Project Implementing Agency (PIA) organized 26 training programs involving State Agricultural Department (Jaisalmer), Non-Government Agency (NGO), KVK-Jaisalmer and KVK-Mohangarh. These trainings were, however, poorly attended by only 14.67% of the respondents. The reasons for not attending the training programs as reported by the beneficiaries were primarily lack of awareness, domestic activities, and lack of time (Fig. 4).

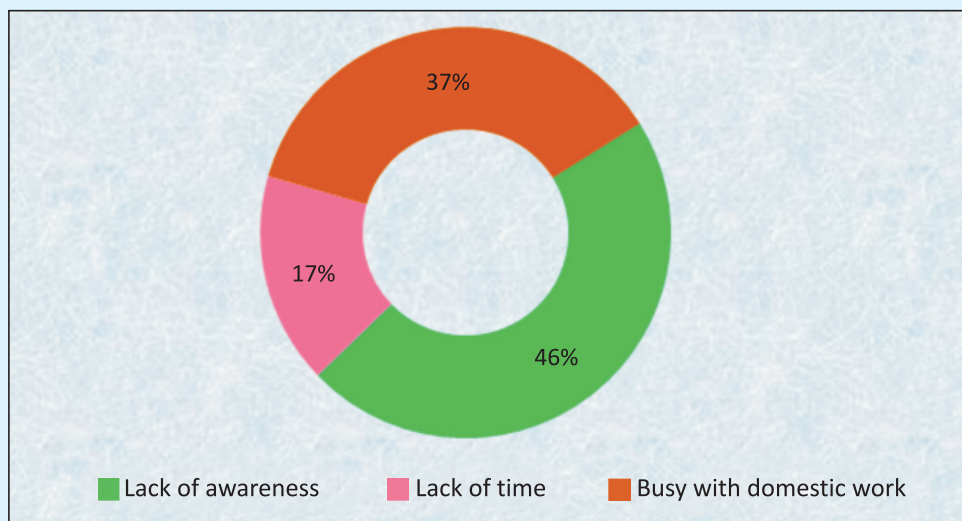


Fig. 4. Reasons for not attending training

Usefulness of watershed development program and mode of participation

Only 46.67% of the beneficiaries opined that execution of the watershed increased the availability of water in the area and helped in conserving soil moisture. In case of mode of participation in watershed activities 44% of the sample respondents said that they contributed their physical labour in watershed related activities, while 15.33% of the respondents reported their participation by providing some financial contribution. However, they did not reveal amount of actual contribution made.

Impact Assessment

Income generation, crop production and adoption of technologies

It was found that through micro-watershed activities the sample households generated income by livestock and crop production to the extent of +32.73% over the pre-project period average income. The pre-project average annual income was Rs. 38,153 which in post-project had increased to Rs. 50,641. Execution of watersheds increased the area, production and average yield of both *kharif* and *rabi* crops (Table 13). There was introduction of moth bean and castor as new crops in the area. These two crops were cultivated in 50.80 and 3.20 ha areas, respectively.

Table 13. Crop production and cropping pattern

Crop	Pre-project			Post-project		
	Area (ha)	Production (q)	Avg. yield (q ha ⁻¹)	Area (ha)	Production (q)	Avg. yield (q ha ⁻¹)
<i>Kharif</i>						
Bajra	320.32	2341.50	7.31	334.72	2693.00	8.05
Mung bean	5.50	35.60	6.47	132.34	1183.50	8.94
Moth	-	-	-	50.8	304.50	5.99
Guar	334.86	2176.60	6.50	376.48	2748.00	7.29
Til	78.24	191.00	2.44	67.52	207.24	3.06
Jowar	35.52	325.00	9.14	50.18	833.00	16.60
Groundnut	8.25	103.12	12.50	11.52	207.20	17.98
Castor	-	-	-	3.20	7.00	2.18
<i>Rabi</i>						
Mustard	57.12	495.00	8.66	70.24	788.00	11.21
Wheat	24.00	313.44	13.06	28.8	732.00	25.41
Cumin	13.12	99.71	7.60	16.32	169.40	10.37
Gram	15.60	127.90	8.20	18.88	206.50	10.93
Taramira	3.60	15.73	4.37	4.80	23.00	4.79

