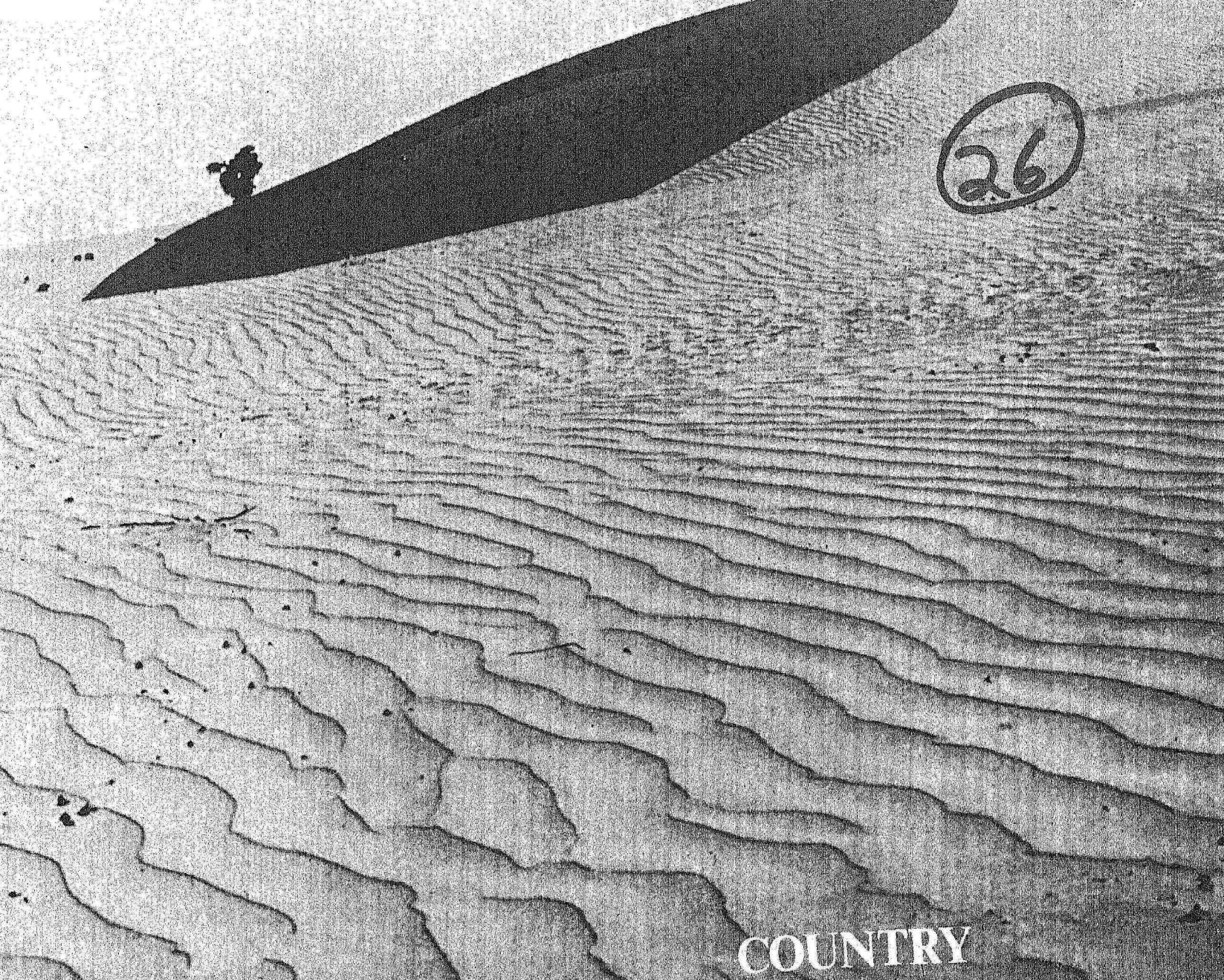

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COUNTRY
REPORT

26

INDIA

ESCAP WORKSHOP
20-23 OCTOBER, 1981

IMPLEMENTATION OF THE PLAN OF ACTION TO COMBAT DESERTIFICATION

COUNTRY REPORT—INDIA

ESCAP WORKSHOP
20-23 OCTOBER, 1981

CENTRAL ARID ZONE RESEARCH INSTITUTE
JODHPUR-342003, INDIA

Contents

Introduction

India is one of the few countries which conceived the problems of the desert and desertification soon after its Independence (1947). When the twenty small administrative units were integrated into the present-day state of Rajasthan, it was possible to coordinate the activities of various agencies interested in the development of the desert area and to create a unified Master Plan for the direction, operation and superintendence of all such activities. Attention was further focussed on the deterioration referred in the First Five Year Plan that "Indian desert of Rajasthan has been spreading outwards in a great convex arc—at the rate of about half a mile per year for the last 50 years". In recognition of the problem, the National Institute of Sciences (now Indian National Science Academy) organised a Symposium on the "Rajputana Desert" in the year 1952, on the recommendations of which the CAZRI was established, firstly in 1952 as the Desert Afforestation Station. This was perhaps the first and a major state organised step in the Afro-Asian Countries to contain the desert.

The arid and semi arid zone in India is spread in 8 states of India but 90 per cent of the hot desert is located in northwest India, out of which 62 per cent is located in the state of Rajasthan. It is by far the most populated desert of the world and the manifestations of deterioration of environment are more evident in this region as compared to others. Continuing research work at CAZRI and by other organisations has made the Thar the "best studied" desert in the world.

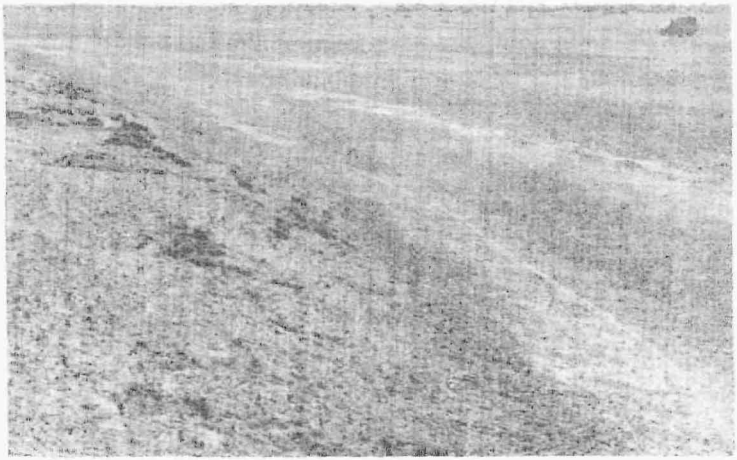
India presented a well documented case study on "Desertification problems in the Luni Development Block" at the United Nations Conference on Desertification held at Nairobi during 1977, besides presenting a Country Report prepared by Department of Science

STATE-WISE AREA OF THE ARID ZONE IN INDIA

State	Area under the arid zone (km^2)	Percentage of the total arid zone in India
Rajasthan	1,96,150	62
Gujarat	62,180	19
Punjab	14,510	5
Haryana	12,840	4
Maharashtra	1,290	0.4
Karnataka	8,570	3
Andhra Pradesh	21,550	7
Total area	3,17,090	—
Jammu and Kashmir*	70,300	—

*Cold arid zone.

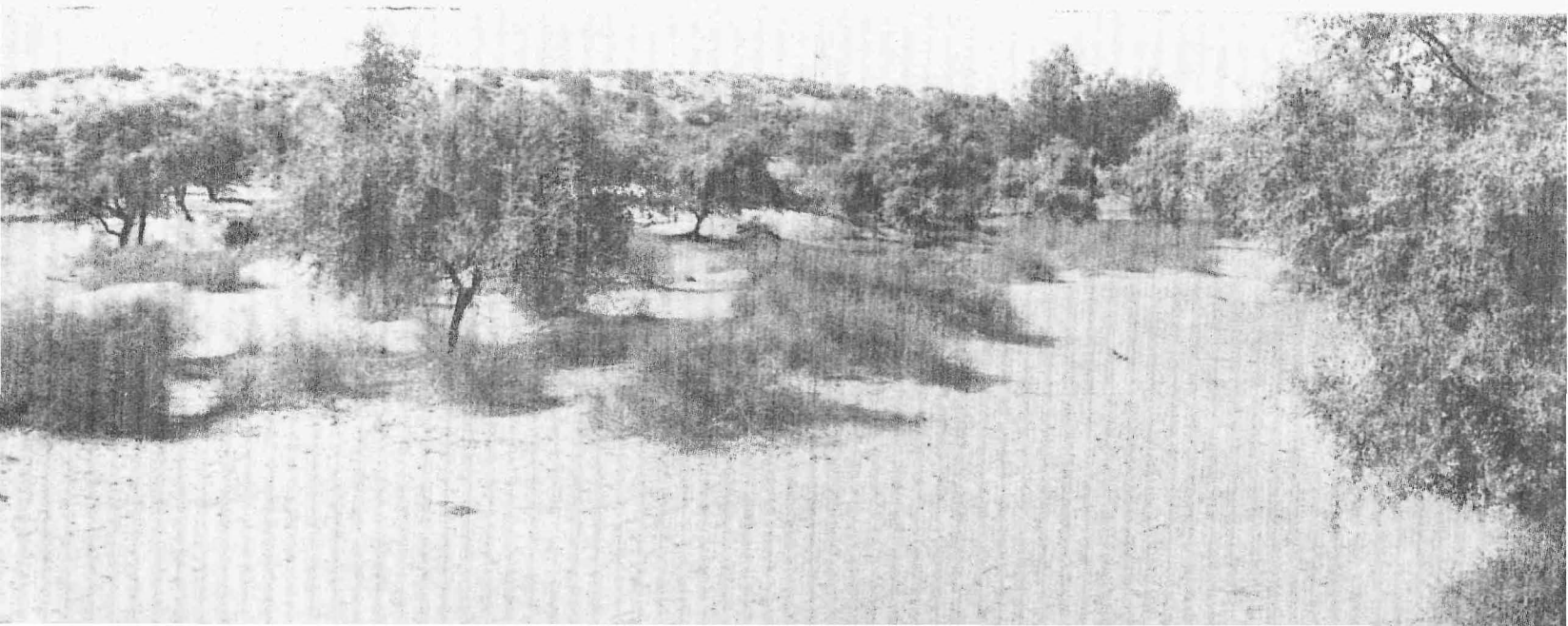
SOURCE: A. Krishnan in Desertification and its Control.



Desert plain devoid of vegetation. The inter-play of man's over exploitation and degradation of the land due to over grazing become conspicuous in more than 60 per cent of the Indian arid zone by the vanishing grasslands

Due to the pressure of the population even the marginal lands are cultivated. It is estimated that during the last two decades the cultivation on marginal lands has increased by 54 per cent

and Technology, Govt. of India. In addition, a compendium "Desertification and its Control" was published by the Indian Council of Agricultural Research, New Delhi. Thereafter, the Arid Zone Association of India in collaboration of other agencies organised a post-conference international symposium on Arid Zone Research and Development at CAZRI during 1978 which was attended by 400 participants from 20 countries. It was followed by a post-congress seminar on Anthropology and Desertification which was again held at CAZRI, Jodhpur, in 1978. A number of collaborative projects with International agencies were started to conduct research (with UNRISD) and for developmental purposes (World Bank), which are being taken up on a large scale. The Government of India and State Governments in the arid and semi arid zones realised the alarming situation and reacted in apt manner by taking right decisions, providing funds for anti-desertification programmes, created facilities for their perception, for establishing infra-structure to study the problems and for evolving strategies to minimise the hazards, for transfer of technology and have organised result-oriented extension programmes by creating appropriate agencies.



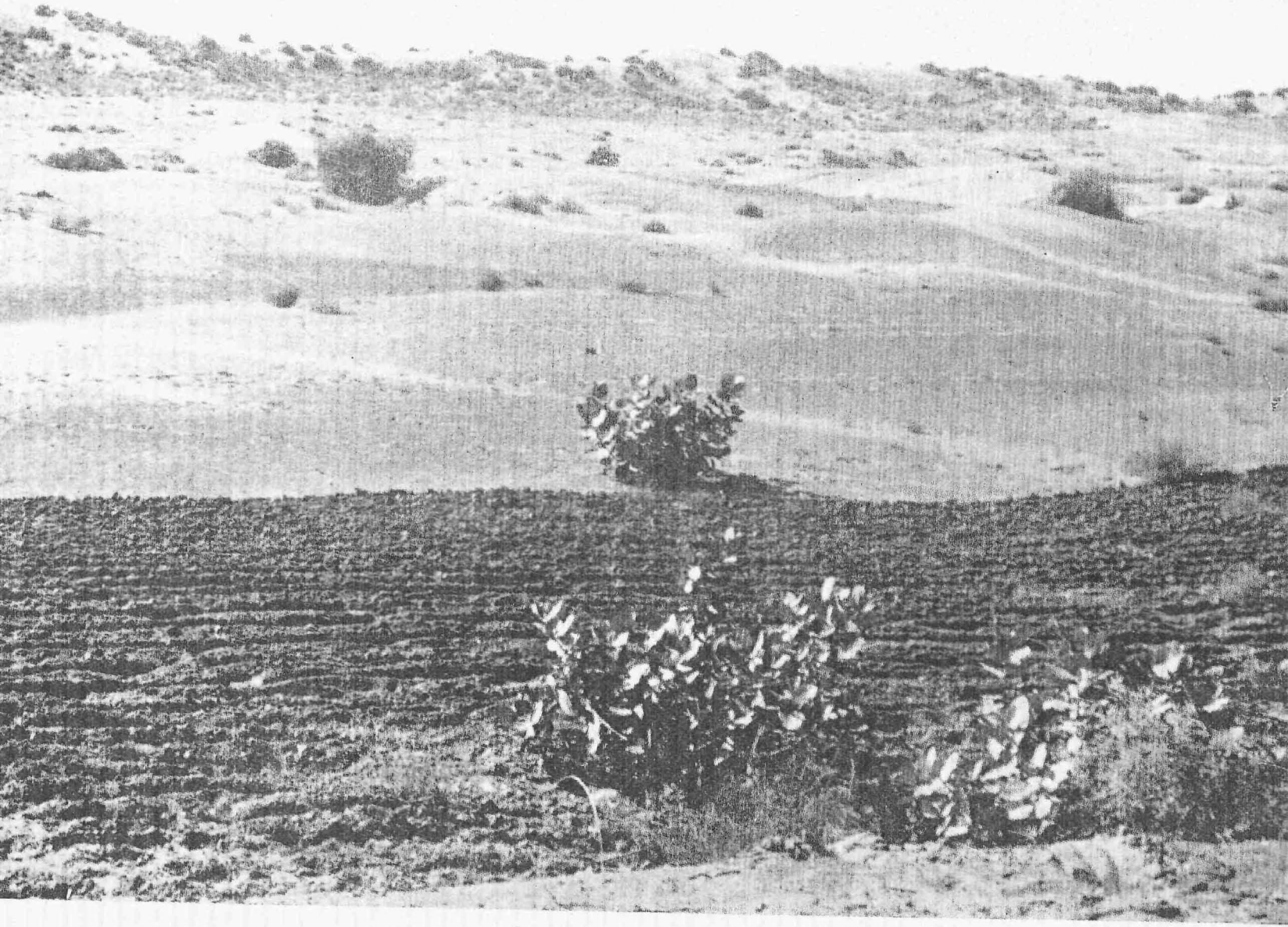
The Indian Desert

The entire area stretching from the Sahara to the Thar appears to be a meteorologically homogeneous one. Besides, physiographic and anthropogeographic conditions of the region are comparable to identical phase in contiguous hot deserts. From a broader view point, the northwest hot arid zone of India is the eastern extremity of 'Great Plain'. In the Indian desert, before the aridity set in, the streams were alive and carried sufficient silt into the sea. Thereafter, the run-off decreased and these streams now flow subterraneally along these dead channels. The confluences of the main channels now form salt basins. This process is still in progress as new salt basins are being formed on lower reaches on the smaller tributaries.

