NATURAL RESOURCES APPRAISAL FOR SUSTAINABLE DEVELOPMENT OF JUNA MITHA KHERA

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FOREWORD

The challenging task for the development of twelve villages of the arid Rajasthan into model villages using technologies developed by the Central Arid Zone Research Institute, Jodhpur was assigned to this Institute by the District Rural Development Agency, Government of Rajasthan. Juna Mitha Khera village of Barmer district is one of the twelve villages identified for sustainable development.

It is needless to emphasise that the appraisal, assessment and integration of natural resources is an essential pre-requisite for preparing action plans at the village, block, district or basin level. Therefore, an integrated natural resources survey of the village was carried out by the multidisciplinary team of scientists of CAZRI and an inventory of the resources was prepared. The potentials and limitations of the resources in the village, alongwith some suitable recommendations for sustainable development, have been highlighted in this report.

It is earnestly hoped that the report will form a sound basis to prepare a rational action plan for integrated development of this village and also help in providing some guidelines to the planners, policy makers and development agencies to chalk out action plans for villages of the district located under similar morpho-climatic conditions.

6.8.96

(A.S. FARODA)
Director

PREFACE

Researches on the physical, biological and socio-economic aspects of the Indian arid zone are being conducted at the Central Arid Zone Research Institute (CAZRI), Jodhpur, for last four decades. Based on the findings of these researches, suitable technologies for overall development of arid areas have been developed and tested at the farmer's field. The Institute also carried out integrated resources survey at the instance of the Government of Rajasthan, Gujarat, Punjab, Haryana and Karnataka and suggested plans for development at the village, block, district and basin levels. These suggestions have been and/or are being implemented through viable action plans by the concerned States for overall development of natural resources, including agriculture, horticulture, rangeland development, silvipasture, agroforestry, animal husbandry, surface and ground water development, etc.

Keeping in view the expertise of this Institute and various useful technologies developed, the District Rural Development Agency (DRDA) of Rajasthan assigned a challenging task to this Institute for the development of some identified villages located in Jodhpur, Nagaur, Jaisalmer, Bikaner, Pali and Barmer districts. The details of the project were discussed by the Director and the Scientists of CAZRI with the development officers of the concerned districts at a meeting held at CAZRI, Jodhpur, under the chairmanship of the Special Secretary, SS & IRD, Government of Rajasthan. The modalities of the project were then finalised. The financial assistance for the execution of the project in each village was provided by Government of Rajasthan.

However before undertaking the actual development work in the villages, an appraisal and assessment of their natural resources are of paramount importance. Accordingly, integrated survey of the natural resources viz., geology, geomorphology, soil, vegetation, surface water, ground water and present landuse, using cadastral map, aerial photographs, satellite imagery and survey of India topographical maps, was conducted in each of the identified village. The present report describes the results of integrated resources survey conducted in Juna Mitha Khera village of Barmer district.

A. Singh

(Surendra Singh)
Head of Division

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Patwari, village level workers and experienced and progressive farmers of the village deserve an appreciation for providing all possible help and information required by the members of the survey parties for various activities to be initiated for over all development of the village.

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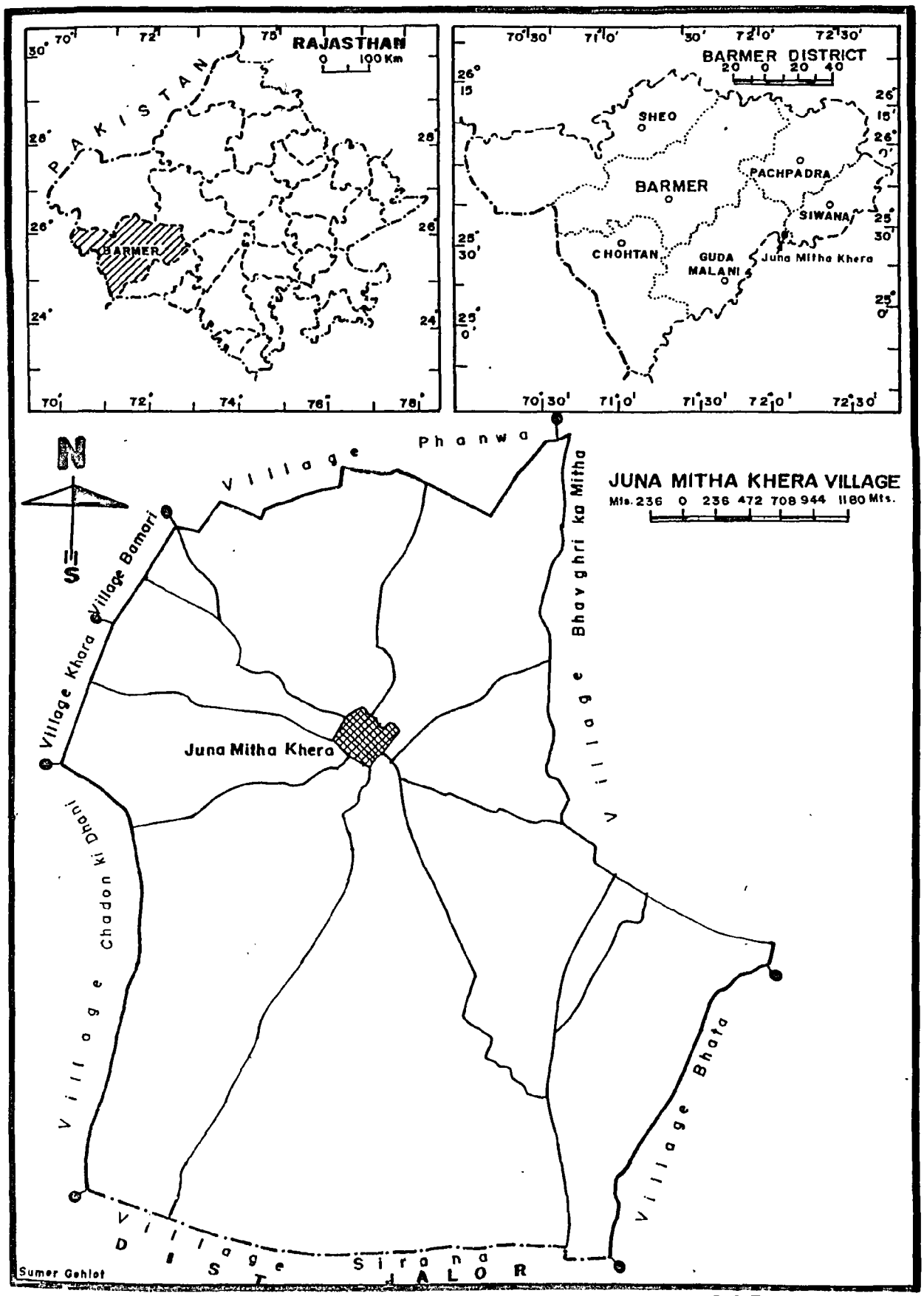
CHAPTER I

INTRODUCTION

Juna Mitha Khera village of Pachpadra tehsil, Barmer district has a total geographical area of 2039 ha. It is located between 25°27'50" to 25°31'28 N latitude and between 72°03'24" to 72°06'26" E longitude. The village is linked by a metalled road in south-west of Sindhari at 26 km distance. It has a common boundary with Dhanwa and Bamni village towards north, Bhata and Bhavgari-ka-Mitha villages towards east, Chandan-ki-Dhani and Khara villages in the west and Sirana village of Jalor district towards south (Fig. 1). The northern and south-eastern part is sandy plain whereas rest of the village area is covered by high dunes, most of them are under cultivation. The entire ecosystem is so nicely maintained that there is a good stand of trees and shrubs and the reactivation of sand is minimum. The village has 468 land holdings (Fig. 2). The size of larger holding comprising of marginal agricultural land, is 44 ha.