It was observed that with the adoption of high yielding varieties, yield increased by 6 to 14.67% during post-project period compared to 8.66% in pre-project period, while there was a decline in the use of local varieties during the same period. As a result of watershed activities increased use of chemical fertilizers was observed. In post-project period 16% respondents reported the use of chemical fertilizers compared to none in the pre-project period (Table 14). For the same periods manure users declined from 54.67 to 41.33%.

Table 14. Use of fertilizers

Type of fertilizer	Pre-project (No.)					Post-project (No.)				
	Yes	%	No.	%	Total	Yes	%	No.	%	Total
Chemical	0	0.00	150	100.0	150	24	16.00	126	84.00	150
Vermi-compost	31	20.67	119	79.33	150	29	19.33	121	80.67	150
Manure	82	54.67	68	45.33	150	62	41.33	88	58.66	150

The response of farm beneficiaries to the plantation of horticultural trees was not very encouraging as only 10% of them planted horticultural trees. In the total 678 horticultural trees planted the share of *Cordia myxa (Lasora)* was 53.09% followed by *Ziziphus mauritiana (Ber)* (44.7%). The share of citrus lime was only 2.21% (Fig. 5). Thus, *lasora* and *ber* were the only horticultural trees those had found favour with the beneficiaries.

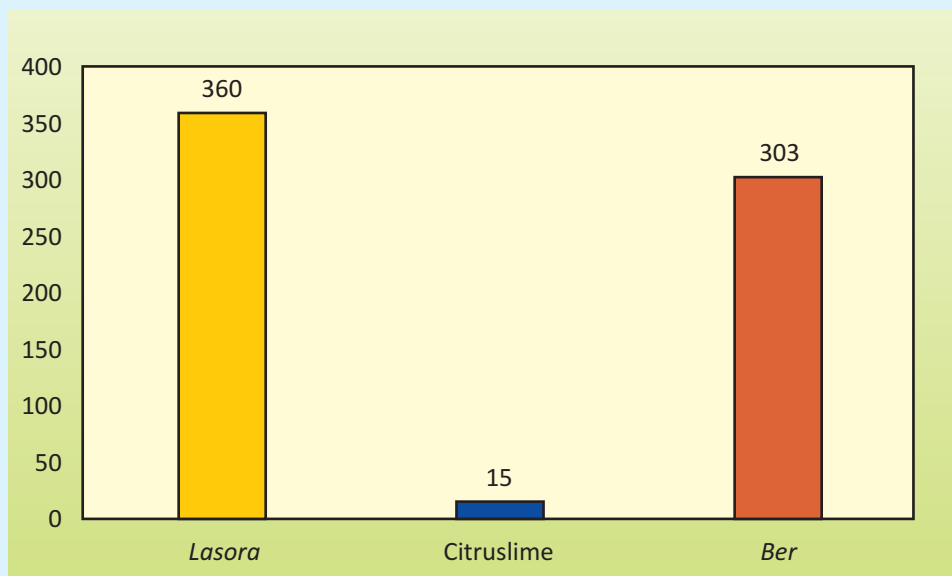


Fig. 5. Horticultural trees planted (multi responses)

Land, livestock, fodder, fuel and water table

The impact of watershed was quite significant on the availability of additional agricultural land, 24.67% respondents told that farm land under cultivation increased (Table 15). An additional area of 269.67 ha was brought under cultivation with introduction of micro-watershed activities. The positive impact was also evident on purchase of new livestock; 911 animals including cattle, buffaloes, camel, sheep and goat etc. were added in post-project period. With introduction of watershed, majority of the respondents reported that there was an increase in availability of fodder and fuel, and rise in water table. It was found that income and expenditure of individual farm families also increased during the period, which helped farmers to procure some permanent assets for household and agricultural activities. Use of mobile phones and other electronic gadgets increased with the enhanced income.