In spite of low-nutrition diet, the health of desert inhabitants is excellent. The milk products which they consume might be the reason for their good physique

The average annual rainfall of the region varies from 150 to 500 mm with a coefficient of variation as high as 60-70 per cent. The distribution of rainfall is also erratic, occurring mostly in the period July to September. During summer, the mean daily maximum temperature is generally 40°C and 22 to 28°C during winter. The mean minimum temperature varies from 24 to 26°C during summer and 4 to 10°C during winter. The mean diurnal temperature variation ranges from 12 to 17°C. The mean relative humidity during summer varies from 36 to 50 per cent and from 66 to 78 per cent during monsoon during the morning hours. In the afternoon, however, there is an expected drop and the mean values range from 20 to 35 per cent during summer and 48 to 60 per cent in the monsoon season. The mean evaporation during summer exceeds 10 mm per day. The potential evapotranspiration values during summer (April-June) vary from 7 to 9 mm per day. The mean daily wind speed is recorded to be highest during summer and monsoon seasons, 8-20 km/h.

Arising out of the paucity of rainfall, the surface

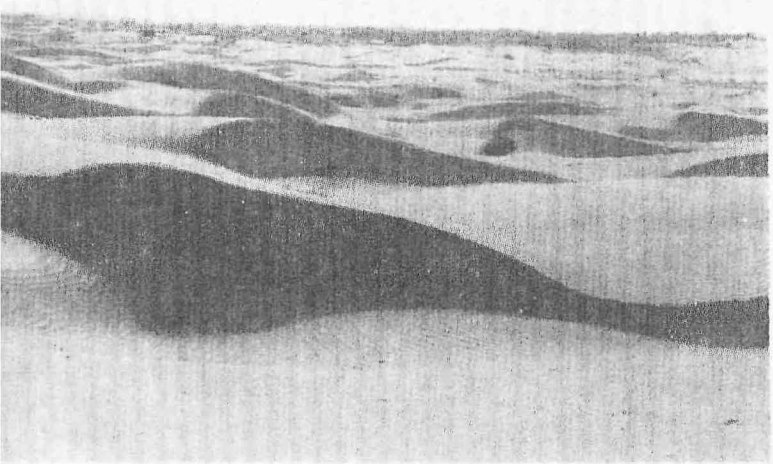


A typical landscape of the sandy desert

A typical desert hutment

water resources are also scarce. In the extreme south-west there is an organised drainage emanating from the western slope of the Aravalli that covers about 30,000 km^2. Here also in response to rain the actual flow is limited to a few days only. In the north-west there is another small stretch under the influence of Ghaggar river. In the rest major part of the tract points of run-off are there and water from them is intercepted or collected right from historic time onward. These depending upon rainfall are able to meet the human and livestock needs from a few days to months, after which preforce people have to depend on ground-water. The tracts under the direct influence of integrated drainage or those that get recharged through sub-surface flow have reasonably good potential, much of which is already being exploited. Such regions cover nearly 30 per cent of the arid zone. In rest of arid zone the ground water is too little, too deep and also not quite potable. However, even in this tract the people through a conjunctive use of surface and ground water are able to sustain themselves though with considerable difficulty.

The barchan sand dunes are most vulnerable to wind action and are the major arena of sand shifting



The topography of western Rajasthan is not a result of superficial or biogenic agencies, but is attributed to geological processes largely in the nature of the sheet movements leading to peneplanation, rapid changes in the drainage system, enormous accumulation of loose rocky materials, deepening of water-

table and consequent famishing of vegetation, and thereby accentuation of desertic conditions. A thick sedimentary sequence ranging in age from Early Palaeozoic (or even older) to Middle Eocene is exposed in the western Rajasthan desert. The sedimentation, with many intervening breaks, continued up to Late Palaeozoic times till the major uplift and erosion which preceded the next major marine transgression in the Jurassic. The study of the geomorphology of the southern arid zone has shown that two cycles of erosional surfaces are present, one of which is responsible for the accordance of the summits in this area which consist of domes, whalebacks, flat domes, inselbergs, koppies, pediments and pediment passes.

The region comprises a vast stretch of Quaternary alluvial plain and wind sorted sands. Its mean elevation in the east at the foot of Aravalli mountains is generally 350 to 450 m above sea level and from here the plains slope in the easterly and south-westerly directions to elevation of about 100 m in the west and 20 m in the south-west towards the Rann of Kutch.

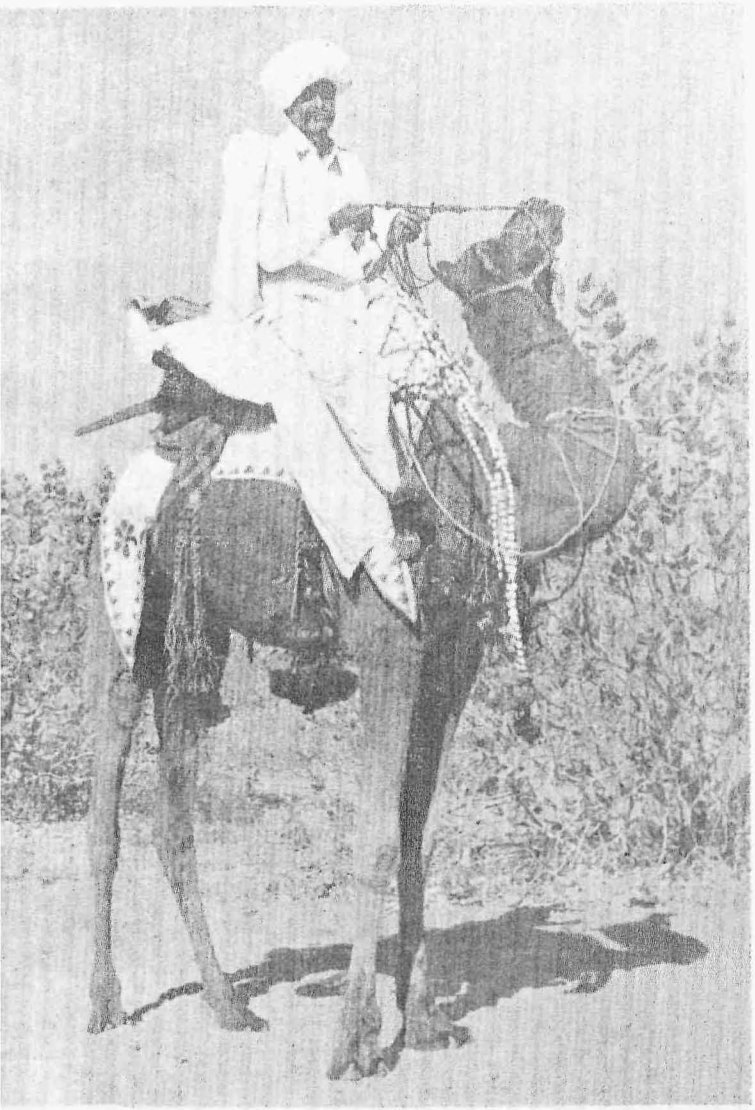
A village nadi. It is traditional in every desert village to create a small pond to harvest the rain water for drinking purpose. 90 per cent of the nadis retain water for only 4 to 5 months. Thereafter, water has to be fetched from long distances

Most spectacular amongst the land-forms are the dunes. These are present in 58 per cent area of the region. Within this in nearly 30 per cent of the area dunes proper cover 60 to 100 per cent of the area, in 58 per cent these constitute 20 to 60 per cent of the area. The area of occurrence of dunes lies in the northern and western half of the region but even here it is not a contiguous feature and does have inclusions of dune-free corridors as the area from Pokran through Bap to Bikaner. A variety of dune types such as coalesced parabolic, longitudinal transverse, barchan and obstacle has been recognised. Amongst these parabolic and coalesced parabolic dunes are dominant. The dunes are very variable in height—the common range being 10 to 80 metres

and those occurring in Jodhpur and Barmer are the highest. The dunes are highly sandy and contain only 1.8 to 4.5 per cent clay and 0.4 to 1.3 per cent silt. The inter-dunes and associated plains are also light textured, though with some more of silt and clay. These have a varyingly developed concretionary strata at depths commonly of 40 to 120 cm. There is an appreciable strata of old surfaces having well developed calcrete often with some well rounded rock fragments underneath or exposed at the surface.

The central and southern part of the arid Rajasthan is made up of medium and fine textured soil developed from in-situ or alluvial parent material. This region is almost devoid of any signs of deflation or of aeolian sand. These soils are well aggregated and these have a good moisture retention capacity. These soils as also those of dunes and sandy plains are somewhat low in nitrogen but well provided with phosphorus, potassium and various other nutrient elements. Though the soils test low in nitrogen, it is not a limitation in establishment and maintenance of good vegetation cover. However, under arable farming application of fertilizer is necessary for optimum yields.

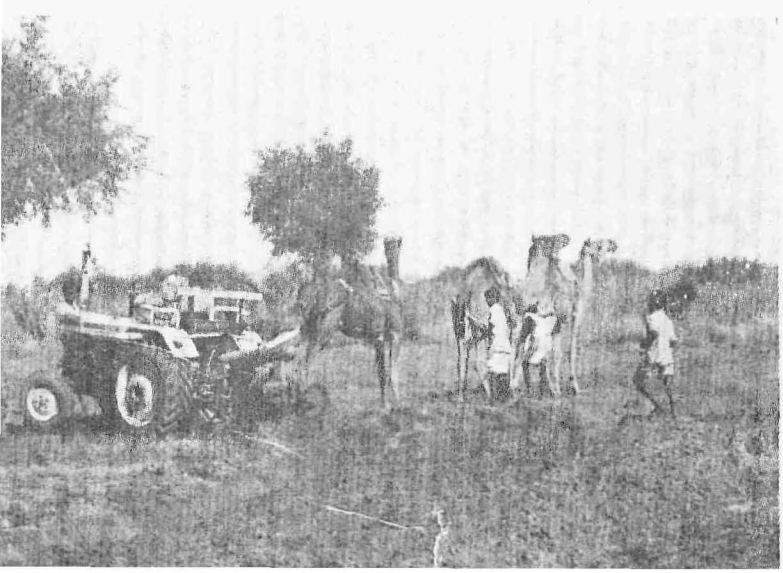
Biogeographically, the majority of the desert biota exhibit Saharo-Rajasthani affinities as opposed to middle-Asian.



The desert people are very hardy. Camel is one of the major sources of transport

Undisturbed desert in extreme western Rajasthan. Absence of biotic interference is evident by the presence of profuse vegetation

Ploughing the desert soils with camels and tractors during June, when the wind action is strongest, aggravates the soil erosion



Population pressure induces the desert farmer even to cultivate the barren sand dunes which are disturbed by ploughing and shifting of sand enhances. Subsequently, the wind bourne sand settled at unwanted locations

The Problem : Deterioration of Desert Environment

Besides climatic vagaries, erratic monsoon and extremes in diurnal temperatures, the Indian desert is confronted with two major problems : escalation of (i) human and (ii) livestock populations. All other processes are in reality the consequences of these two major factors causing desertification and deteriorating the desert environment.

The human population, starting with a base of roughly 3.56 millions in 1901 registered a linear escalation and increased to 10.23 millions till 1971, almost a three-fold increase in the arid districts of Rajasthan ! The growth rate (158 per cent) in the hot desert is more than that of the country (132 per cent). The density of population varies from 157 to 4 persons per km^2 decreasing with the annual amount of precipitation. As a consequence, in western Rajasthan, the cultivation on marginal lands increased by 44.6 per cent during 1951–61 and by an additional 9.47 per cent during 1961–71. Pastures and other types of lands declined by 16.8 and 6.95 per cent during the two decades. The increase in rainfed farming on marginal lands has not only resulted into decline in crop productivity per unit area but has enhanced soil erosion, degraded the soil fertility, and has resulted in over-exploitation of ground water.

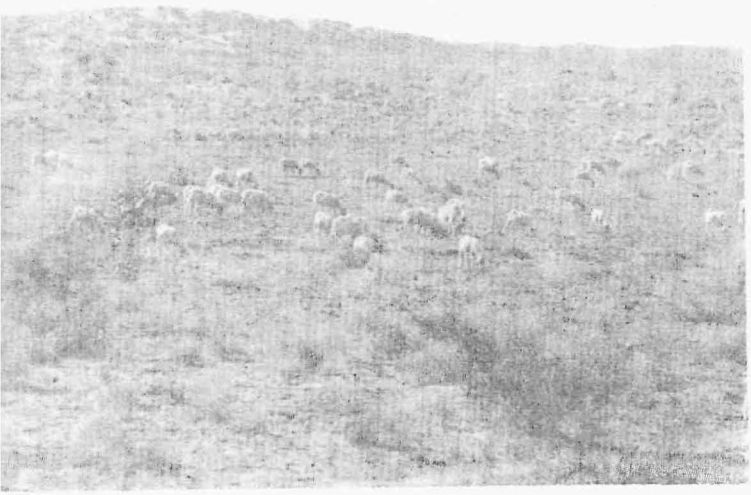
Dense population of livestock leads to migration from the desert to non-desert areas, even in different states, creating sociological, economical as well as political problems

The increasing human population is a serious stress, particularly on the vegetal resources of the desert. The trees and shrubs and even their roots are indiscriminately cut by the rural population for fuel, top feed, thorn fencing and the construction of thatched hutments. It has been estimated that the requirements of the people in the desert in respect of the woody biomass has increased from 1.85 million tonnes in 1951 to 3.33 million tonnes in 1971. Moreover, the desert people have developed peculiar food habits. All the available air-dried seeds and pods of the trees are used as delicacies. The seeds of *Acacia senegal*

(*kumat*), the fruits of *Capparis decidua* (*kair*) and the pods of *Prosopis cineraria* (*sangri*) are harvested. Almost all the fruits of *Zizyphus nummularia* (*ber, jhadberi*) growing in accessible parts of the desert are harvested for human consumption. The seeds of grasses, e.g. *Panicum turgidum, P. antidotale, Cenchrus biflorus* and *Echinochloa colonum*, are mixed with millet for making chapatis (unleavened cakes) especially during drought years. The grass seeds are supposed to add to the nutritive value of the food. The intensity with which seed collection is made for direct human consumption throughout the desert region seriously affects the natural process of regeneration of the desirable plant species in the inhospitable terrain.