JUNA MITHA KHERA VILLAGE
LOCATION



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CHAPTER II

CLIMATE

Juna Mitha Khera village lies in the low and erratic rainfall zone. The average annual rainfall recorded at Pachpadra is 320 mm which is received in the month of July and August. May and June are the hottest months with mean maximum temperature of 41.9°C and 40.3°C, respectively. The mean minimum temperature during December and January is 10°C and 12°C, respectively. Some times for a short period, the minimum temperature reaches below freezing point and frost condition prevails. Agricultural droughts are common due to the adverse climatic conditions and natural hazards.

CHAPTER III

GEOLOGY

Geology of the village Juna Mitha Khera is concealed under a thick cover of wind blown sand of 9.8 to 30.5 m thickness. The rhyolite outcrop is exposed at the western vicinity of the village. In general, the Quaternary sediments comprising of windblown sand and older alluvium predominantly cover the entire village area. However, on the basis of dug-cum-bore wells observations, the water bearing formation is older alluvium comprising of sand, silt, clay and *kankar* in variable propotion. The mixed pyroclastic material of the rhyolite in the form of phenocrysts noticed in only two wells situated in western side of the village settlement. The geological succession is given in Table 1.

Table 1. Geological succession

Age	Period/System	Lithology
Quaternary	Recent	Wind blown sand, medium to fine grained, buff to grey in colour, well sorted and well rounded by wind action with minor bands of clay and *kankar*
	Sub-recent	Older alluvium, semi-consolidated silty sand with clay and gravel and often impregnated with lime *kankar*
----------Unconformity----------		
Pre-Cambrian	Post Delhi	Rhyolite consists of felsic lava flows along with pyroclastic and welded tuffs, compact and hard in nature having columnar joints and fractures

Source: Memoir GSI 114, 1984.

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GEOMORPHOLOGY

Juna Mitha Khera village has a dominantly sandy undulating terrain. Flat areas are very less. Five landform units have been identified and mapped in the village (Table 2, Fig. 3) and their salient characteristics are described below.

Rocky upland

A small, 3 m high rocky upland on rhyolite, covering 0.1 per cent area of the village, occurs along western boundary. Its present low height and denudation are due to extensive quarrying for building material. This unit generates some run off from its very small catchment.

Colluvial plains

A narrow, 60 to 90 cm deep colluvial plain surrounds the small rocky upland, covering only 0.6 per cent area of the village. The sediments are a mixture of angular rhyolite fragments and aeolian sand. The unit gives way to the deep alluvial plains at its distal end.

Deep flat sandy older alluvial plains

This unit occurs mainly in the central part of the village and covers its 7.6 per cent area. The sediment depth is more than 10 m, followed by a carbonate-rich silt and clay horizon which gives way to coarse riverine sand or calcrete further down the profile. Defused carbonates, however, occur throughout the profile. This unit has a mean grain size of 2.52 phi. It forms a backborne of the village in agricultural production, especially after a number of tubewells have been sunk during the last few years.

Sandy undulating older alluvial plains

This is the second largest unit of the village and is dominant in the north, as well as in a narrow strip between the dune-covered areas in the south. These plains, covering 33 per cent area of the village, have 1 to 3 m high sand streaks and sandy hummocks, mostly along the peripheries of the fields, but many are noticed within the field also. The dominant mean sand grain size of these plains is 2.74 phi. Flat areas of these plains are dominated by mean grain size of 2.60 phi. At few places, the height of the sandy undulations is 5 m or more. The undulations along the field boundaries have tree and shrubs which attract more sand, while those within the fields are regularly under the plough. Many tubewells have come up in the southern part of the village where the farmers are utilizing the unit for double cropping. Much of the area of this unit in the north is under the *kharif* monocropping, except a few plots with electrified wells. Potable ground water has been found in the central and southern parts at an

average depth of 100 m, especially in the riverine sand of palaeochannels. Although tractor is extensively used for ploughing, the landscape is less affected by wind erosion problems because of maintaining a good vegetation cover on the slopes of the higher sandy undulations, and sand dunes and keeping some plant residues in the crop fields.

Sand dunes and interdune plains

This is the largest unit in the village, covering its 58.7 per cent area, especially in the southern part. Coalesced parabolic dunes of 15 to 35 m height are the most dominant dune type. A small area of the village is occupied by transverse dunes in the western part of the village. The dunes are mostly stabilized and have a good cover of natural vegetation, including trees and shrubs (Plate 1). The mean grain size is 2.54 phi. Crestal reactivation is not very high. Small and narrow interdune plains occur in between the dune chains and most of them are undulating. The dune-interdune sequence is almost totally under cultivation of dryland crops, but has better natural vegetation cover than many dune-interdune sequence in Barmer region. Few wells have been now drilled to irrigate the interdune plains.

Table 2. *Landform units*

Landforms units	Area (ha)	(Percentage)
Rocky upland	1.3	0.1
Colluvial plains	13.0	0.6
Deep flat sandy older alluvial plains	155.4	7.6
Sandy undulating older alluvial plains	671.7	33.0
Sand dunes and interdune plains	1197.4	58.7
Total	2039.0	100.0

CHAPTER V

SOILS AND LANDUSE CAPABILITY

The entire area of the village has been mapped under two soil series and their phases (Fig. 4). The salient characteristics of these soils series are described below.

Dakhan series

These soil series are members of sandy, mixed, hyperthermic family of Psammentic Haplocambids. The surface soils are pale brown (10 YR 6/3 d) and brown (10 YR 5/3 m); loamy fine sand, fine sand and non-calcareous. These soils are more than 150 cm deep. The Dakhan soils are associated with sandy hummocks of variable height and have been degraded by moderate wind erosion/deposition (Plate 2). Soils under irrigation have high sodicity. The physico-chemical characteristics of the typical soil profiles are presented in Table 3.