Table 15. Post-project Impact

Items		Type of response							
		Yes		No		No opinion			
More farm land under cultivation		37 (24.67)		96 (64.00)		17 (11.33)			
Number of cattle purchased & type	Cattle	100	30	560	200	6	15	911	
	Buffalo								
Fodder increased		Yes		No		No opinion			
		125 (83.33)		9 (6.00)		16 (10.67)			
Availability of fuel		127 (84.67)		8 (5.33)		15 (10.00)			
Water table increased		45 (30.00)		68 (45.33)		37 (24.67)			
Approximate water (feet)		< 20 ft. 21 (52.50)		> 20 ft. 19 (47.50)					
Household expenditure increased		Yes 69 (46.00)		No 60 (40.00)		No idea 21 (14.00)			
Percent increase in household expenditure		15% 19 (27.54)		20% 6 (8.70)		> 20% 9 (13.04)		No idea 35 (50.72)	
Additional area brought under cultivation [(Post-project)– (Pre- project)] (ha)		269.67							

Figures in parenthesis are percentage

Opinion of respondents on activities in future watershed programs

The beneficiary respondents were asked to express their opinion about the activities to be given more importance/emphasis in future watershed program in the

area under study. Their opinion reported in Table 16 revealed that 33.33% sample respondents favoured plantation of fruit and other trees followed by supply/arrangement to make seed and fertilizer available (27.38%), construction of tanka (18%), arrangement of drinking water for animals (16.66%) and arrangement of ration and fodder for animals (13.33%). The opinion of respondents regarding construction of *diggies*, construction of tube wells, fencing around field, generation of labour employment, construction of pond and arrangement of veterinary hospitals ranged from 8.67% to 4.66%. Some respondents also expressed their opinion about building of anicut, increase in height of dams and levelling of land, etc.

Table 16. Opinion of respondents about watershed program (multi responses)

Opinions	Respondents	
	Number	Percentage
Plantation of fruit and other trees	50	33.33
Arrangement of seed and fertilizer	41	27.38
Construction of <i>tanka</i>	27	18.00
Arrangement of drinking water for animals	25	16.66
Arrangement of ration and fodder for animals	20	13.33
Construction of tube wells	13	8.67
Construction of <i>diggies</i>	13	8.67
Fencing around fields	12	8.00
Generation of labour employment	10	6.67
Construction of ponds	9	6.00
Arrangement of veterinary hospitals	7	4.66
Building of anicuts	6	4.00
Need to increase height of dams	5	3.33
Levelling of land	4	2.67

PHYSICAL EVALUATION OF WATERSHEDS

Twenty micro-watersheds scattered across the Jaisalmer district, executed by the Forest Department, Jaisalmer, were physically evaluated by the team by visiting the sites along with the representatives of the department. It was observed that the main activity undertaken by the forest department under watershed development program in all the micro-watersheds was plantation of different tree species mainly *Acacia tortilis*, *Acacia senegal*, *Prosopis cineraria*, *Ziziphus numularia* and some other local tree species. The plantations were done mainly on mobile (active) sand dunes in different phases covering 20-25 hectare area at one site.

Micro windbreak of dead wood vegetation (mulching) of *Leptidinea pyrotica* in checkered board pattern was used in initial phase of the plantation to protect saplings from wind abrasion. On windward side a distance of 5 m was maintained between two lines, while a distance of 4 m was maintained across the direction of wind. However, on some low height sand dunes mulch was not applied. The survival percentage of trees varied from 75-85% in the various sites. Pastures had also been developed on these sites, but presently they were not visible as all of these sites were more than 10 years old. In general, it was observed that plantations were more successful on dunes than on flat lands/pediments. The main purposes of the plantation were to control movement of sand to cultivated fields and habitations (Fig. 6), to provide fuel wood to the beneficiaries' households and fodder to animals (Fig. 7), and these were largely achieved. At one location it was also reported that where proper sanitation facilities are not available, plantation also provided safer site for defecation to the residents of the villages, especially to the women.