In spite of the low productivity of the arid lands Rajasthan sustains a fairly high population of livestock. Paradoxically, along with the reduction in the grazing area during the last two decades, the livestock population has registered an alarming increase, from 9.4 million in 1951 to 15.5 million (almost double) in 1972. The livestock density per 100 hectares rose from 72 in 1951 to 175 in 1971 in the desert districts but in the adjoining districts, this enhancement was not so spectacular (25 per cent as against 293 per

The present fuel need of the human population in the Indian desert is increasing with the enhancement of population



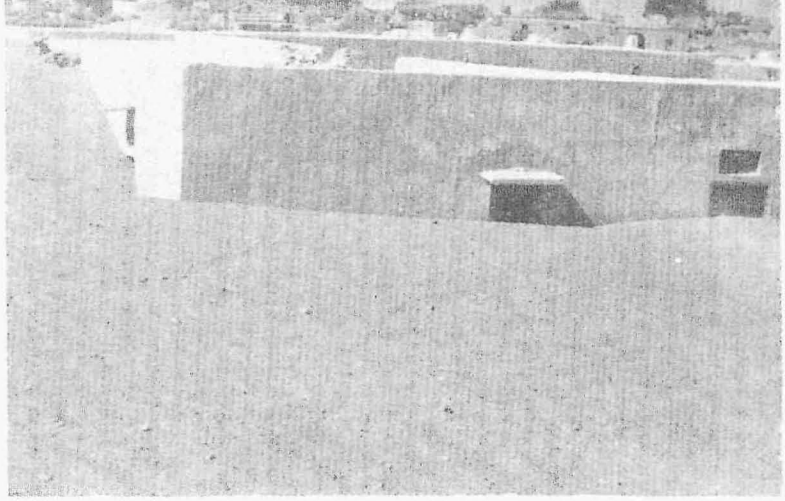
Over-grazing is one of the major problems of the Indian desert. Associated with indiscriminate exploitation by man, it has already turned about 4.5 per cent of the desert in an irreversible situation whereas about 76 per cent is highly to moderately vulnerable to processes of desertification

cent in desert districts). The goat and sheep populations ranged from 57.1 to 69.3 per cent during this period. Owing to continued droughts during 1967-71 with the consequent migration and mortality, the number of hardy animals, e.g. the goat, increased substantially (34% increase). The data thus not only reveal a preponderance of the goat and sheep populations in the arid Rajasthan but also point to their increase during the years of drought.

The pressure of livestock on the grazing lands results in the depletion of vegetation resources and at certain habitats in the desert, the natural successional trends have been reversed :

Cenchrus setigerus, C. ciliaris
↓ ↑
Eleusine compressa
↓ ↑
Cynodon dactylon
↓ ↑
Indigofera
↓ ↑
C. biflorus
↓ ↑
Aristida spp.
↓ ↑
Bare sand

Livestock population exceeds the carrying capacity of the land. In western Rajasthan the livestock population has multiplied one and a half times in recent past



60 per cent of the Rajasthan desert is covered by sand which encroaches the townships

Due to severe depletion of food species, the livestock productivity has declined and has induced their migration and nomadism in the human population.

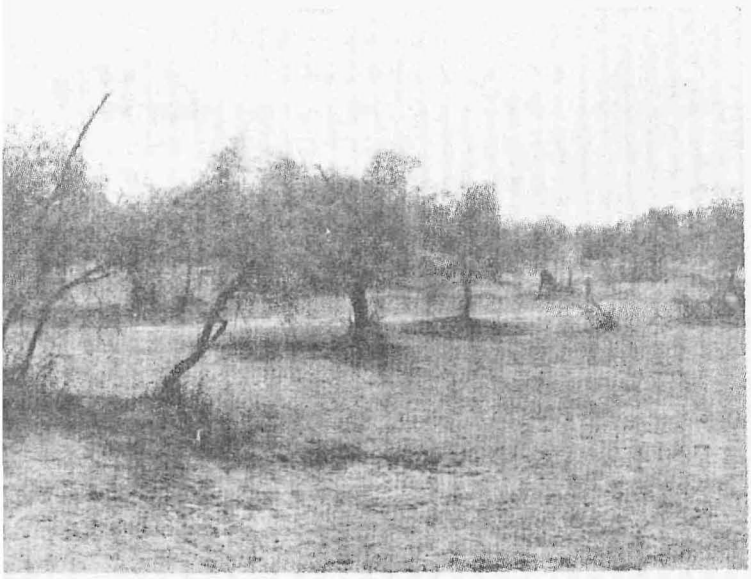
A general approach to improve productivity of arid lands is to bring irrigation water, chiefly for raising crops. Incoming of water into a desert also affects the ecosystem adversely. It is evident that in Anupgarh Shakha area, the water table is rising at an average rate of 1.52 m per year. At places the rate is 3 m also. In Ghaggar flood area water table has risen by 6—9 m. On the basis of water table changes in the Shri Ganganagar district, estimates are that the problem will attain a critical limit with present rate of rise in static water level in about 9 to 275 years in different zones. Besides, the perched water table rise along with sub-surface gypsum bed is also creating severe water logging hazard.

For collecting rain water for subsequent irrigation, village ponds, dams across prior channels have been constructed in many parts of the Thar desert. These human efforts have also resulted in deteriorating the desert ecosystem. They have pushed up the water table and spread of salinisation. Salinity due to construction of tanks has developed in small development block. Evidence shows that prior to 1958, an area of

8.3 km² of once productive lands has been salinised beyond use. Since 1958 salinity has spread within this block laterally and during this period an additional area of 15.6 km² has been so effected. It is feared that if the situation continues, the problem would spread to another 40 km² in this block.

Comparison of results of studies carried out in the Luni Block over a period of 18 years (1958-1976) shows that due to human interference, sand movement activity leading to further accentuation of undulation has taken place over an area of 166 km² or 8.4 per cent of the total area of the block. Simultaneously 67.9 km² has undergone deflation. It was also observed that recent sand activities have led to an increase in the thickness of sand on previously created fence line hummocks by 15 to 30 cm and to have enhanced their width by 1-2 metres. The area so affected is 163.3 km² or 8.2 per cent of the total area of the block. The stabilised sand dunes in the extreme northwest also show an increase of sand piling by 1 to 2 metres on the flank and 3 to 5 metres on the crest.

Likewise, in the Rajasthan desert, it is revealed that about 9,290 km² or 4.35 per cent of western Rajasthan has already been affected by the processes of desertification. 1,62,900 km² or 76.15 per cent of the area has been categorised as highly and moderately vulnerable and 41,692 km² or 19.5 per cent of the area is moderately to slightly vulnerable to the various processes of desertification.



Grazing pressure on the ground vegetation reverses the succession of vegetation species

Implementation of Plan of Action to Combat Desertification

assessment of the problem

Based on the critical indicators (Physical, Biological and Social), a project on Monitoring of Desertification Processes was formulated by CAZRI in 1978. To cope up with the magnitude of problems related to desertification which show a variety of forms of surface expressions, remote sensing techniques for analysis have been employed. Particularly to study the encroachment of desert in an eastern direction, false color mosaic of space imageries pertaining to Rajasthan and surroundings were studied for a reconnaissance and semi-detailed appraisal for the perception of sand encroachment. The sands appear in the false color mosaic as light yellow to green while medium to heavy textured soils appear in dark green to bluish tone. Taking advantage of this tonal differentiation, the areas covered by sand as well as sand-free areas were easily detected, delineated and mapped. It is observed that the bulk of the areas affected by sand dunes and sand sheets occur in the extreme west of the Aravallis up to the Indus River system and Haryana, Punjab and Delhi in the north followed by a discontinuity in the midwest. Further, sand is also found to be concentrated in pockets around Jaipur, Kuchamana, Dausa, Agra and south of Dholpur. This feature was distinctly reflected in light yellow to light green tone in the false color mosaic. The Rann of Kutch appears in dark green mottled tone with bluish tinge implying thereby the absence of sand. Ground survey of this area, in 1977, showed no evidence of sand formation either.

Procuring potable water is the major task of the desert inhabitants

From the foregoing it has been deduced that the sand dunes and sand sheets only occur as discontinuous patches from the Rann of Kutch to the northeastern part of Haryana and Delhi. Further, whatever sand piling has occurred around Jaipur, Agra and Dholpur seems to have originated from intense local biotic disturbances such as improper cultural practices, overgrazing and indiscriminate cutting of trees.

Thus, the discontinuous distribution of sand dunes and sheets in the western sector discounts the transport of sand by wind from the southwest. This has also been confirmed by the comparative study of incidence of sand shown in the ONC (USA) map of Rajasthan and the false color composite of Landsat for 1977 which do not show any evidence of lateral movement of sand from the southwest to the northeast. Further, in the absence of any sand piling in the Rann of Kutch, the wind borne theory of sand from the Rann as advocated by some critics (National Institute of Sciences, 1952) appears to be completely ruled out. There is thus no *prima facie* evidence to indicate that desert is spreading towards Delhi-Mathura-Agra region.

Based on interpretation of Landsat imageries (Bands 4 and 5 supplied by ISRO, Ahmedabad), maps on 1:2.5 million and 1:2 million scale have been prepared which also indicate that there are no evidences to show the spread of the Indian desert. This inference is also supported by the socio-economic surveys of the region. Further work is continuing in Haryana and western U.P.

Assessment of vulnerability of smaller area to desertification processes is also an important subject of study at the CAZRI. The band 5 computer printout map depicts the vulnerability to desertification processes of aeolian landforms in a small subscene in the Middle Luni Basin. This feature is reflected in light and dark tone pixels. Analysis of the pixels reveals that the areas of dark pixels due to the presence of vegetation and moisture (brightness value 0—65), which occupy an area of 3.36 km² in the subscene, are least vulnerable to desertification (table, left). The light to dark gray pixels due to moderately sparse to sparse vegetation (brightness value 66—69) indicate areas moderately vulnerable involving an area of 6.07 km² in the subscene. The bright pixels, due to accu-

ASSESSMENT OF VULNERABILITY OF AREAS TO DESERTIFICATION IN THE WESTERN PART OF THE MIDDLE LUNI BASIN (COMPUTER PRINTOUT OF BAND 5)

Vulnerability	Gray level	Value	Number of Pixels	Area in km²	Per cent
Moderate	2—3	66—69	1346	6.07	28.8
High	4—6	70—83	2599	11.72	55.3
			4690	21.15	100.00

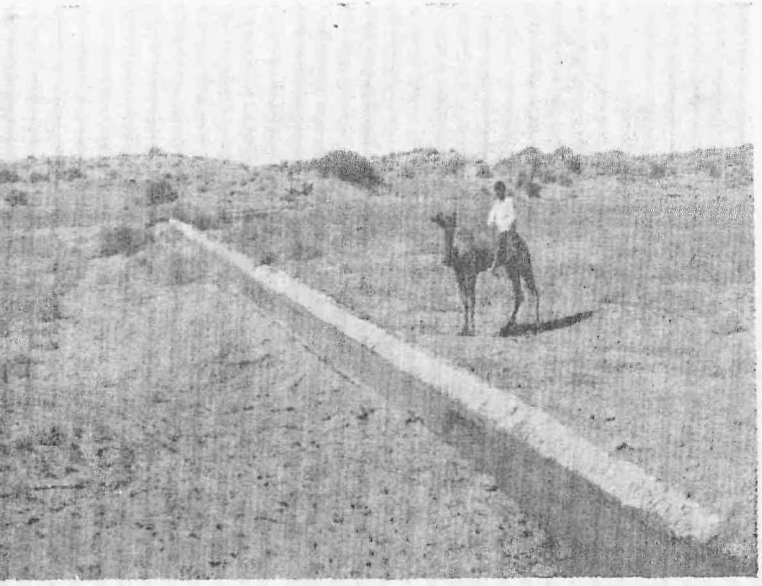
mulation of fresh sands and no vegetation (brightness value 70—83) constitute the areas highly vulnerable to desertification and seem to occupy the largest area (11.72 km²) in the subscene.

CAZRI has prepared a number of atlases on agriculture in Rajasthan, agro-demography and sheep ecology.

land use planning and management

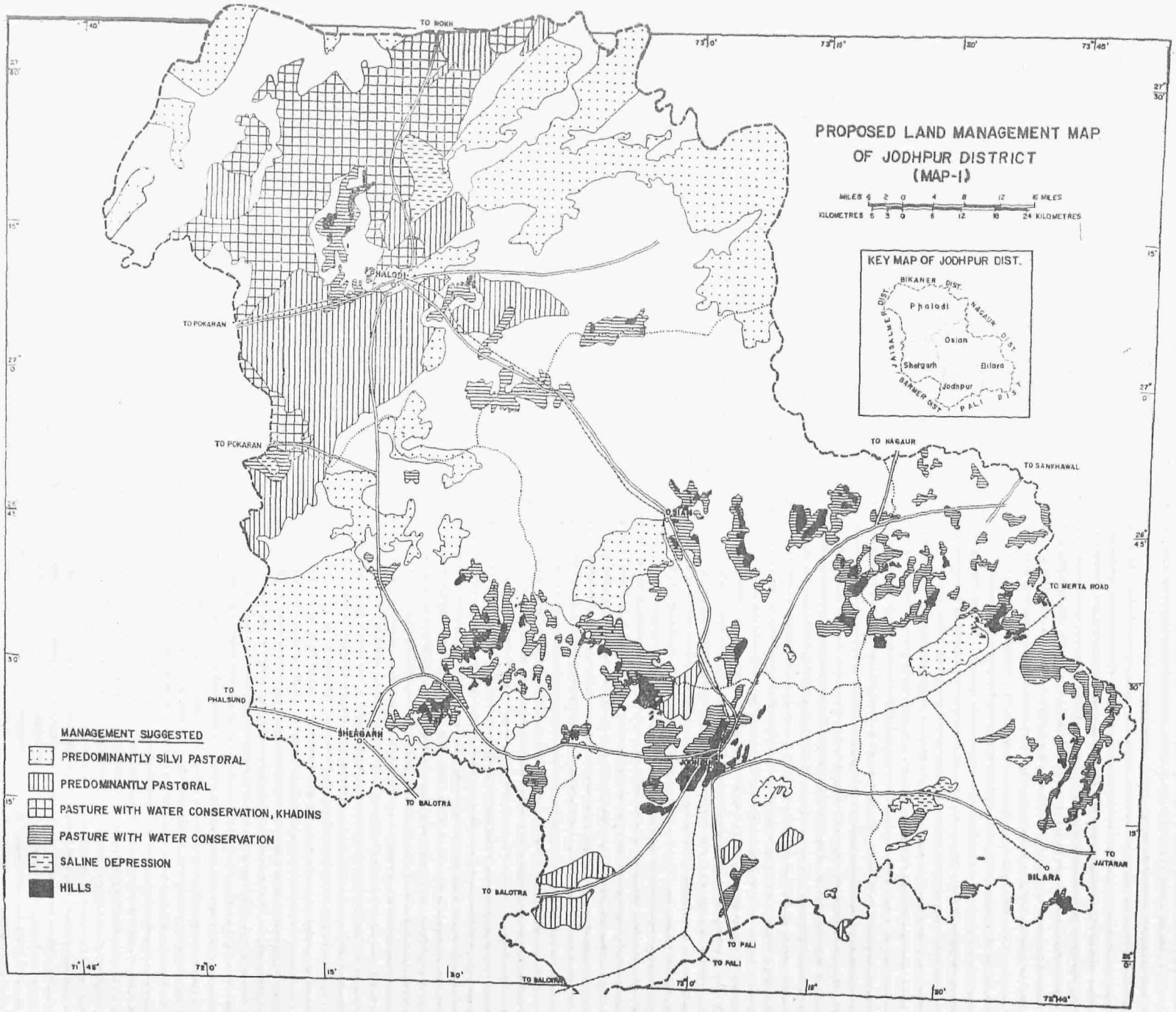
Integrated natural resource surveys are being conducted by CAZRI and that of other bio-physical aspects by several other organisations. The survey areas are selected on the basis of the intensity of vulnerability to desertification. About 1,00,000 km² area has been covered by the CAZRI. These surveys have yielded valuable information for a better land use planning and management. On the basis of evaluation and assessment of physical, climatic and biotic factors, management plans for better land use practices based on ecologically and economically sound principles have emerged. A number of hazards of technologies to be implemented have also come to light.