Table 3. Physico-chemical characteristics of Dakhan series

Depth (cm)	pH	EC (dSm^{-1})	$CaCO_3$ (%)	Gravels (%)	Particle size distribution (%)				ME (%)	WHC (%)
					Clay	Silt	Fine sand	Coarse sand		
					Dakhan (Khasara No. 27)					
0-20	8.95	0.29	0.42	Nil	4.3	2.3	86.3	6.6	5.1	24.9
20-55	9.12	0.27	0.33	Nil	4.3	6.5	82.6	6.1	7.7	24.2
55-90	9.20	0.32	0.24	Nil	5.2	6.7	80.8	7.4	6.5	23.9
					Dakhan hummocky (Khasara No. 270)					
0-20	9.24	0.34	0.43	Nil	5.8	3.1	79.0	11.1	7.8	23.4
20-60	9.44	0.39	0.31	Nil	8.4	6.5	75.5	8.4	10.4	30.2
60-90	9.42	0.45	0.78	Nil	6.8	6.5	78.0	7.0	8.3	32.3

Range in characteristics: The soils are pale brown (10 YR 6/3) and brown (10 YR 5/3). These soils are fine sand at the surface and loamy fine sand in subsoil. But in hummocky and highly hummocky phases the solum is uniformly fine sand in texture. Such soils are more than 150 cm deep.

Dakhan variant

These soils differ from the soils of Dakhan series as they have more silt and clay and qualify for sandy loam and loam texture below 20 cm depth. The colour of such soils is also darker i.e. (10 YR 5/3 brown d) than the Dakhan series. These soils are non-calcareous and

very deep. The physico-chemical characteristics of a typical soil profile are given in Table 4.

Table 4. Physico-chemical characteristics of Dakhan variant

Depth (cm)	pH	EC (dSm^{-1})	$CaCO_3$ (%)	Gravels (%)	Particle size distribution (%)				ME (%)	WHC (%)
					Clay	Silt	Fine sand	Coarse sand		
0-20	8.48	0.34	1.26	Nil	6.7	6.5	70.4	14.2	8.8	31.8
20-60	8.52	0.43	1.09	Nil	9.9	15.7	62.3	9.0	13.2	34.4
60-80	8.81	0.35	0.30	Nil	11.7	13.9	62.4	9.2	14.6	30.0
80-130	8.87	0.30	0.87	Nil	10.8	9.8	67.7	9.1	12.9	22.1

Fertility status: In Dakhan soils, the values of organic carbon in 54 per cent samples ranged from 0.10 to 0.17 per cent (mean value 0.128%) and in 33 per cent samples from 0.02 to 0.09 per cent (mean value 0.063%). Nearly 75 per cent samples of hummocky and highly hummocky phases of Dakhan soils contained 0.06 to 0.09 per cent organic carbon (mean value 0.073%). In normal and hummocky soils, the available potassium was in the range of 138 to 270 kg/ha (mean 172.6 kg/ha). The available phosphorus was very low in surface (mean 6.7 kg ha^{-1}) and subsoil (5 kg ha^{-1}). The available phosphorus in 62 per cent surface soils ranged from 3.1 to 7.0 kg ha^{-1} and in 85 per cent subsoils from 8.8 to 7.0 kg ha^{-1}. In 38 and 15 per cent surface and subsoil samples, respectively, the available phosphorus was in the range of 7 to 8 kg ha^{-1}.

Irrigation water quality and effect on soil characteristics: The analysis of irrigation water and the irrigated soils of Dakhan series (Table 5) revealed that the soils have developed high sodicity. The soils of Dakhan series are being irrigated by moderately saline (EC 2.49-5.75 dSm^{-1} water containing high residual sodium carbonate (6.6-12.1 me L^{-1}) and high sodium adsorption ratio (33.9-49.8). Soils irrigated with these waters have high pH_2 (9.15-9.45) and crusted surface, while the unirrigated soils have normal range of pH_2 (7.97-8.75) and no crust formation. If irrigation with these waters is continued without proper management, there will be serious problem of soil sodicity, soil compaction and reduced infiltration which will lead to severe land degradation.

Table 5. Effect of irrigation water on characteristics of Dakhan series soil

Site No.	Name of the farmer	*Khasara* No.	Irrigation				Irrigated soils	
			EC (dSm^{-1})	RSC	SAR	pH	EC (dSm^{-1})	Soil texture
Dakhan								
1	Ganesh Ram Chaudhary	304	3.17	9.2	36.1	8.48	0.34	lfs
5	Jagmel	329	3.56	9.1	42.6	9.23	0.32	lfs
6	Ganeshji Suthar	375	5.75	3.0	34.0	9.25	0.23	lfs
7	Udhara Ram	325	6.72	0.0	33.9	9.13	0.67	fs
17	Ratna Ram	33	4.97	9.0	46.0	9.19	0.25	fs
18	Bhura Ram	53	4.55	12.1	49.8	9.15	0.32	fs
23	Durga Ram	27	6.53	6.6	48.9	8.95	0.29	fs
24	Durga Ram	27	6.53	6.6	48.9	9.15	0.29	fs
25	Durga Ram	27	6.53	6.6	48.9	9.18	0.25	fs
30	Sona Ram	389	4.37	7.9	44.7	8.85	0.19	fs
Dakhan hummocky								
12	Lumba Ram	270	2.49	9.0	35.0	9.44	0.39	fs
13	Lumba Ram		2.49	9.0	35.0	9.18	0.19	fs
14	Durga Ram	632	5.35	8.9	43.8	9.23	0.27	fs
15	Durga Ram	632	5.35	8.9	43.8	9.18	0.15	fs
Dakhan highly hummocky								
27	Dungar Ram	9	4.10	9.2	45.7	8.95	0.31	fs
Unirrigated soils								
11	Budaraji (hu_1)	214	-	-	-	8.35	0.65	fs
16	Budaraji (hu_0)	318	-	-	-	8.75	0.42	fsl
19	Bhura Ram	53	-	-	-	7.97	0.07	fs

Distribution and extent: Soils of Dakhan series occupy 1064 ha (52.2%). Out of which, 317.9, 91.4 and 93.4 ha area is under hummocky, highly hummocky phases and Dakhan variant, respectively.

Interpretation: The Dakhan and Dakhan variant soils are very deep and of coarse to medium texture. The available water capacity of these soils range from 106 to 160 mm per metre depth. These soils, have good rooting depth for all the crop grown in the area and also for natural vegetation. The hummocky and highly hummocky soils are prone to wind erosion/deposition problem. The brackish ground water containing high residual sodium carbonate is hazardous and likely to have deleterious effect on crop growth and yield. Consid-

crable area of Dakhan soils is under irrigated agriculture and reasonable yields of *isabgol*, cumin and mustard are being obtained from them. Major constraints and management re quirement of different mapping units of Dakhan series are presented in Table 6.