Survey team also observed that for initial watering of plants and storage of water, "open circular *tanka*" of 8 ft diameter and 8 ft depth was constructed at many sites with given budget of Rs. 5000. Since these *tankas* were constructed temporarily for plantation, cement plaster of 1.5" thickness instead of stones was used for lining. At some sites where stones were used partially for construction of *tanka*, these have been taken away by villagers for personal use. Covered stone masonry *tankas* of about 15 m³ capacities were also constructed at few locations for the sole purpose of providing drinking water to forest guards and other persons engaged in the plantation work. Only in *Dabala* micro-watershed a farm pond, half-moon terraces and V-ditch were constructed for soil and water conservation. Beside *tanka* no other major engineering structure was observed in any of the micro-watershed during the survey.



Fig. 6. Chickpea during post-project: Growing good crop was difficult in pre-project period



Fig. 7. Fodder and fuel availability increased in post-project period

Though most of the work done by the forest department was undertaken in watershed projects but basically all the activities were done following “cluster” approach rather than truly “hydrologically” delineated watershed approach which was practically not present in the district. The overall performance of the work (mainly plantation) done by the forest department was very satisfactory.

Ten watersheds executed by the *Zila Parisad* (Land Resources), Jaisalmer were also visited by the team along with the *Zila Parisad* representatives. The district is divided in three regions i.e. Jaisalmer, Sam and Sankada. Three watersheds each in Jaisalmer and Sam and four watersheds in Sakanda were visited for the impact evaluation. The selection of sites by the *Zila Parisad* for the developmental activities was based on "cluster" rather than “hydrologically” delineated approach. The Jaisalmer district has flat topography (or very little slope) with sandy plains. The rainfall in the Jaisalmer district is very less (<250 mm) and because of little slope and sandy terrain, runoff potential is very less. The main activities undertaken through cluster approach were construction of *tanka* (20,000-25,000 litres capacity) and *khadins*. Vegetation components were missing in most of the watersheds. For construction of *khadins*, earthen embankment was used to concentrate runoff, however at 1-2 locations outlet of *khadins* were not observed. Groundwater recharge due to *khadins* could not be ascertained due to absence of wells/tube wells in the watershed areas. However, at one location in Sankada region (Sankada-II), recharge due to *khadins* could be verified due to the presence of well/tube well in the project area. The performance of watersheds varied with soil type and micro-climate of the region. In general, watersheds in Sankada region performed better in comparison to Sam and Jaisalmer regions. The team felt that there was a strong need to involve agronomy/forestry and social science specialists in planning and follow up phase for better impact and visibility of measures undertaken in watersheds. Since most of these watersheds undertaken for developmental activities were more than 10 years old, hence many of the activities undertaken during the execution phase had either been phased out or were not visible. It is therefore felt by the team that continuous minimum input is essential to maintain the momentum of the work in the watershed areas.

CONCLUSION

Based on the impact evaluation done it can be concluded that the impact of micro-watershed activities among the beneficiary households was quite positive. The representation of sample population in micro-watershed areas covered almost all the castes/communities. The economy of the district was primarily based on agriculture and among the sample population it was found that all the respondents were engaged in agriculture and allied activities. The participation of farmers in watershed areas was by and large satisfactory. However, the formation of Self Help Groups (SHGs) among the beneficiary households was not encouraging. This may be due to lack of knowledge of farmers about self-help group or lack of efforts by the officials. The SHGs could have been promoted among the beneficiaries for empowering especially the women.

The impact of micro-watershed activities was also seen in diversification of cropping pattern as moth bean and castor crops were the new introductions in the project area. After the introduction of watershed activities in the area under study, a sizeable amount of land had been brought under cultivation with the greater introduction of horticultural trees. It was found that the surroundings of micro-watershed areas were benefited through conserved moisture and rise in water table in irrigation wells. The sources of income also got new impetus by rearing of livestock. There was an increase in income of sample respondents through increased agricultural and livestock production.



Sand dune stabilization under watershed program



Tanka constructed under watershed program



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