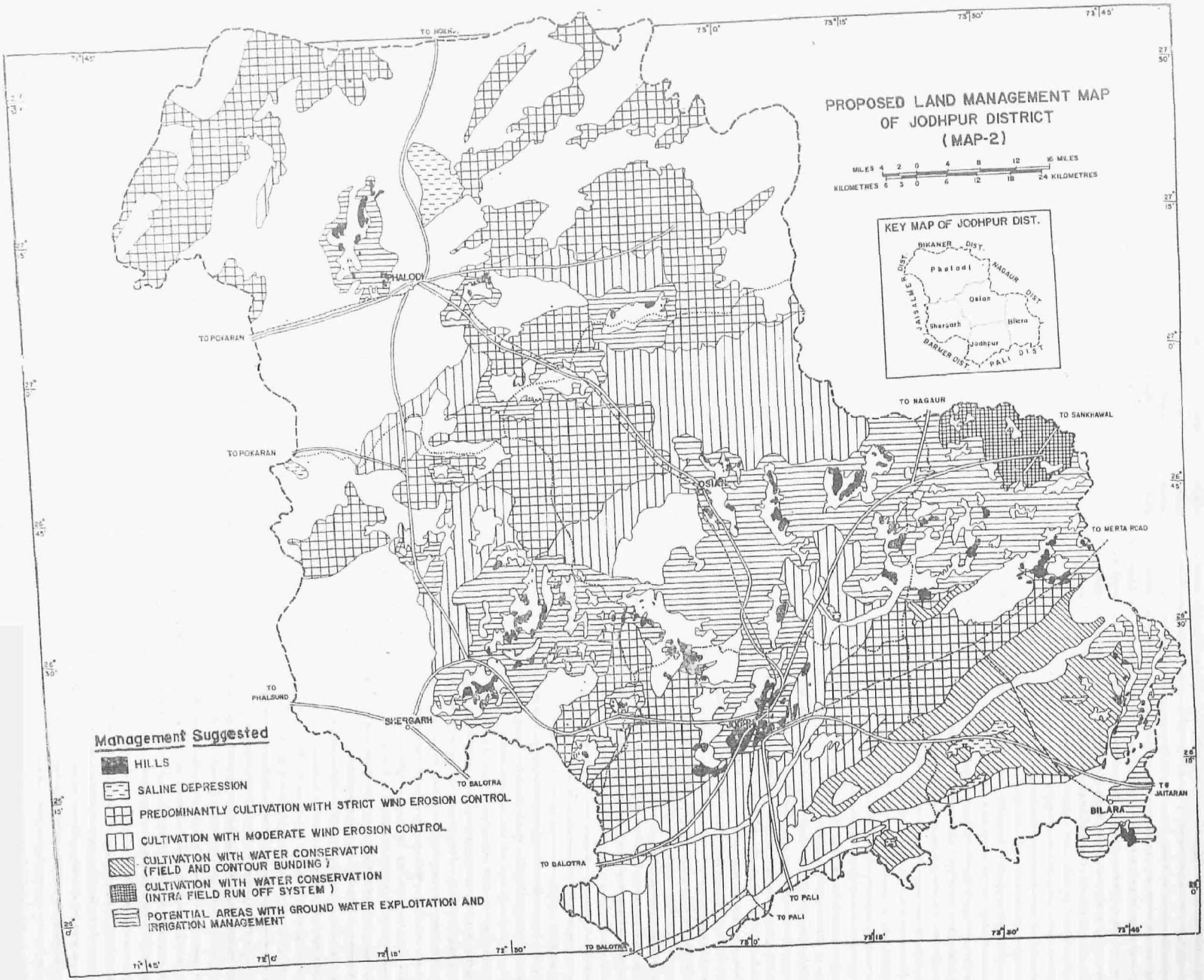
Water brings hope to the desert

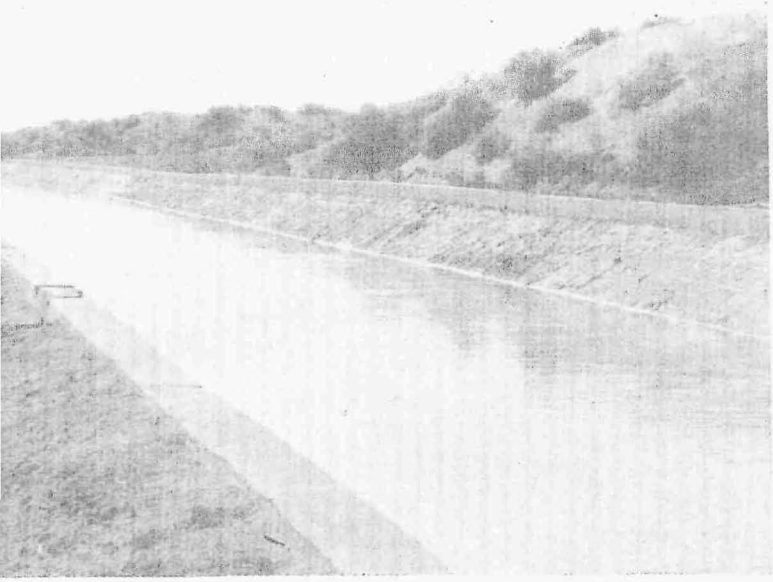


Different soil survey, agricultural and other developmental organisations of Haryana, Punjab and Gujarat are also doing work for land use planning and management in the desert areas. For carrying out this type of survey the basic data are collected from various sources. The Economic, Statistics and Revenue departments of the various State Governments supply the revenue and statistical and land use data which are so essential for regional planning. Survey of India, Dehra Dun is the main source to provide large scale topographical maps and aerial photographs which are main tools for carrying out natural resources survey.

The receiving station of National Remote Sensing


PROPOSED LAND MANAGEMENT MAP
OF JODHPUR DISTRICT
(MAP-I)
MILES 4 2 0 4 8 12 16 MILES
KILOMETRES 6 3 0 6 12 18 24 KILOMETRES
KEY MAP OF JODHPUR DIST.
BIKANER DIST.
JAISALMER DIST.
NAGAUR DIST.
BARMER DIST.
PALI DIST.
Phalodi
Osian
Shergarh
Bilara
Jodhpur
TO NOKH
PHALODI
TO POKARAN
TO POKARAN
TO NAGAUR
TO SANKHAWAL
OSIAN
TO MERTA ROAD
TO PHALSUND
SHERGARH
TO BALOTRA
TO BALOTRA
TO PALI
TO PALI
TO BALOTRA
BILARA
TO JAITARAN
MANAGEMENT SUGGESTED
PREDOMINANTLY SILVI PASTORAL
PREDOMINANTLY PASTORAL
PASTURE WITH WATER CONSERVATION, KHADINS
PASTURE WITH WATER CONSERVATION
SALINE DEPRESSION
HILLS


PROPOSED LAND MANAGEMENT MAP
OF JODHPUR DISTRICT
(MAP-2)
MILES 4 2 0 4 8 12 16 MILES
KILOMETRES 6 3 0 6 12 18 24 KILOMETRES
KEY MAP OF JODHPUR DIST.
BIKANER DIST.
JAISALMER DIST.
NAGAUR DIST.
Phalodi
Osian
Sheregarh
Bilara
Jodhpur
BARMER DIST.
PALI DIST.
TO NOKH
PHALODI
TO POKARAN
TO POKARAN
TO NAGAUR
TO SANKHAWAL
OSIAN
TO MERTA ROAD
TO PHALSUND
SHERGARH
JODHPUR
TO BALOTRA
TO JAITARAN
BILARA
TO BALOTRA
TO PALI
TO PALI
Management Suggested
HILLS
SALINE DEPRESSION
PREDOMINANTLY CULTIVATION WITH STRICT WIND EROSION CONTROL
CULTIVATION WITH MODERATE WIND EROSION CONTROL
CULTIVATION WITH WATER CONSERVATION (FIELD AND CONTOUR BUNDING)
CULTIVATION WITH WATER CONSERVATION (INTRA FIELD RUN OFF SYSTEM)
POTENTIAL AREAS WITH GROUND WATER EXPLOITATION AND IRRIGATION MANAGEMENT

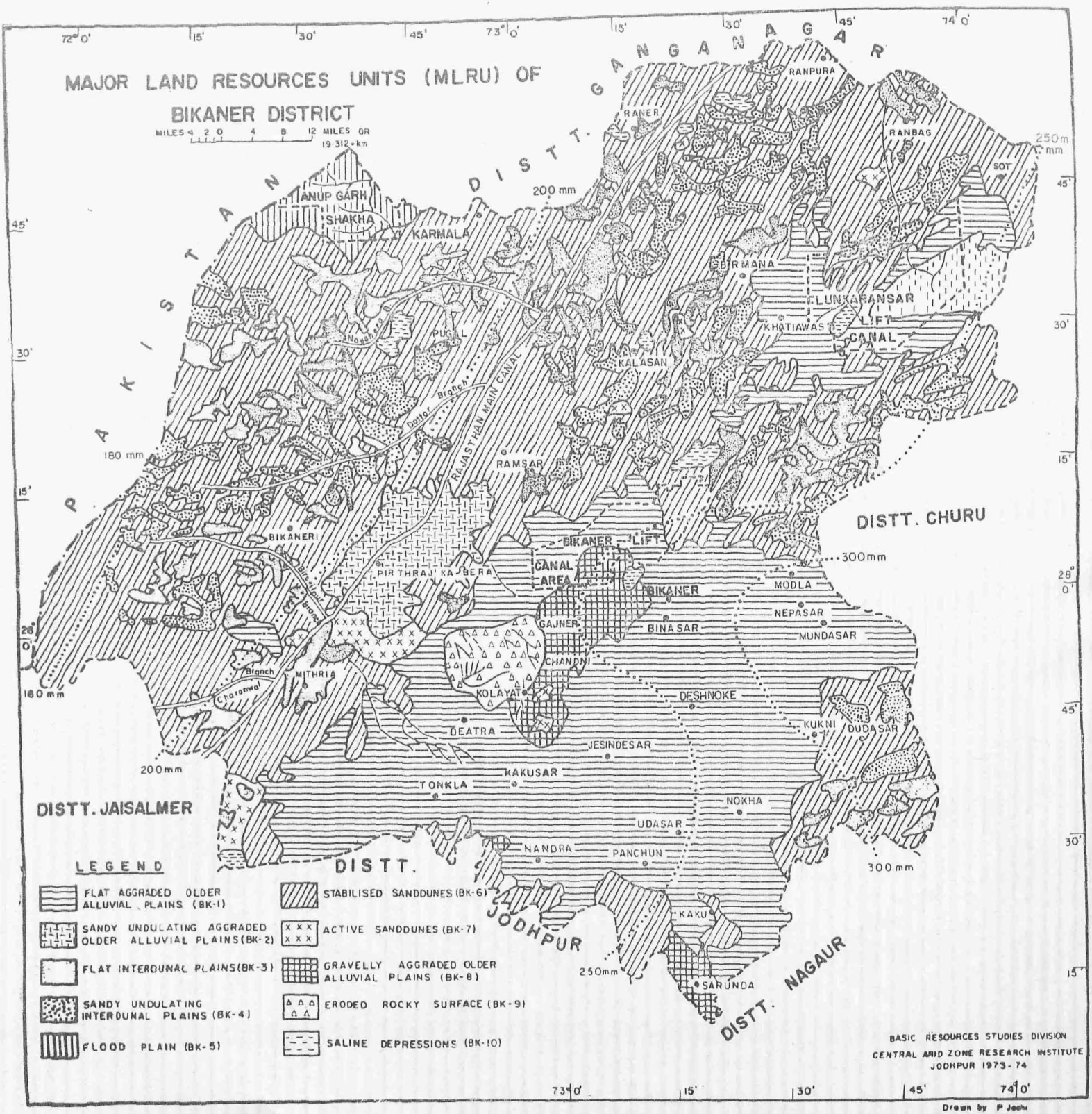


Rajasthan canal passing through the sand dune habitat. Though a massive project, it will irrigate 11 *per cent of the Rajasthan desert*

Agency (NRSA), Hyderabad, began taking test data from Landsat since August 1979. The station has now become operational from January 1980 and users can obtain Landsat data products (70 mm chips, transparencies, color composites etc.) from NRSA. Besides, a large number of application projects are currently in progress at NRSA including natural resources survey, water resources survey and various soil studies.

National Atlases Organisation supplies maps of various scales that are useful for basic resources surveys. Indian Space Research Organisation and its Space Applications Centre besides their own research programme supply sequential Landsat imageries which are very helpful for regional surveys. Indian Meteorological Department is the main source for supply of meteorological data which are probably a primary need for considering developmental planning of arid and drought-prone areas.

Since the approach of mapping the land system as expressed on aerial photographs by a distinctive pattern remains bristled with difficulties in areas with immense biotic activity, a new concept of composite mapping unit—Major Land Resources Unit (MLRU)—has been developed at CAZRI. This unit enables the composite mapping of areas having similar resource potential and management needs. In other words, besides the recurring pattern of soil, land form and vegetation, the MLRU has the receiving pattern of human activities and resource potential of an area for development planning. The human factors are supported by the socio-economic surveys. Integrated natural resource surveys of the following regions have been completed: Rajasthan—Bikaner, Jodhpur, Nagaur, Lower Luni Basin; Gujarat—Santhalpur district; Haryana—Mahendragarh district; and Andhra Pradesh—Chilakeri district.