Table 6. Major constraints and management requirement of Dakhan series soils

Mapping unit	Area	Major constraints	Landuse capability	Management requirement
Dakhan-variant-lfs-d5 / A-e_1	93.4	Coarse/medium textured soils irrigated with brackish water	IIIc	Efficient irrigation system with gypsum application
Dakhan-fs-d5 / A-e_1	421.7	Fine sandy soils having high water percolation rate, irrigated with brackish water	IIIcs	Efficient water management for irrigation with gypsum application
Dakhan-fs-d5 / B-e_2	78.3	Fine sandy soils having high water percolation rate, irrigated with brackish water	IIIcsea	Efficient water management for irrigation with gypsum application
Dakhan-fs-d5 / B/C-e_2	61.3	Fine sandy soils, high water percolation, moderate wind erosion and sand sheeting	IVcsea	Agroforestry under rainfed, judicious irrigation with gypsum application and plantation of *ber* and *anar* in combination with crops
Dakhan-hu_1-fs-d5 / B-e_2	317.9	Fine sandy soils with scattered hummocks on the surface, moderate soil erosion, uneven surface at places	IIIcsea	Agroforestry under rainfed, shrubs and grasses on the field fencing and hummocks
Dakhan-hu_2-fs-d5 / B/C-e_2	91.4	Fine sandy soils, highly hummocky uneven surface	IVcsea	Suited for silvipastures and occasional cultivation with suitable conservation measures

Thus 837 ha area of the Dakha series is well suited for irrigated cropping whereas 152.7 ha requires conservation measures to control wind erosion/deposition by growing bushes/grasses on the hummocks and adopting minimum tillage.

Dune complex

The dune soils are member of the mixed, hyperthermic family of Typic Torripsamments. The dune soils are pale brown (10 YR 6/3), fine sand and slight calcareous. These soils are very deep, having undulating surface and very low available water capacity (50-60 mm/metre). But because of porous sandy strata, the rain water moves in the solum and moisture in deeper zones is available to trees. The physico-chemical characteristics of a typical soil profile are presented in Table 7.

Table 7. Physico-chemical characteristics of the dune soils

Depth (cm)	pH	EC (dSm^{-1})	$CaCO_3$ (%)	Gravels (%)	Particle size distribution (%)				ME (%)	WHC (%)
					Clay	Silt	Fine sand	Coarse sand		
Dune (Khasara No. 160)										
0-20	9.23	0.23	2.36	Nil	2.5	3.2	87.3	4.0	4.2	25.4
20-50	9.21	0.19	1.40	Nil	1.5	3.2	84.7	8.2	3.6	20.6
50-100	8.97	0.10	1.13	Nil	1.6	3.2	85.9	8.0	3.2	22.2
Dune (Khasara No. 278)										
0-20	8.16	0.11	1.83	Nil	5.1	1.4	70.6	20.6	2.9	22.5
20-60	8.09	0.07	1.83	Nil	3.5	3.2	72.8	18.4	3.2	19.7
60-100	8.18	0.08	2.10	Nil	4.3	2.4	67.7	22.6	3.6	20.9

Range in characteristics: The soils through out the village are uniformly pale brown (10 YR 6/3), fine sand and very deep. The surface is uneven and has sand veneer of variable thickness.

Distribution and extent: The dune soils cover 922 ha (45.2%) area of the village and occur in the southern and the south-western parts of the village.

Fertility status: These soils are very low in organic carbon and 67 per cent samples showed organic carbon in the range of 0.02-0.08 per cent with mean value (0.05%). Available potassium was medium in 63 per cent samples in the range of 101-138 kg ha^{-1} with mean value (120 kg ha^{-1}). Nearly 37 per cent samples had low available potassium ranging from 78 to 84 kg ha^{-1} with mean value (84 kg ha^{-1}). The available phosphorus was very low in surface (4.2-8.1 kg ha^{-1}, mean 6.6 kg ha^{-1}) and in subsoil (3.1-3.4 kg ha^{-1}, mean 3.3 kg ha^{-1}).

Interpretation: The dune soils are not suitable for agriculture. However, these may support a good stand of trees, shrubs and grasses (Plate 3) due to which the sand bodies are stable and

reactivation of sand is only near the village habitation. Recently a number of wells have been bored and water is available for irrigation. This water is being used for raising *isabgol*, cumin and mustard crops using sprinkler method of irrigation. But the water contains high RSC and soils have turned alkaline (Table 8). While growing irrigated crops, there should be minimum

Table 8. Effect of irrigation water on characteristics of dune complex soils

Site No.	Name of the farmer	Khasara No.	Irrigation			Irrigated soils		
			EC (dSm^{-1})	RSC	SAR	pH	EC (dSm^{-1})	Soil texture
Dune complex								
8	Maga Ram	128	2.83	8.60	31.1	9.19	0.19	fs
9	Uka Ram	151	3.58	11.0	43.9	9.22	0.21	fs
10	Lumba Ram	160	2.81	4.50	20.5	9.23	0.23	fs
Unirrigated soils								
22		278	-	-	-	8.16	0.11	fs

use of heavy machinery for soil manipulation. the constraints and management requirement of different mapping units are given in Table 9.

Table 9. Major constraints and management requirement of Dakhan soils

Mapping unit	Area (km^2)	Major constraints	Landuse capability	Management requirement
DC-fs-d5 $\frac{}{B/c(comp.)-e_2}$	421.1	Uneven surface, sandy soil, prone to wind erosion	VIcsea	Silvipasture and conservation farming. Minimum tillage for raising *isabgol* and cumin, wherever irrigation water is available
DC-fs-d5 $\frac{}{C/D-(comp.)-e_2/e_3}$	233.0	Uneven surface, sandy soil, at places moderate to severe sand reactivation	VIIcsea	Silvipasture, wind erosion control by providing mulches and minimum soil tillage
DC-fs-d5 $\frac{}{C/D-e_2/e_3}$	268.2	Uneven surface, sandy soil, at places moderate to severe sand reactivation	VIIcsea	Silvipasture, wind erosion control by providing mulches and minimum soil tillage

CHAPTER VI

VEGETATION

Vegetation of Juna Mitha Khera village on different landforms and different landuses (Fig. 5) is described below.

Sand dunes

The sand dunes with their activated tops covered with fresh sand supported a tree shrub cover of *Prosopis cineraria* (69 plants/ha) *Acacia jacquemontii* (10 plants/ha) alongwith *Aerva pseudotomentosa* (500 plants/ha), *Leptadenia pyrotechnica* (60 plants/ha) *Calotropis procera* (19 plants/ha),*Crotalaria burhia* and *Panicum turgidum* (10 tussocks/ha). Here, some regeneration in *Prosopis cineraria* (110 plants/ha) was also noticed. Such vegetation is generally characterised by all the dunes except those in the south-central part of the village. Here, especially in *khasra* numbers 170,171,115,116 dune fields supported *Acacia senegal* (30 trees/ha) *Tecomella undulata* (20 trees/ha) and *Maytenus emarginata* alongwith *Aerva pseudotomentosa* and *Calotropis procera*.

Most of these dunes are cultivated in *kharif* season and in rest of the year they are used as grazing ground.