MAJOR LAND RESOURCES UNITS (MLRU) OF
BIKANER DISTRICT
MILES 4 2 0 4 8 12 MILES OR
19·312 km
PAKISTAN
DISTT. GANGANAGAR
RANPURA
RANER
RANBAG
SOT
250m mm
200 mm
ANUP GARH
SHAKHA
KARMALA
BIRMANA
LUNKARANSAR
KHATIAWAS
LIFT CANAL
PUGAL
Nausar Branch
Dotla Branch
RAJASTHAN MAIN CANAL
KALASAN
180 mm
RAMSAR
DISTT. CHURU
BIKANERI
BIKANER LIFT CANAL AREA
PIR THRAJ KA BERA
Bitrasar Branch
300mm
MODLA
BIKANER
NEPASAR
GAJNER
BINASAR
MUNDASAR
CHANDNI
Charanwal Branch
MITHRIA
KOLAYAT
DESHNOKE
KUKNI
DUDASAR
DEATRA
JESINDESAR
200mm
KAKUSAR
TONKLA
DISTT. JAISALMER
NOKHA
UDASAR
NANDRA
PANCHUN
300 mm
DISTT. JODHPUR
KAKU
250mm
SARUNDA
DISTT. NAGAUR
LEGEND
FLAT AGGRADED OLDER ALLUVIAL PLAINS (BK-1)
SANDY UNDULATING AGGRADED OLDER ALLUVIAL PLAINS (BK-2)
FLAT INTERDUNAL PLAINS (BK-3)
SANDY UNDULATING INTERDUNAL PLAINS (BK-4)
FLOOD PLAIN (BK-5)
STABILISED SANDDUNES (BK-6)
ACTIVE SANDDUNES (BK-7)
GRAVELLY AGGRADED OLDER ALLUVIAL PLAINS (BK-8)
ERODED ROCKY SURFACE (BK-9)
SALINE DEPRESSIONS (BK-10)
BASIC RESOURCES STUDIES DIVISION
CENTRAL ARID ZONE RESEARCH INSTITUTE
JODHPUR 1973-74
Drawn by P Joshi

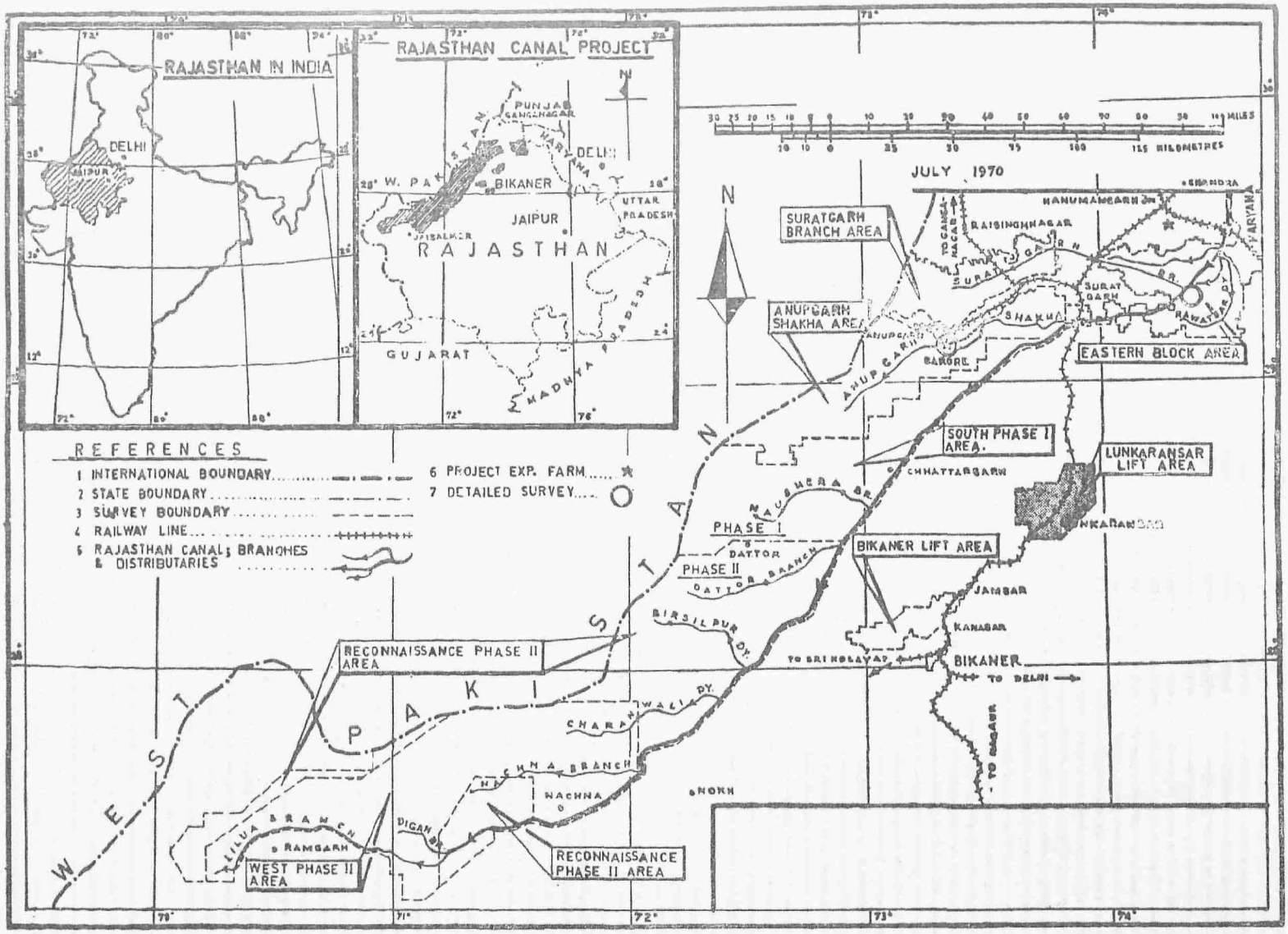
The National Bureau of Soil Survey and Land Use Planning, National Remote Sensing Agency and a few other organisations are also carrying out survey work in various fields. The Rajasthan Government is further utilising the resource surveys in planning the land use in Upper Luni Basin and Rajasthan Canal Command Area.

Such surveys also point out the acceleration of desertification process due to man made decisions. Once a perennial river, the Ghaggar takes its origin from Siwalik ranges in the Himalayas near Simla. Its natural course runs through Punjab, Haryana and northern Rajasthan, and it flows into Pakistan to meet the river Indus. The Ghaggar is a dried up river in the present times but with the development of irrigation in Punjab, Haryana and northern Rajasthan and due to spilling of drainage channels into it, the flood intensity of Ghaggar in Rajasthan has aggravated during recent years. In order to find a suitable solution to combat Ghaggar floods, the Rajasthan Government diverted the excessive water flow into 18 interdunal depressions of various size and shape involving enormous quality of about 0.73 million acre feet of water which had disastrous effect due to seepage of water. These stored depressions caused water logging in about 440 hectares of fertile land !

Improved cropping techniques have increased the production in the arid lands

The Rajasthan Government have established a Desert Development Board for coordinating the efforts of various departments and organisations and managing land use in arid and semi arid regions in the State. The ICAR has also established the Regional Committee No. 6 to identify research needs of the desert states (Gujarat, Haryana, Punjab and Rajasthan) and to formulate proper management.

The University of Jodhpur is conducting land use survey of the Luni basin in collaboration of ISRO.


RAJASTHAN IN INDIA
DELHI
JAIPUR
RAJASTHAN CANAL PROJECT
PUNJAB
GANGANAGAR
HARYANA
DELHI
BIKANER
UTTAR PRADESH
JAISALMER
JAIPUR
RAJASTHAN
GUJARAT
MADHYA PRADESH
JULY 1970
SURATGARH BRANCH AREA
ANUPGARH SHAKHA AREA
EASTERN BLOCK AREA
SOUTH PHASE I AREA
LUNKARANSAR LIFT AREA
BIKANER LIFT AREA
PHASE I
PHASE II
DATTOR BRANCH
NAUSHERA BR.
CHHATTARGARH
JAMBAR
KANASAR
BIKANER
TO DELHI
TO SRI NOHAVAR
BIRSILPUR DY.
RECONNAISSANCE PHASE II AREA
WEST PHASE II AREA
RECONNAISSANCE PHASE II AREA
CHARANWALI DY.
CHHA BRANCH
NACHNA
DIGAN
LILUA BRANCH
RAMGARH
NOKH
TO BAGAR
HANUMANGARH
RAISINGHNAGAR
SURATGARH
SHAKHA
ANUPGARH
BARORE
REFERENCES
1 INTERNATIONAL BOUNDARY
2 STATE BOUNDARY
3 SURVEY BOUNDARY
4 RAILWAY LINE
5 RAJASTHAN CANAL & BRANCHES & DISTRIBUTARIES
6 PROJECT EXP. FARM
7 DETAILED SURVEY
WEST PAKISTAN

The Plant Protection Directorate of Government of India has established a special wing for forecasting the invasion of locust by advanced remote sensing techniques.

improvement of irrigated agriculture and water management

Extensive irrigated agriculture facilities exist in Punjab, Haryana, and northern Rajasthan and these are being further augmented through the construction of the Rajasthan Canal which envisages to transform about 11 per cent of the barren uninhabited areas of western Rajasthan into a vast granary.

In accordance with the Indus Water Treaty and in order to utilise the waters of rivers Ravi, Beas and Sutlej, Rajasthan has been allotted 9860 million cubic metres of water. To bring this water to Rajasthan 204 kms of Rajasthan Feeder and 445 kms of Rajasthan Main Canal, total 649 kms, are being constructed. The work was commenced in 1958. Rajasthan Canal has a gross area of 20.00 lac hectares of which 13.00 lac hectares is culturable commanded area. The intensity of irrigation has been kept at 110 per cent. For facilities of construction and administration the project has been split into 2 stages termed as Stage I and Stage II. Stage I comprises 204 kms of Rajasthan Feeder, 189 kms of Rajasthan Main Canal and 2880 kms of branches, distributaries, minors, etc. The culturable commanded area is 5.36 lac hectares which with an intensity of 110 per cent shall give an annual irrigation of 5.9 lac hectares. Likewise Stage II comprises 256 kms of Rajasthan Main Canal and 4000 kms of branches, distributaries and minors. The culturable commanded area under flow irrigation in Stage II is 5.00 lac hectares and under lift irrigation it is 2.6 lac hectares. Whereas in Stage I there is only one lift canal known as Bikaner-Lunkaransar Lift Canal involving a lift up to 60 metres, and a culturable commanded area of 50,000 hectares, Stage II includes 5 Lift Irrigation Schemes in accordance

Researches at CAZRI to optimize yield of grasses has yielded results. A number of high yielding strains of grass species have been selected and propagated in the desert region

Inter-cropping of legume and grass

with the recommendations of the National Agricultural Commission made in its interim report on desert development. These five lift schemes are Kolayat, Gajner, Phalodi, Pokaran and Nohar-Sawa, involving a lift up to 60 metres and a culturable commanded area of 2.6 lac hectares. The intensity of irrigation in Stage II has been kept at 92 per cent.

In addition programmes are in vogue to fully utilise the underground water resource in the Jaisalmer-Chandan-Lathi region in Rajasthan keeping in view the need of its judicious use as recommended by Ground Water Boards of Central and State Governments.

To suit the availability of irrigated water, research work on water use, irrigation system and models, and cropping patterns, salinity and water logging problems is in vogue at the Central Arid Zone Research Institute, Jodhpur; Central Soil Salinity Research Institute, Karnal; Central Soil Conservation Research Institute, Dehra Dun and in the agricultural and conventional universities in the desert states.

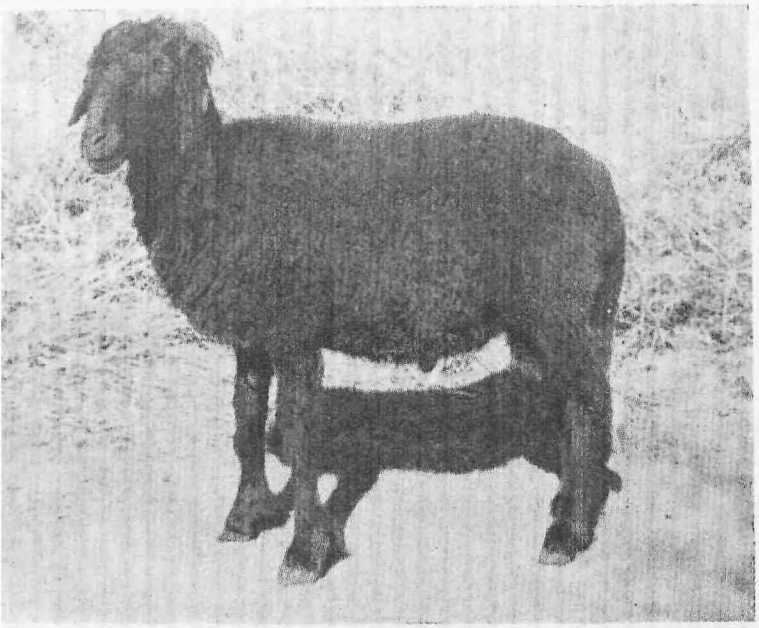
On the basis of intensive eco-toxicological research work carried out on the insect and rodent pests, well tested technologies are available to minimise pre-harvest and post-harvest losses inflicted by these pests.

improvement of rangeland, livestock production and wildlife management

Extreme and intensive studies to establish scientific methods for the upgrading and utilisation of the denuded rangeland in different bio-climatic zones and vegetation types in the desert region have been carried out by CAZRI. A number of technologies for establishing pastures, to regenerate natural ranges, for their protection, carrying capacity, stocking rate, and water harvesting have been standardised and demonstrated at about 60 range management and soil conservation paddocks spread over western Rajasthan. Fruitful technologies have also been developed for soil conservation by the Central Soil Conservation Research Institute, Dehra Dun. Drought Prone Area Programme (DPAP) and Department of Desert Afforestation and Pasture Development (DDAPD) have taken up range management programmes in a big way.

Livestock production is a major lifestay of desert people. Although the livestock sector in Rajasthan accounts for 12 per cent of total income of the State and provides employment to about two-thirds of the population, yet the fact remains that the productivity of livestock is rather low. The challenging problem was taken up by the CAZRI, Central Sheep and Wool Research Institute (CSWRI), Avikanagar, and the Animal Husbandry Departments of various desert states. Based on the national breeding policy for improving sheep in the region for enhancing carpet and apparel wool production and quality, intensive cross breeding programmes were taken up at CSWRI. In addition, a new product—the lamb pelt—has been introduced to raise the economic level of the desert dwellers. Karakul, fat-tailed carpet wool breed of USSR, has been introduced in India. Crosses of Karakul with extremely coarse and hardy breeds like Malpura, Sonadi and Marwari have shown promise for producing acceptable quality lamb pelts. The cross bred sheeps are better adapted to arid conditions.

Crosses of Karakul and Malpura breeds of sheep are thriving in the Indian desert



Karakul lambs are expected to yield expensive materials for woollen clothings

A woollen coat stitched out of Karakul pelts

Improvement in the quality and quantity of wool produced by desert sheep has been achieved through selective breeding of the right types of biochemical polymorphic traits, and by chemically protecting feed proteins from microbial degradation in the rumen. Intermittent (twice-weekly) watering of sheep has been proved to be a better management practice both in terms of sustained or even improved animal production and in almost 50 % saving of water.

Goats have been alleged to be 'desert-makers' but physiological and sociological studies taken up at CAZRI and those on forage utilisation efficiency aspects at CSWRI have indicated that they can be well utilised for meat and mohair production. These programmes are being taken up on a larger scale. The role of the goat in arid agriculture has been reassessed and its continuance in sufficient number has been advocated.

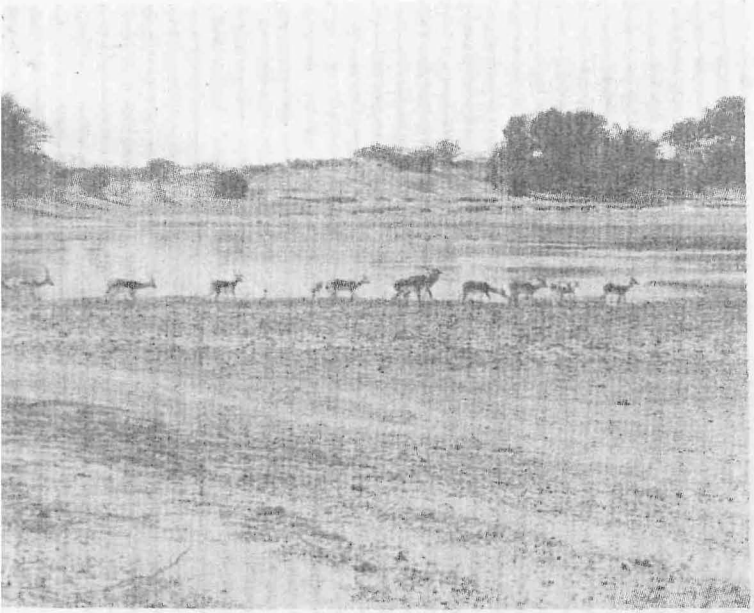
Appreciable progress has been made during the last seven years in respect of dairy development which has been organised through farmers' cooperatives. At the village level primary milk producers' cooperative societies are organised which, besides collecting milk, also provide technical knowhow for increasing milk produc-

tion which inter-alia includes supply of balanced cattle feed, veterinary first-aid, artificial insemination and fodder seeds of improved variety. A laboratory is established in every society for testing the quality of milk, since payment is made on the basis of fat content. 2200 dairy cooperative societies have been organised spread over 19 districts of the State.

The village level societies have been federated into 11 district-level milk producers' cooperative unions set up on milkshed basis. These unions have established animal health and technical input centres from where inputs are sent to the village-level societies. The mobile veterinary unit visits every society once in a week.

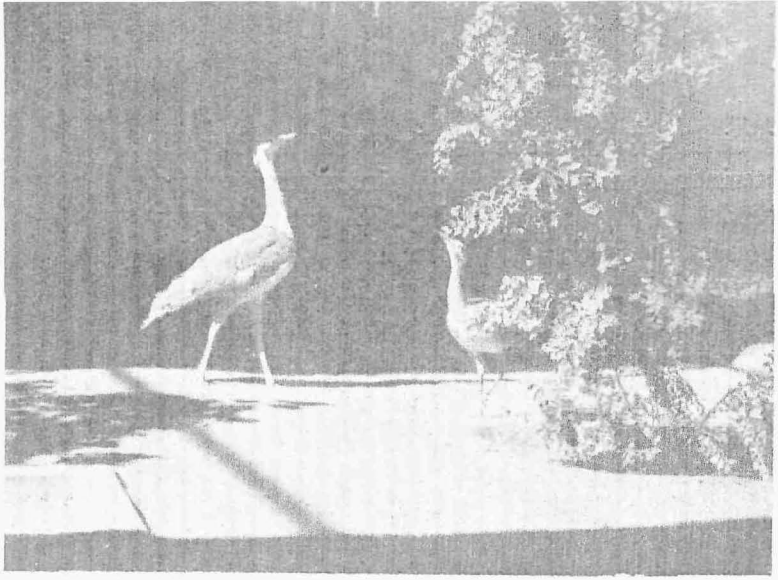
The district milk producers' unions have been federated into their apex body, the Rajasthan Cooperative Dairy Federation. The Federation has set up a number of dairy plants and chilling centres to process the milk received from the district unions. It has also set up cattle feed plants for the supply of balanced cattle feed and Frozen Semen Bank to supply frozen semen for cross-breeding of cattle.

Protection by Bishnoi community on religious ground has yielded results. Black Bucks, though on the red data book, are found in thousands around Bishnoi villages



Bikaner district has been covered under Operation Flood-I. A feeder balancing dairy of 1.0 lakh litres per day capacity has been set up at Bikaner.

Another similar dairy of 1.0 lakh litres per day capacity has been set up at Jodhpur. Six chilling centres each of 10,000 litres per day capacity were set up at Pokaran, Pali, Balotra, Merta, Loonkaransar and Sardarshaher. The capacity of these chilling centres has been expanded to 20,000 or 30,000 litres per day. The capacity of dairy plants at Jodhpur and Bikaner is also being expanded to 1.5 lakh litres each. New chilling centres are being set up at Barmer, Nagaur, Phalodi, Falna, Rajagarh and Chittorgarh.



The 'rare' Great Indian Bustard is still not uncommon in the Thar

Under Desert Development Programme a 1.0 lakh litre capacity dairy plant is being set up at Hanumangarh and 20,000 litre chilling centres at Suratgarh, Nohar, Ganganagar and Jhunjhunu.

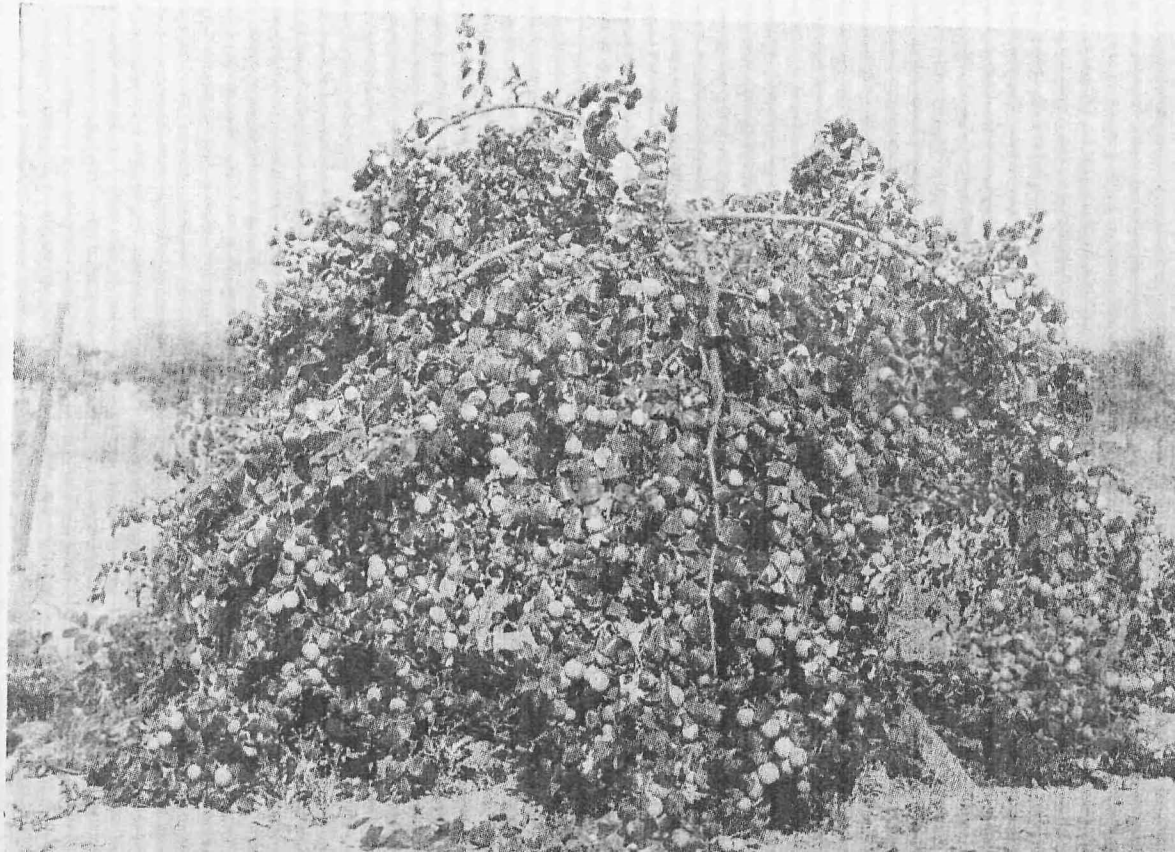
Wildlife management has also received special attention of the State Governments of Gujarat, Haryana and Rajasthan, especially in the arid and semi arid regions. It is an encouraging situation that the density of wildlife species in the desert is still appreciable whereas some of them have almost vanished from the country, namely the Wild Ass, *Equus hemionus*; the Black Buck, *Antelope cervicapra*; the Indian Gazelle, *Gazella gazalla* and the Great Indian Bustard, *Choriotes nigriceps*. The three desert states (Gujarat, Haryana and Rajasthan) have declared the establishment of a number of sancturies for preserving the wildlife. A Desert National Park has also been established in the Jaisalmer-Barmer districts in Rajasthan for the conservation of flora and fauna in its native environment. In this context, the Regional Stations of Botanical and Zoological Surveys of India are lending useful support to the programmes.

The Rann of Kutch in Gujarat harbours the only population of Wild Ass, *Equus hemionus*. A sanctuary has been created at Dharangdhara for their protection. After the formation of the sanctuary, their population has increased. A programme is being carried out for ringing Flamingoes at their nesting sites.

improvement of rainfed farming

CAZRI, Agricultural Universities, Departments of Agriculture in the region and the especially established Coordinated Project on Dryland Agriculture of ICAR with its 24 centres spread all over the country are engaged in planning and conducting research for evolving strategies for rainfed farming chiefly pertaining

The minor millet is an insurance crop to combat short droughts. Resistant to a number of pests and diseases, Setaria italica *can yield up to* 18 *quintals per hectare*



A budded ber (Zizyphus mauritiana) *yields* 40 *to* 60 *kg. fruits per season*

Date palm is being successfully grown in many parts of the Indian desert

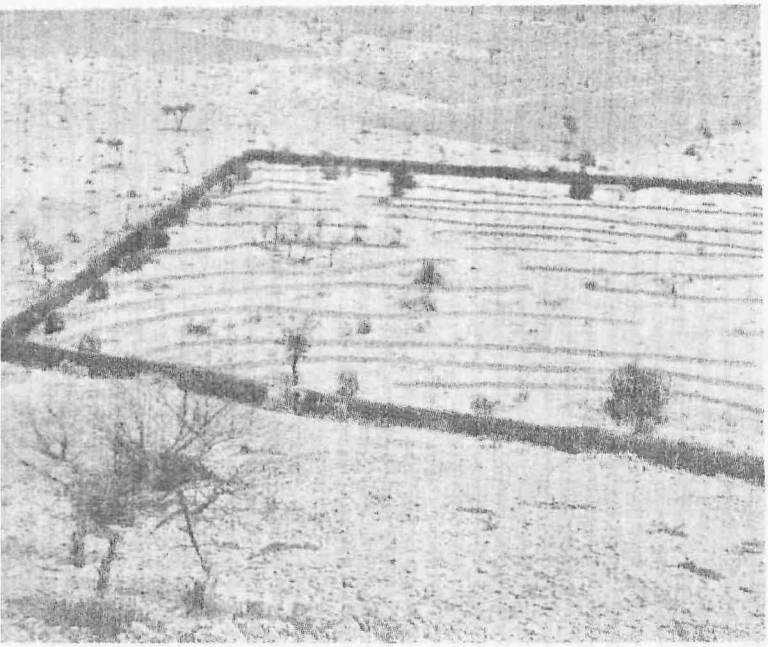
Jojoba, a plant from California. The seeds contain about 50 per cent liquid wax with chemical properties more or less identical to those of the oil from sperm whale. This oil is an excellent agent to increase the antibiotic yield of penicillin, can be used as oil, base raw-material for manufacture of cosmetics and all lubrication purposes

to the following measures :

—Identification of efficient crops and varieties, cropping systems.
—Optimal crop geometry, population, planting patterns.
—Optimal fertiliser use levels and improving efficiency thereof.
—Evaluating mulches, effective conservation procedures.
—Screening available new plant materials for introduction/substitution.
—Designing and developing improved agricultural implements.
—Harvesting and storing inevitable run-off and its recycling strategies for meeting aberrant weather situations.

Based on these major principles, sound crop production strategies have been developed to combat the following aberrant rainfall situations:

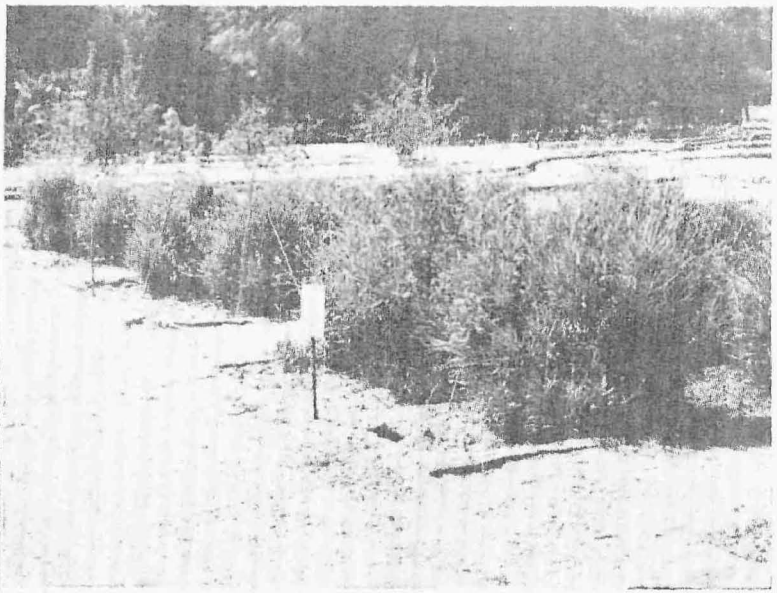
—early onset of monsoon.
—late onset of monsoon.
—early recession of monsoon.
—'breaks' in monsoon at the seedling stage, at flowering, and grain formation stage of dryland crops.
—normal and above normal rainfall years.