Low dunes and hummocks had predominance of *Acacia jacquemontii* (40 plants/ha), *Aerva pseudotomentosa* (500 plants/ha), *Sericostoma pauciflorum* (1460 plants/ha) and *Crotalaria burhia* (2280 plants/ha). However, there was significant number of trees of *Prosopis cineraria* (25 trees/ha), *Tecomella undulata* (30 trees/ha) and shrubs of *Calotropis procera* (20 plants/ha), *Ziziphus nummularia* (110 plants/ha), *Leptadenia pyrotechnica* (60 plants/ha), *Lycium barbarum* (10 tussocks/ha).

Sandy undulating interdune plains

This landform unit supported a fair density of *Prosopis cineraria* (50 plants/ha), *Tecomella undulata* (20 plants/ha), and *Calotropis procera* (10 plants/ha) (Plate 4). Presence of younger *T. undulata* (40 plants/ha) confirmed its regeneration on these situations. These plains, mainly sandy in nature had greater density of *Capparis decidua* (110 plants/ha), followed by *Prosopis cineraria* (30 plants/ha) and *Ziziphus nummularia* (20 plants/ha) amongst woody perennials. However, amongst shrubs *Aerva pseudotomentosa* (570 plants/ha) and *Calotropis procera* (70 plants/ha) were major associates. *Balanites aegyptiaca* was also present, occassionally. Herbaceous vegetation at these sites comprised of *Aristida mutabilis, Cyperus arenarius, Convolvulus microphyllus*, and *Arnebia hispidissima*, altogether constituting 2 to 3 per cent cover.

Weeds in the crop field were mainly *Cyperus rotundus, Trianthema portulacastorum, Pulicaria ungustifolia* and *Convolvulus microphyllus.*

Condition of vegetation

Vegetation on most of the habitats has optimum expression in terms of height and crown spread. All the tree species had height in the range of 3 to 4.5 m and crown cover 11 to 22 m^2. (Table 10). Even the woody shrubs of *Acacia jacquemontii* had 3 to 4 m height and cover of 16.2 m^2. *Leptadenia pyrotechnica, Capparis decidua* and *Calotropis procera* had canopy spread 1 to 3 m^2. *Ziziphus nummularia, Lycium barbarum, Sericostoma pauciflorum* and *Crotalaria burhia* had less than 1 m height and upto 1 m^2 cover spread. Flourishing habit of *Aerva pseudotomentosa* (1.5 m height and 0.9 m^2 cover) indicated occurrence of fresh sand, such as on crests.

There are as such no grazing lands. But the fallow lands are used as grazing ground. These areas support good stands of *Panicum turgidum* and *P. antidotale.* These alongwith crop weeds mentioned above constitute the grazable material. Important species encountered in the village are given in Table 10.

Table 10. Vigour of vegetation

Species	Height (m)	Cover (m^2)
Trees		
Acacia senegal	4.5	17.4
Prosopis cineraria	4.4	15.5
Tecomella undulata	4.0	11.2
Acacia tortilis	3.5	22.0
Shrubs		
Acacia jacquemontii	3.2	16.2
Calotropis procera	2.0	2.5
Ziziphus nummularia	0.4	2.5
Leptadenia pyrotechnica	1.3	1.3
Lycium barbarum	0.6	0.3
Capparis decidua	1.3	2.5
Under Shrubs		
Aerva pseudotomentosa	1.5	0.9
Sericostoma pauciflorum	0.5	0.6
Crotalaria burhia	0.7	0.6
Perennial Grasses		
Panicum turgidum	1.0	1.4

CHAPTER VII

SURFACE WATER

The surface water resources in the village are very poor due to low and erratic rainfall, sandy and dune complex terrain and high evaporation and seepage losses. Most of the activities in the village are, therefore, based on ground water resources. There are eleven *nadis* in small and medium size groups located mostly in the interdune plains near the foot of the dunes (Fig. 6). Total storage capacity of *nadis* is nearly 1,36,520 m^3 and used mainly for animal drinking and bathing. The stored water lasts for only 0.5 to 5 months due to high seepage losses from their permeable sides and bottom and high evaporation losses from free water surface. However these *nadis* are very useful for recharging the depleted aquifers in the zone of their influence. Some of the *nadis* have received large amount on sediments due to degradation in their catchments and stored water lasts only from 15 to 30 days after rainy season (Plate 5). The stored water in *nadis* is having pH 8.6 and EC 240 μScm^{-1}. The capacity and the other characteristics of the existing *nadis* are given in Table 11.

Table 11. Present status of *nadis* and their characteristics

Location *(Khasra No.)*	Water spread area (m^2)	Capacity (m^3)	Dependency (months)
12	16,600	8,300	1-3
75	6,200	3,100	1-2
108	38,000	47,500	2-5
167	11,200	5,600	2-3
173	35,000	26,200	2-4
233	12,500	6,250	1-3
253	4,900	2,450	1-2
264	6,100	3,050	0.5-1
261	38,400	30,720	2-4
269	2,800	1,400	0.5-1
322	3,900	1,950	0.5-1

Rainwater falling on agricultural fields is utilized for *in- situ* moisture conservation through peripheral bundings. At some locations, the concentrated runoff over the time has resulted in sheet, rill and gully erosion. However, the gullies are shallow and narrow and disappear at lower reaches in the agricultural fields. The contribution of rainwater from the doner zone to the agricultural fields helps in practicing runoff farming on limited scale.

Drinking Water Sources

In village settlement, the domestic water supply is through ground level reservoir (GLR) with community taps. The water source for GLRs are tubewells. The system is maintained by the state PHED. In the isolated settlements (*dhanis*) the open wells are available for domestic water supply.

CHAPTER VIII

HYDROGEOLOGY

The main hydrogeological formation in the village area is of Quaternary age comprising of Recent to Sub-recent deposits which are semi-consolidated in nature and largely older alluvium with coarse sand and gravels intercalated with clay, silt and *kankar* extending in the zone of saturation. The groundwater, therefore, occurs at deeper depth and is saline with moderate discharge. Hydrogeological investigations based on 27 observed wells covering whole of the village revealed that in general all the wells are dug-cum-bore wells except one public well which is not in use due to high salinity. Due to this reason, the well has been abandoned. However, water supply is periodical from Padru village located at 15 km distance. All the dug-cum-bore wells observed are being used for irrigated farming using sprinkler method of irrigation.

The water bearing formation as observed from the dug-cum-bore wells is older alluviam. Most of the wells are situated either on top of the sand dunes or in interdune plains. Hydrogeological and physico-chemical characteristics of dug-cum-bore wells are given in Table 12 and the spot values in Figure 7.