Water harvesting by contour furrows increases the grass production

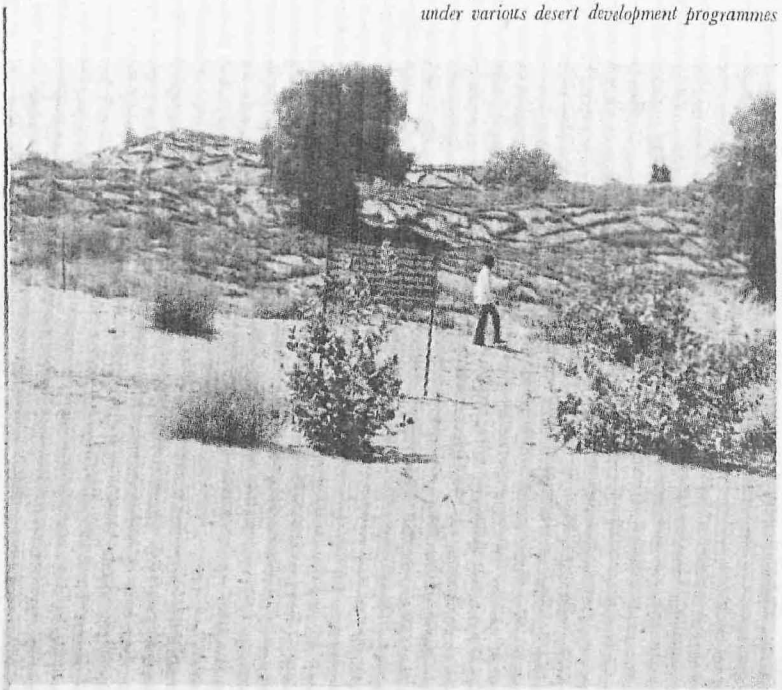
The standardised technologies are being transferred to farmers through Drought Prone Area Programmes, Operational Research Projects, and Extension and Education Wings of various Institutes, Universities and State Departments. Apex level training courses on Watershed Management are being organised at CAZRI and CSCRI, Dehra Dun.

Notable success has been achieved by the CAZRI



Guayule, a rubber plant from central Mexico is doing well at the CAZRI Research Station and two-year-old cultivation is expected to yield 1200 to 1500 kg. rubber per hectare

Sand dune fixation work has been taken up on a large scale in the Indian desert under various desert development programmes

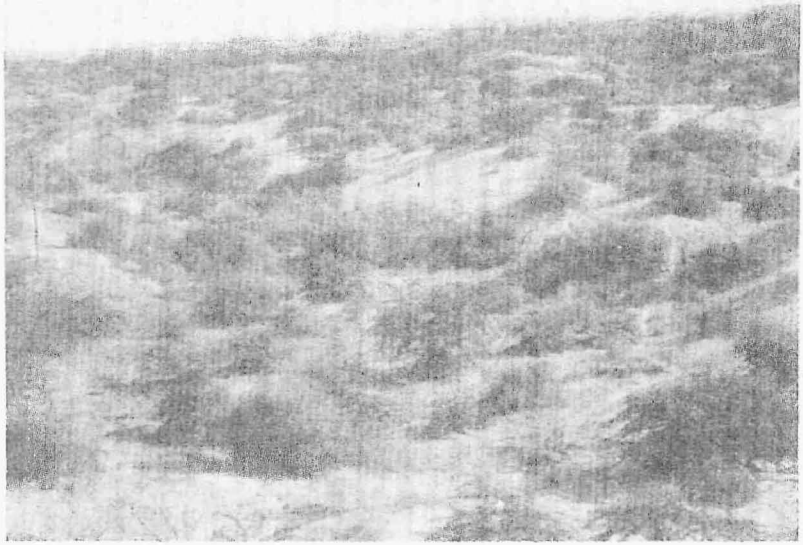


in standardising techniques for establishing rain-fed *ber* (*Zizyphus mauritiana*) orchards in the desert region. A number of orchards established over inter-dunal plains are doing well in such a cost-worthy manner that arid horticulture has become popular among farmers.

Research work for the utilisation of the desert resources, namely organic produce from desert plants, is being carried out at CAZRI. An indigenous know-how has been developed for the extraction and refining of Candelilla wax conforming to cordite factory specifications from the leafless stems of *Euphorbia antisyplitica*. The fruits of an indigenous plant, *Balanites roxburghii*, yield on an average 1.8—2 per cent of commercially acceptable diosgenin—an important raw-material for steroid hormone and oral contraceptives. Scoparone, a drug under clinical trials as a hypotensive and tranquillizing agent, has been isolated in 0.91 per cent yield from the inflorescence of *Artemisia scoparia*. Plantations of Jojoba (*Simmondsia chinensis*) and Guayule (*Parthenium argentatum*) have been established to assess the yield of liquid wax and rubber from these plants.

Sea water irriculture has been successfully evolved at the Central Salt and Marine Chemicals Research Institute, Bhavnagar. It has been possible to grow *bajra* (millet, *Pennisetum typhoides*) under direct irrigation of sea water as a supplemental source of irrigation.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at Hyderabad is intensively studying the resource conservation and management aspects in its Farming Systems Research. It serves as a world centre to improve the genetic potential for grain yield and nutritional quality of sorghum, pearl millet, pigeonpea, chickpea and groundnut.



A re-forested sand dune system near Bikaner. The average cost of Rs. 760 per hectare for stabilising dunes gets repaid after the end of the 13th year

ICRISAT has been using mainly soil loss as an index for desertification process. In small plot studies, multi-slot divisions and collection tanks are used for monitoring runoff and soil loss. In watershed based studies, parshal flumes, stage level recorders and automatic silt samplers are generally used for hydrologic monitoring. The effect of different management practices on soil tilth are also being monitored. Based on such studies a number of technologies for double cropping on vertisols and runoff management have been standardised. Improved practices of tillage, seeding, fertilization, crop geometry and pest management have also been studied to improve rainfed farming in India.

revegetation of destroyed surfaces

Serious efforts have been made to plan, organise and provide funds to improve the desert environment. In 1970-71 the Government of India sponsored a Rural Works Programme for organising labour intensive and production oriented works in the drought prone districts of the country which was in addition to the normal developmental efforts in these districts under the State plans. Priorities prescribed in the Rural Works Programme were :

—major, medium and minor irrigation projects

Avenue plantation in Haryana

Re-vegetation of the denuded land. Cost effective technology for sand dune fixation has been standardised at the CAZRI

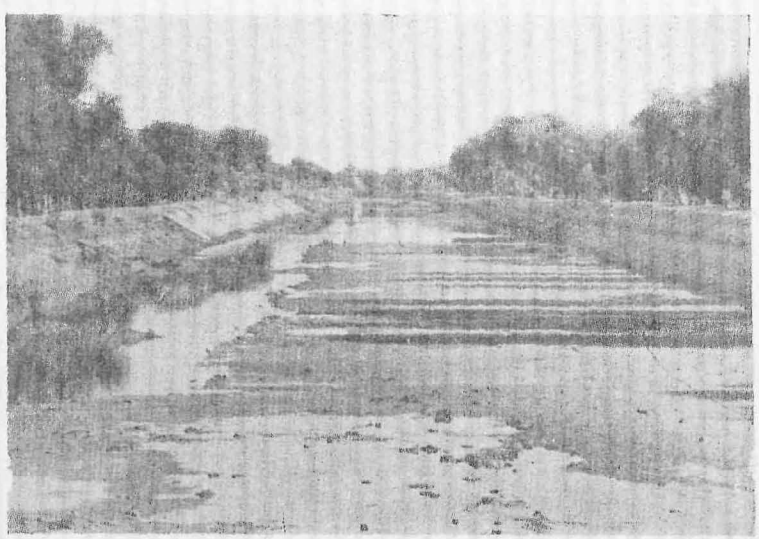
Eucalyptus plantations are becoming popular

including land levelling and other infrastructure facilities
—soil conservation and afforestation works
—increase agricultural production
—establishment of marketing complexes
—village and district roads necessary to open up the area

Later the scope of the programme was enlarged to an integrated area development scheme to seek a permanent solution of the problems of drought in these districts. Accordingly the emphasis shifted from labour-oriented to problem-oriented schemes. This programme was designated as the "Drought Prone Areas Programme" (DPAP) in 1972-73. Various components of the programme are :

—Development and management of water resources
—Soil and moisture conservation measures
—Afforestation with special emphasis on Social and Farm Forestry
—Development of pasture lands and range management in conjunction with development of sheep husbandry
—Livestock and dairy development
—Restructuring of cropping pattern and changes in agronomic practices

Canal side tree plantation



Plantation of shelterbelts increase the crop production by about 20 per cent

—Development of subsidiary occupations
—Development of infrastructure
  —drinking water supply scheme
  —rural electrification
  —rural roads
  —milk routes

The strategy of DPAP is to maximise the production in good rainfall years and to minimise losses when the monsoon fails. Since the development of agriculture has obvious limitations in these areas, the farmers are encouraged to take up subsidiary occupations like animal husbandry, poultry, sericulture and horticulture. Development of a comprehensive package of facilities including processing and marketing has been attempted for such subsidiary activities to enable farmers to derive remunerative prices for their produce. Infrastructure for dairying and sheep breeding has been developed to support cattle rearing and sheep rearing avocations. To improve ecology as also to meet the requirements of the local population, both cattle and human, forestry has been taken up relatively extensively. Earlier emphasis was on the development of forest rangelands and restoration of the neglected forests. Rural electrification to assist the exploitation of ground water has been promoted.

The Government of India launched another programme in 1977-78 designated as "Desert Development Programme" for an integrated development of the desert areas for increasing productivity, income level and employment opportunities for the inhabitants through optimal utilisation of physical, human, livestock and other biological resources. The schemes covered under the Programme included pasture development, cattle development, dairy development, sheep development, camel development and forestry. For infrastructural development only rural electrifi-

cation was permitted on a limited scale. Later the element of individual beneficiary schemes were also introduced. The programme was extended to 19 districts (126 blocks) in 5 States of the country, viz. Rajasthan, Haryana, Jammu & Kashmir, Himachal Pradesh and Gujarat. Of these, 11 districts (85 blocks) were in Rajasthan, the major beneficiary of this programme. This compared with coverage of DPAP extended to 73 districts (401 blocks) in the country (including 18 part-districts) spread over 13 States. Rajasthan again figured prominently in DPAP contributing 79 blocks and 13 districts in the above total. These two programmes have since been running simultaneously in a number of districts. For instance, in Rajasthan DPAP and DDP are in operation in 9 districts.

The Government of Rajasthan revitalised the Desert Development Board and established a Department of Afforestation and Pasture Development, which is functioning in an efficient manner. The major components of this revegetation programme and the achievements till 1980-1981 are :

—Farm forestry (12.18 lakh ha)
—Silvi-pastoral plantation (4750 ha)
—Village fuel-wood and fodder plantation (2800 ha)
—Sand dune stabilisation (13850 ha)
—Shelterbelt-cum-roadside plantation (4304 row km.)
—Pasture development (19500 ha)
—Fodder bank (10600 quintal)
—Canal side plantation (3600 ha)

The proposed financial outlay under the Desert Development Programme for various forestry schemes mentioned above for the plan period has been kept as Rs. 18.5 crores.

The afforestation programme in Rajasthan Canal

Project area, which envisages protection of canals, roads and farmlands from shifting sand dunes and supply of fuelwood, timber and fodder, is being implemented with the assistance of the World Bank within the project area of 2 lakh hectares (Phase I of Stage I). For the remaining 2.46 lakh hectares (Phase II of Stage I), advance action has been initiated. Various works being implemented are shelterbelt plantation along canals and road, fuelwood plantations near villages, sand dune stabilisation, and pasture development. The progress of physical achievements during the past years is very hopeful to revegetate at least parts of the desert region. Allocations available for these works during the sixth plan period are Rs. 7.7 crore.

Similar massive programmes are in vogue in Haryana and Gujarat. Strategies have also been developed by the CSMCRI, Bhavnagar, to revegetate the Coastal dunes through plantations of plants like Guayule, Jojoba, Juncus and Buffalo Gourd.

improvement of human conditions

Feasible national demographic policies have been laid out by the Government and a very large number of centres for family planning have been established throughout the country. The voluntary programme is backed by a scheme of fairly remunerative incentives. Health of people is very well looked after in Government hospitals and dispensaries which provide free medical care.

Besides population control, steps are being taken for improving general literacy standards, providing diversified base or occupations other than agriculture including agro-industries.

Settlement programmes for migratory and nomadic populations have been evaluated after undertaking intensive research work on their socio-economical

aspects, psycho-ethological parameters, traditions, kinship and symbiotic relationships. Employment opportunities to them are also being enhanced.

CAZRI has taken up an extensive study on the social aspects of desertification in collaboration of UNRISD. The project has been successful and has induced a new understanding of the behaviour and traditions of desert people.

drought risk insurance

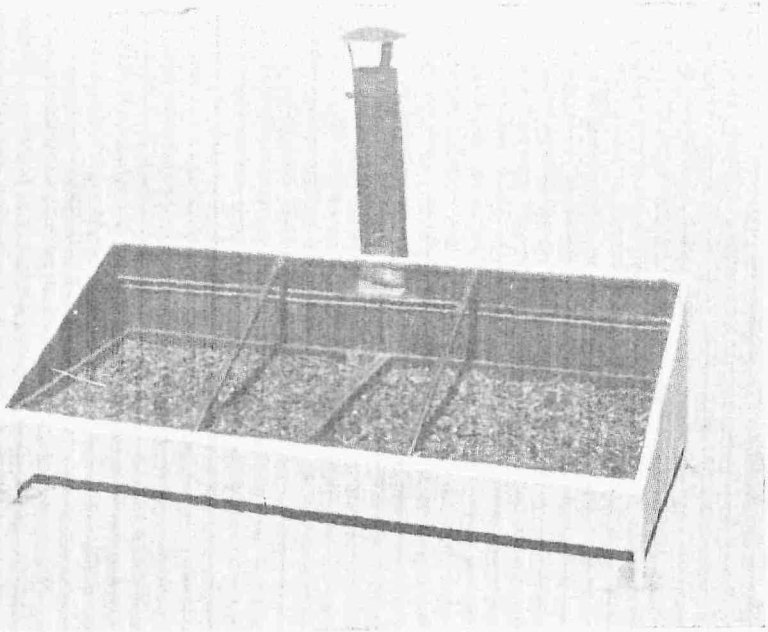
The DPAP programme, as mentioned earlier, is based on the philosophy of providing insurance from drought risks. The nationalised banks have come forward in a big way to provide loans at low interest rate to the needy farmers.

strengthening national capabilities in science and technologies

The Food Corporation of India has established large stocks of foodgrains and the Forest Departments of various states have created fodder banks for providing them to drought affected areas.

As an integral part of Indian Science Policy a number of Central and State Research Organisations, Agricultural and Conventional Universities in the arid and semi arid zones of India are functioning to evolve technologies for combating desertification *vis a vis* local conditions and to tranfer them to various implementing agencies and farmers in the rural environment.