During the field survey it has been observed that the electrical conductivity (EC) and salinity of dugwells was higher varying from 13000 to 15500 μScm^{-1} and 8 to 12 per cent, respectively. However after boring, the EC and salinity of these wells decreased, probably due to change in the properties of aquifer at deeper depth, particularly minerals within the water bearing strata. In the dug-cum-bore wells (Table 12) depth to water varies from 22.9 to 54.9 m, aquifer depth 48.8 to 97.5 m, and salinity 1.5 to 4.0 per cent. The observations recorded on the spot indicated that the electrical conductivity ranges from 3800 to 8500 μScm^{-1} execept in *khasra* numbers 152,216,647,282 and 306 where electrical conductivity varies from 2250 to 3400 μScm^{-1}.

Table 12. Hydrogeological and physico-chemical characteristics of dug-cum-bore wells

Khasra No.	Depth to water (m)	Aquifer depth (m)	EC (μSm^{-1})	Salinity (%)
365	36.5	79.2	6000	3.0
27	22.9	50.3	7000	4.0
88	36.5	91.5	4000	2.5
128	48.8	97.5	4200	2.5
151	54.9	76.2	4000	2.0
152	51.8	82.3	2250	1.5
231	27.4	54.9	4100	1.0
237	36.6	61.0	4800	2.5
216	48.8	94.5	2850	1.5
242	39.6	64.0	5000	2.5
651	39.6	54.9	6000	3.0
648	33.5	-	8500	4.0
647	33.5	-	3200	1.5
304	36.6	32.3	3850	2.0
295	38.0	59.5	5500	3.5
281	54.9	91.5	5000	3.0
282	45.7	94.5	3400	1.5
306	48.8	-	3200	1.5
329	48.8	-	4200	2.0
388	42.7	54.9	8500	4.5
376	48.8	84.7	5000	3.0
383	30.2	-	5000	3.0
15	28.0	48.8	6000	3.5
9	42.7	82.3	4800	2.5
36	42.7	73.1	4200	2.0
73	54.9	73.1	5500	3.0
107	25.9	67.0	6000	3.0

CHAPTER IX

PRESENT LANDUSE

The salient characteristics and spatial distribution of various landuse categories (Fig. 8 & Table 13) are discussed below.

Table 13. Present landuse

Mapping unit	Landuse category	Area (ha)	Percentage (%)
Cultivated Lands		1836.18	90.05
A_{11}	Irrigated double cropping with intensity of cultivation (> 100%)	243.57	11.94
A_1	Monocropped land with intensity of cultivation (80-100%)	630.29	30.91
A_2	Monocropped land with intensity of cultivation (60-80%)	882.03	43.26
A_3	Monocropped land with intensity of cultivation (30-60%)	80.29	3.94
Wastelands			
B_1	Sandy waste	138.80	6.81
B_3	Rocky/gravelly waste	138.30	6.78
Miscellaneous Landuses			
P	Permanent pasture and agor with nadi	18.61	0.91
C	Cart track	18.23	0.89
S	Settlement	22.85	1.12
N	*Nala*	2.16	0.11
L	Thrashing ground (*Lata*)	2.08	0.10
W	Community wells	0.09	0.01
	Total	2039.00	100.00

Cultivated Lands

Cultivated lands (including fallow lands) constitute 1836.18 ha (90.05%) area of the village. Irrigated double cropped land associated with older alluvial plains with intensity of cultivation above 100 per cent constitute 11.94 per cent area and occur dominantly in northern part of the village. Recently due to availablity of ground water for irrigation, crops like *isabgol* (Plate 6), cumin and mustard are being raised in addition to *bajra, moth* and *guar*. Mustard, cumin and wheat are main crops grown in the double cropped areas located in northern part of the village. Therefore, the cropping intensity is comparatively higher here than other areas of this village.

A_1 monocropped lands with 80 to 100 per cent intensity of cultivation constitute (30.91%) of the village area. These lands include both irrigated and rainfed areas. In irrigated single cropped lands which occur adjacent to double cropped area only *rabi* crops are grown. Rainfed cropped lands occupy major part of monocropped lands which are concentrated in northern part of the village. It is apparent that in the year 1994-95, out of gross 510 ha irrigated area, double cropping could be practised only in 244 ha. As per landuse survey, current fallow and 2 to 5 years fallow lands constitute 12.8 and 13.7 per cent of the village area, respectively.

A_2 monocropped lands with 60 to 80 per cent intensity of cultivation associated with interdune plains constitute 43.26 per cent area and mostly occur in the south of village settlement. *Bajra, moth* and *guar* are the major crops raised on such lands.

A_3 lands with 30-60 percent intensity of cultivation comprise 3.94 per cent area and are associated with sand dunes. But due to irregular slopes, presence of undulations and moderate to severe wind erosion/deposition hazard, these lands are not suitable for cultivation. At present, *moth* and *guar* are grown on these lands but production is very low and uncertain.

Wastelands

Sandy wastes in the form of medium to high sand dunes constitute 138.3 ha (6.75%) area. The upper flanks, crests and leeward sides of these dunes are generally reactivated and hence these lands suffer from moderate to severe wind erosion/deposition. Unchecked grazing and cutting of vegetation further accelerate sand drift. Rocky/gravelly wastes bordering Khera village in *Khasra* No. 83 occupy only 9.5 ha area.

Miscellaneous Landuse

This landuse category includes settlements, cart tracks and pastures with *nadis*, and constitutes 1.1,0.89 and 0.91 per cent area, respectively. Main village settlement is centrally located and connected with surrounding villages by cart tracks. The village is a major exporter of cumin and *isabgol* but not connected by metalled road with Sindhari and Balotra. Most of

the people have shifted to the farmsteads (*dhanis*) so that they may look after the agricultural operations efficiently and without wasting their time in coming and going every day.

The village has school, Patwar Bhawan, Gram Sewak Bhawan, Ayurvedic' Dispensary and godown. Other categories include the land occupied by the thrashing ground (*lata*), community wells and *nala*.

Cropping Pattern

Physico-climatic and ground water conditions permit lesser choice of crops in this region. Besides, in certain pockets of irrigated lands double cropping is not feasible. Out of the total cropped area of 1984 ha during 1994-95, 69.71 per cent area was occupied by *kharif* crops and 30.29 per cent by the *rabi* crops (Table 14). *Bajra* was the dominant crop constituting 53.32 per cent of the total cropped area, followed by *guar* + *bajra* (11.94%) and *moth* (4.45%). Besides, *moong* and cowpea are also raised. Cumin is the most promising cash crop occupying 20.31 per cent area, followed by *isabgol* (5.29%), mustard (2.97%) wheat (1.60%) and fodder (0.12%). During the year 1992-93 to 1994-95, the area under cumin and *isabgol* has increased by 213.34 and 74.68 per cent, respectively while the acreage under wheat has significantly declined. The *rabi* cropped irrigated area during this period has increased by 90.3 per cent.

Table 14. Cropping pattern 1994-95

Crops	Area (ha)	Percentage (%)
Unirrigated (Kharif)		
Bajra	898	53.32
Bajra+moth	75	4.45
Guar	201	11.94
Total cropped area (K)	1174	69.71
Irrigated (Rabi)		
Wheat	27	1.60
Mustard	50	2.97
Cumin	342	20.31
Isabgol	89	5.29
Fodder crops	2	0.12
Total cropped area (R)	510	30.29
Grand total	1684	100.00

CHAPTER X

RECOMMENDATIONS

The natural resources appraisal of Juna Mitha Khera village revealed that the area is highly duny and sandy. Recently boring has been done in a number of wells and moderately saline/sodic water is available. This is being used for growing *rabi* crops and has also supported milch cattle husbandry. The dune complex environment is fairly well preserved by good stand of trees and bushes. However, due to increased biotic activities and irrigation with poor quality water, the process of soil degradation has set in. Following recommendations are suggested for increasing the productivity of land and conservation of the environment.

A. Recommendations Based on Natural Resources Survey

Development of surface water resources

1. *Nadis* located in *khasara* numbers 108, 167, 173 and 261 could be renovated for better storage and utilisation of stored water. The proposed activities are desilting, dredging, providing LDPE lining in sides and bottom and silt traps at inlet point. The estimated cost for renovation of *nadis* is Rs. 12 lakh.

2. Twenty improved *tankas* of 15000 litres capacity (Fig. 9) may be constructed at individual household for small and marginal farmers. The catchment around *tankas* may be prepared artificially by compacting and sealing the soil surface to induce runoff. The estimated cost of each *tanka* is nearly Rs.15000. These *tankas* may be used for raising fruit and forest trees.

3. In the fields having undulating topography, bunding at lower sides of the field with vegetative barrier may be done to check soil erosion and to conserve moisture with soil profile. This will help in improving land productivity.

4. Across the gullies, check dams of loose stone and brush wood may be constructed to reclaim the degraded areas.

Natural plant resources development

1. *Tamarix aphylla* and *A. tortilis* on field fences is doing very well and it needs to be popularised.

2. Tree based farming system needs to be encouraged. Amongst tree components, plants of timber importance i.e. *Tecomella undulata* or horticultural importance like zuzube may be considered.

3. On slopy dune flanks growing of vegetative barriers of suitable grasses like *Panicum turgidum* alongwith *Barleria prionitis* and *Aloe barbadensis* should do very well.

4. Community grazinglands may be developed into silvipastures with grasses like *Lasiurus sindicus* on hummocky plains, *C. ciliaris* on sandy plains and *C. setigerus* on gravelly surface.

5. Rocky waste (1 ha approx) should be brought under vegetative cover by growing *Acacia senegal, Ziziphus nummularia* and *Capparis decidua* in half moon terraces.

6. In order to increase tree plantations in the area, farmers should be encouraged to establish the nurseries for raising saplings.

Suggested developmental activities

Following management units for developmental activities (Fig. 10) have been identified and recommendations suggested.

Unit A: This unit has medium textured very deep soils and surface is free of sandy hummocks. There are a number of tubewells where irrigated crops like mustard, cumin, *isabgol* and wheat can be grown in *rabi* season and *bajra, moong, jowar* and *til* in *kharif* season. Sprinklers are already being used for irrigation. Improved varieties of crops, fertiliser application and plant protection measures are needed to increase the crop yields.

Unit B: The area has fine sandy very deep soils and levelled surface. Nearly 60 to 70 per cent area of this unit is being irrigated by sprinklers. The irrigation water is brackish and soils also have developed sodicity. To avoid further degradation application of gypsum as per the 100 per cent gypsum requirement of the soil + quantity of gypsum required to neutralised RSC in excess of 5 me L^{-1} should be applied. The quantity of gypsum calculated for some of the sites varies from 5 to 8 t ha^{-1}. Plantation of *ber, gonda* and *anar* are recommended wherever water quality permits. Agroforestry using moongbean and cowpea and *Prosopis cineraria* and *Acacia tortilis* may be developed under rainfed conditions.

Unit C: This unit due to hummocky surface and deep fine sandy soils is occasionally cultivated. In silvipastures system *Tecomella undulata, Tamarix aphylla* and *Acacia tortilis* trees and *Lasiurus sindicus* and *Cenchrus ciliaris* grasses should be introduced. In pockets, wherever ground water is available, irrigated crops of cumin and *isabgol* can be grown.

Unit D: This unit includes the sand dunes which are not fit for cultivation. there is good cover of trees and shrubs on these dunes except at few places where they have been reactivated due to biotic activities. Silvipastures and conservation farming by growing suitable trees, shrubs

and grasses with minimum tillage is the ideal proposition. However, at places farmers have dug wells and growing cumin and *isabgol* with sprinkler irrigation. This may be continued with minimum tillage and wind erosion control measures like shelterbelt plantation.

Unit E: A small area in the north-west of village has rocky exposure and shallow pediments. This area can be developed into woodlands and pastures by growing *Acacia senegal* and Salvadora trees, *Ziziphus nummularia, Capparis decidua* shrubs and *Sehima nervosum* grasses across the slope.

B. **General Recommendations**

(1) Recently farmers have drilled tubewells at several locations and ground water is available. This is perched water and likely to be exhausted within next 5 to 10 years. Though the farmers here are using sprinklers for irrigation, yet it is suggested that minimum use of water should be made by growing drought tolerant and low water requiring crops.

(2) In most of the tubewells the water is brackish which will deteriorate the productivity of land. To sustain the crop yields, gypsum should be applied as per soil and water requirement.

(3) The soils are deficient in nitrogen and available phosphorus. These nutrients should be applied through fertilizer to get high yields of cash crops like cumin, *isabgol* and mustard.

(4) The available water should be utilised to develop horticultural plantations like *ber* and *anar* which will be permanent assets to the farmers and will improve their socio-economic condition.

(5) The village should be linked with metalled road to Sindhari and Balotra for transportation of agricultural produce to the market.

(6) Since the ground water is available, more emphasis is being given for growing green fodder and to develop buffalo husbandry in a big way to increase the income of the farmers. A veterinary hospital may be established to take care of the health of the animals.

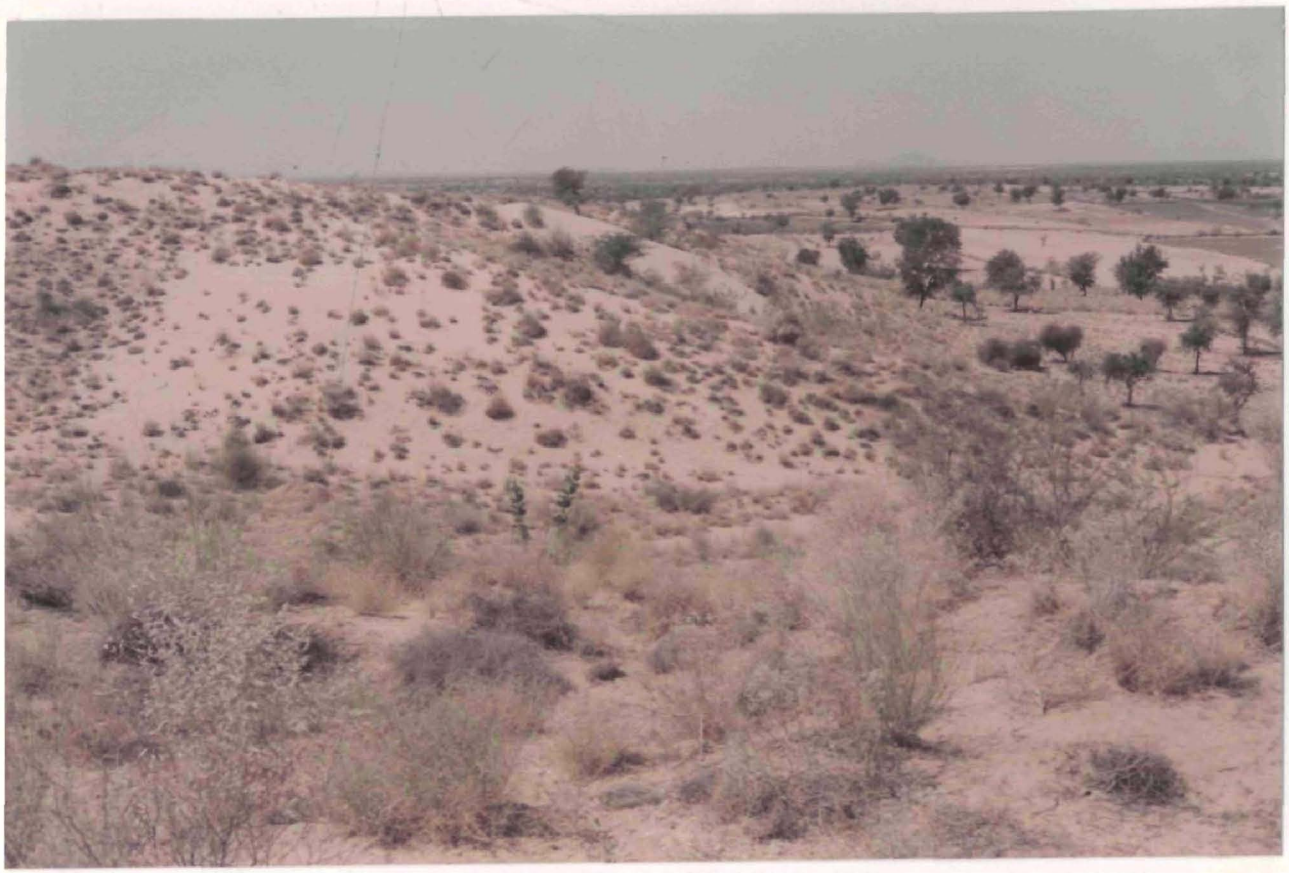

Plate 1. Stabilised sand dunes with good cover of natural vegetation

Plate 2. Dakhan series soils associated with reactivated sandy hummocks and supporting a good stand of trees and shrubs

Plate 3. Dune complex soils associated with stabilised sand dunes and supporting a good stand of trees, shrubs and grasses

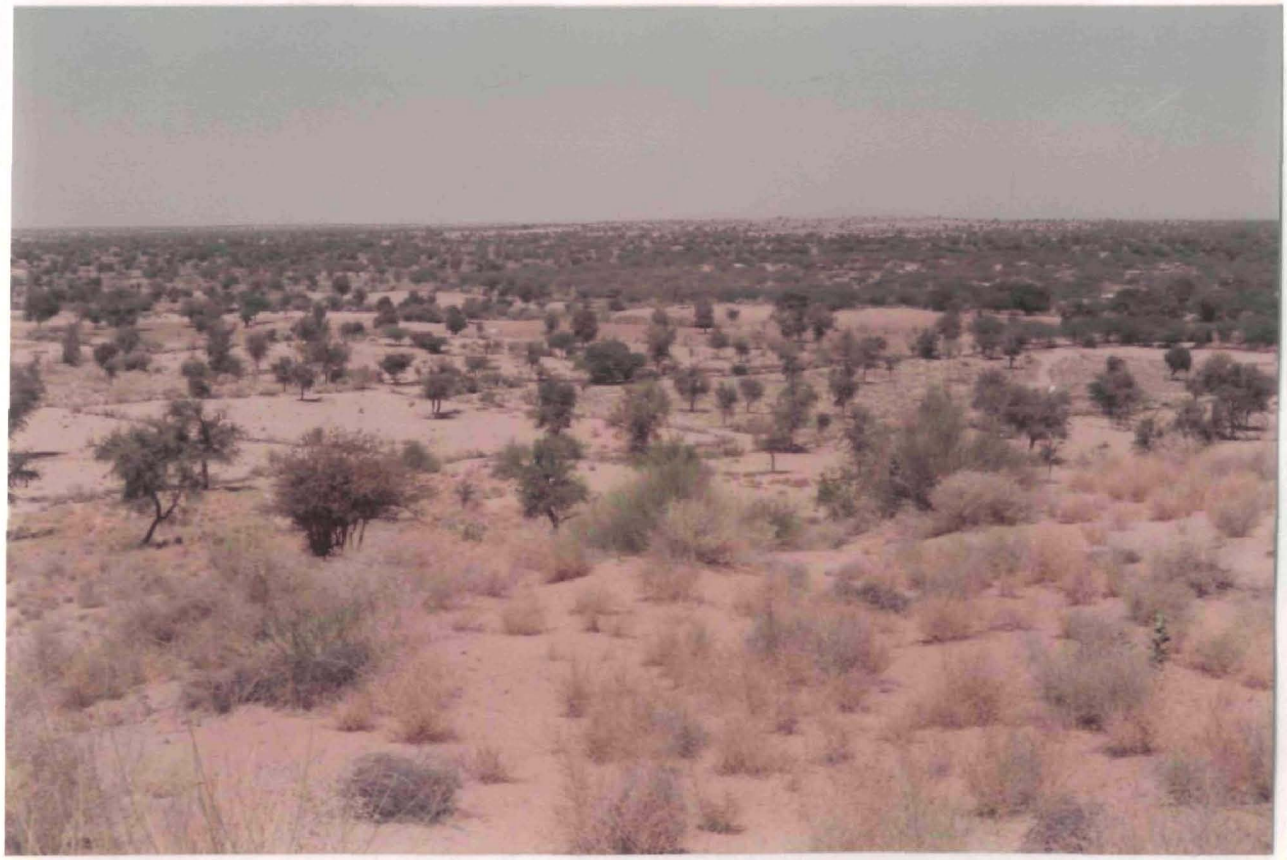

Plate 4. Good stand of *Prosopis cineraria* and *Tecomella undulata* on sandy undulating inter-dune plains

Plate 5. Silting of the *nadi* resulted in the reduction of its water storage capacity

Plate 6. *Isabgol* cultivation with brackish water irrigation