Recognising explicitly the pivotal role that conservation plays for sustained national development, the Government of India has created a Department of Environment (DOE) and a National Committee on Environmental Planning (NCEP). DOE is the 'nodal' agency for environmental protection and eco-development and is playing an important coordinating role in the planning and implementation of all environment monitoring, intelligence and early warning systems besides having direct adminis-



Solar cabinet dryer

trative responsibility for the following:

—Pollution monitoring and regulation
—Conservation of critical ecosystems designated as Biosphere Reserves
—Conservation of Marine Ecosystems

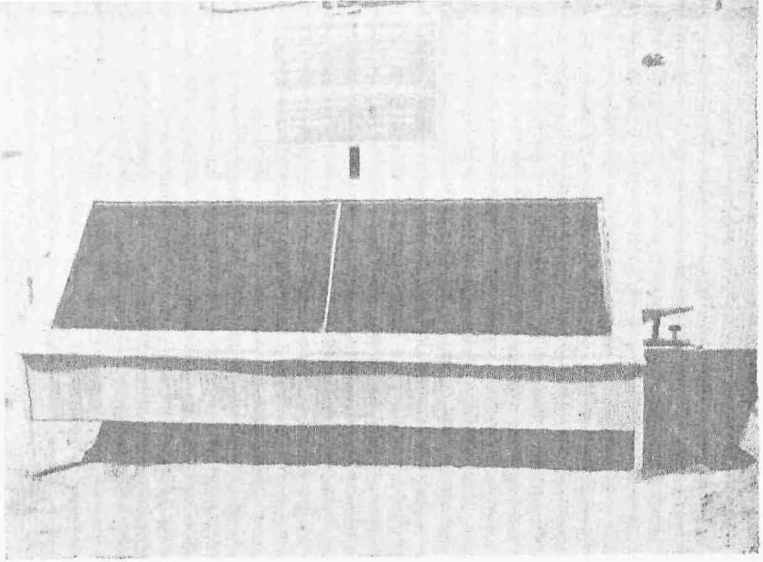
These functions will be supported by the NCEP.

Recently, the Government of India has constituted a Science Advisory Committee to the Cabinet. The Committee will advice on the formulation of the science and technology policy of the Government and on the manner of its implementation. Its functions are to recommend measures for increasing the country's technological self-reliance, with particular reference to the Government's policy on foreign collaboration and import of technology, policy issues relating to the development and application of science and technology and organisational aspects of science and technology institutions. Other functions include filling critical gaps in rational competence, promoting technical co-operation among developing countries and other issues concerning science in international relations.

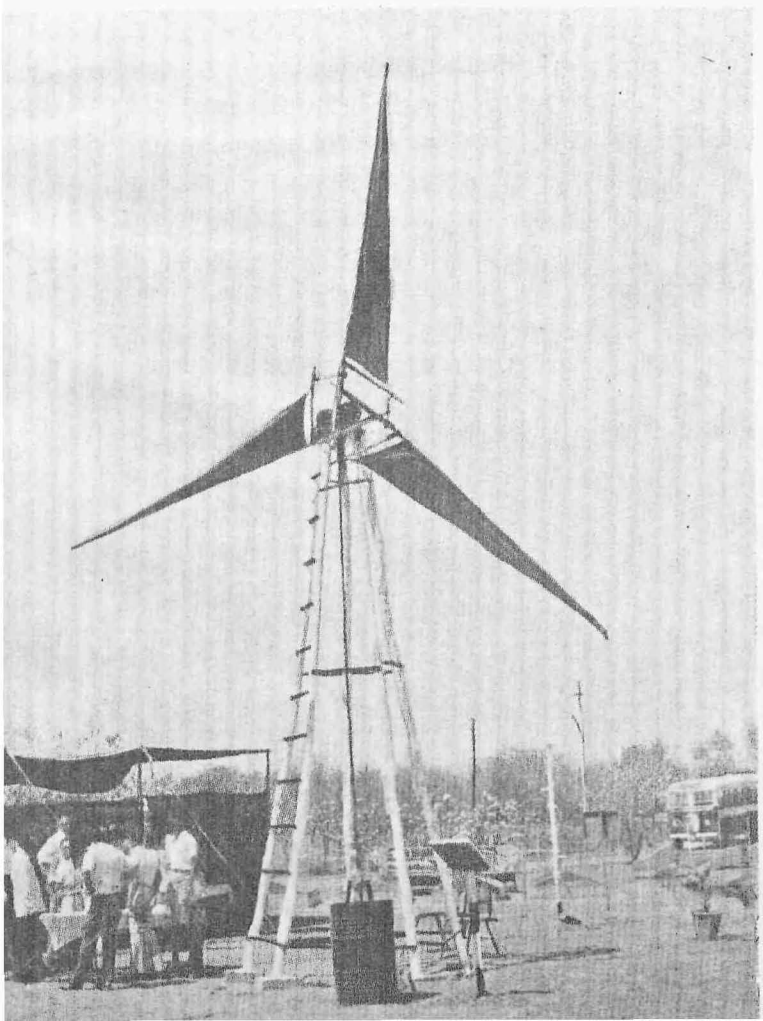
alternative energy sources

Immediate basic requirements of rural areas of India are (a) fuel for cooking, (b) drinking water, and (c) power for lighting, water lifting and farm machinery. The needs of fuel for cooking are mostly met by cutting of trees and burning of cowdung and agricultural waste. The former is the serious cause of desertification and the later deprives the agriculture of a very rich source of organic manure. Drinking water has to be fetched from far-off places. Rural lighting is mostly done by using kerosene whereas power for water lifting and farm machinery is met by manual labour and animal energy, and also from petroleum products, of which there is an acute shor-

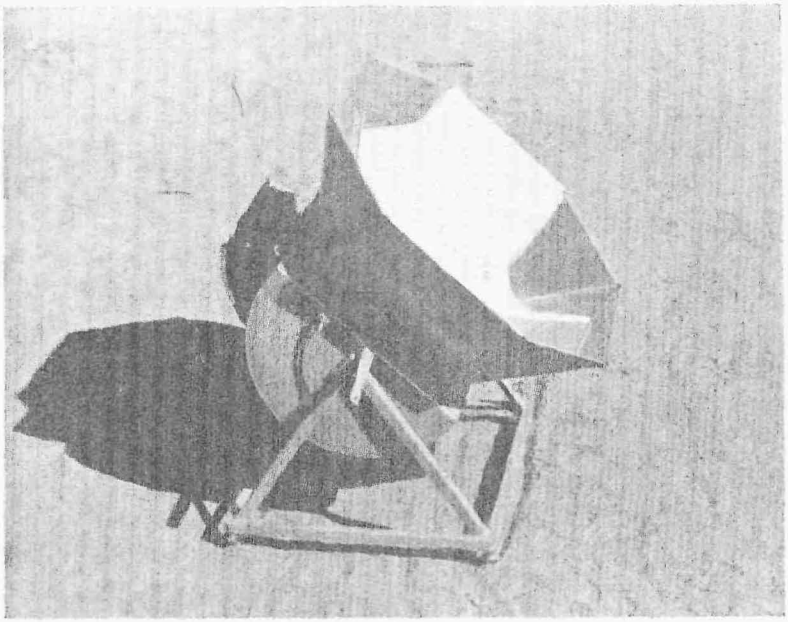
Another source of alternate energy which is available profusely in the desert region is solar energy. A number of gadgets have been fabricated for agricultural as well as domestic use



A low-cost sail-wing wind mill

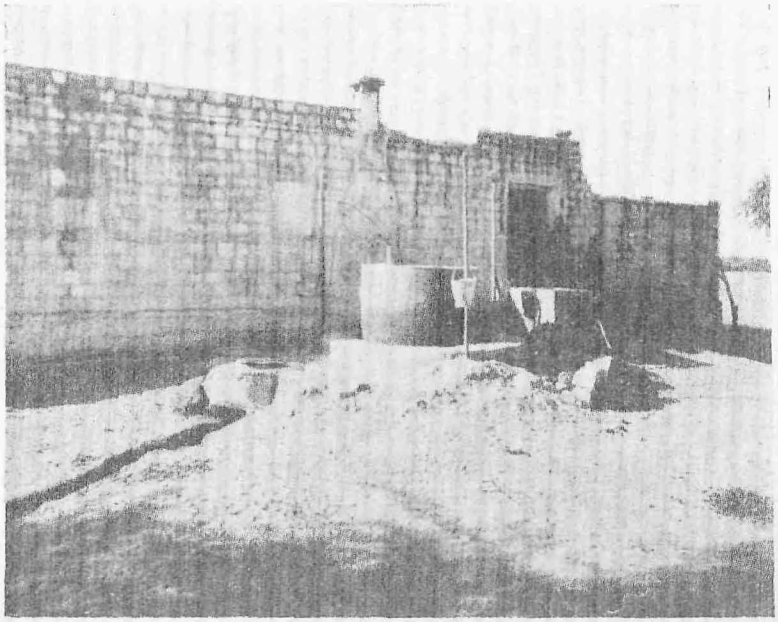


tage. Many of the villages are not covered by the national electric grid. Besides, drying of crops is an important requirement. The present practice of courtyard drying is of long duration, unhygienic and results in wastage of about 15 to 20 per cent by birds and infestation. In view of shortage of fossil fuels, alternative sources of energy (solar, wind, biomass) are being investigated by a number of organisations in the arid zone, e.g. CAZRI, Jodhpur, and CSMCRI, Bhavnagar, Defence Laboratory, Jodhpur, and others. CAZRI has designed and developed a number of solar appliances for water heating, cooking, distillation of saline water into fresh water, drying and dehydration of fruits and vegetables. A number of industries have approached for their large-scale manufacture. CAZRI is also engaged in design and testing of flat plate solar collectors and concentrators, development of heat storage systems and selective surfaces for solar absorbers, and testing of materials for transparent covers, thermal insulation in solar devices. Besides, the institute has also studied the performance of biogas (gobar gas) plants with gas holder (and without) for cooking and lighting. Efforts are also under way to solve the problems in the present biogas plants, viz. corrosion in gas holder, low output during winter and cost.



Solar cooker

A bio-gas plant. If this becomes popular in the desert region, the desert woodlands will be saved immensely

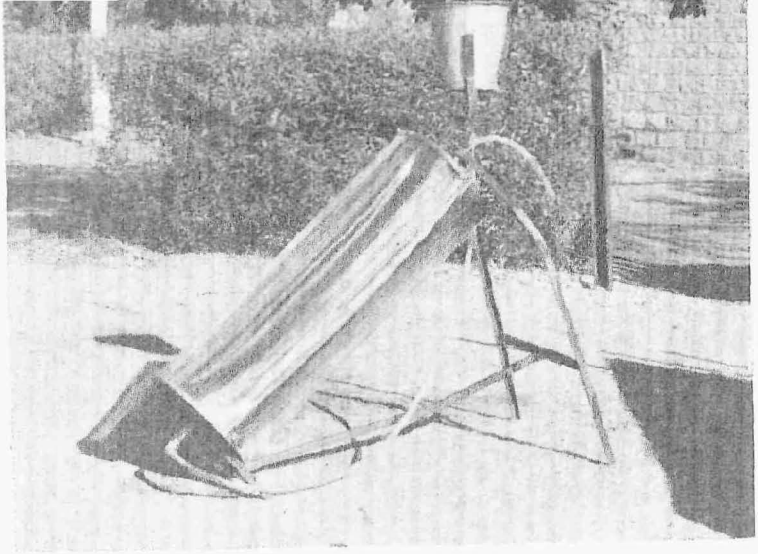


The use of wind power for various purposes to replace conventional energy has not, however, gained momentum, though research work in this direction is in vogue. A suitable low-cost sail-wing wind mill was developed at CAZRI for pumping water.

Feasibility of solar drying, cooking, distillation of saline water into fresh water, wind mills for pumping water and biogas plants is also being demonstrated to the rural community at CAZRI under a PL-480 project. The institute is also coordinating the investigations on solar energy utilization in agriculture at CRRI, Cuttack; PAU, Ludhiana; TNAU, Coimbatore, and University of Udaipur.

Government of India have recently set up a High Level Commission for additional sources of energy with full executive and financial powers. Its main task will be to formulate policies and programmes for the development of new and renewable sources of energy. Broadly, the Commission's responsibilities will be (a) to develop appropriate technology for harnessing solar energy, wind energy, biomass and bio-conversion technology, decentralised energy system and other new areas, (b) to function as the national agency for international cooperation in the field of new and renewable energy sources, (c) to interface research and development with production, by promoting acquisition of technical capability and providing finances for design and engineering of pilot plants and prototype production facilities based on locally invented processes and designs and setting up such pilot plants and prototype facilities, wherever required, for rapid commercialisation of new and renewable energy technologies, (d) to recommend to the Government various incentive measures for commercial use of new and renewable energy technologies by industries, (e) to function as a data bank and to advise the Government on import of technology

Low-cost cylindrical solar water heater



in the area of new and renewable energy sources, (f) to be responsible for operating industrial and import licensing policy and procedures as far as the industries in the new area are concerned, and (g) to develop schemes oriented to the needs of rural India, keeping in view the rural sources of energy available.

training and education

Central as well as State Governments, and Universities are fully aware of the need of training and educating the rural as well as urban populations in respect of habitat conservation and augmenting the productivity of land. As a result many departments have been established for the purpose. Scientific Research Institutes, Universities and State Departments are regularly organising training courses for workers in arid and semi arid zones at various levels, with various objectives. The progress of such programmes is fairly satisfactory. Besides demonstrations in respect of a large number of fields are being arranged to educate the rural masses using all the audio-visual aids, TV, satellite TV, cinema and other extension methods. Very fruitful symposia, seminars and conferences are being arranged for exchange of scientific knowledge and technologies among desert scientists.

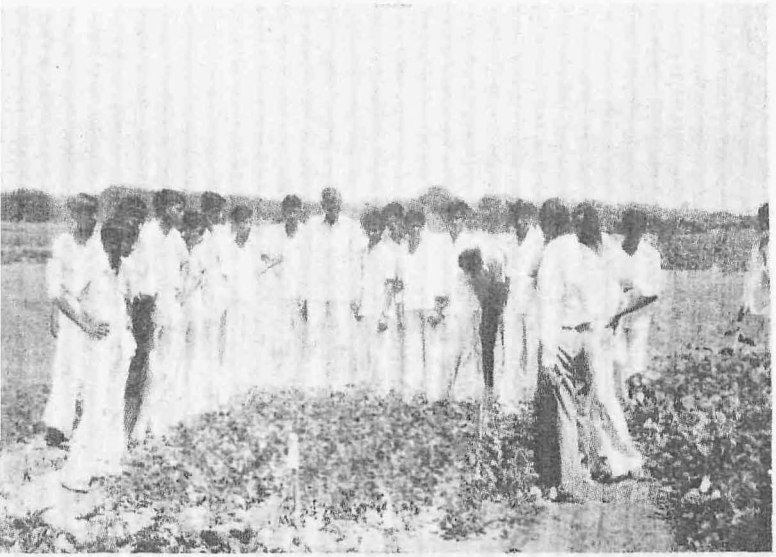
Field trayang to participants of an International Training Course held at CAZRI

Special mention may be made of two programmes launched by ICAR at all of its Institutes and Agricultural Universities: Operational Research Programmes and the Lab to Land Programme. While the major objective of the first is to demonstrate newer technologies to farmers on their own fields, the latter actually inducts farmer families for training and education.

The Jodhpur University is also running a Post-graduate Diploma Course in Desert Technology for Graduate Civil Engineers and Agricultural Engineers. It covers varied topics related to the desert. This course is also taught at the Master of Engineering level.

national machinery for combating desertification

At present the DPAP and the Desert Development and Integrated Rural Development Programmes function as the coordinating and executive authorities in the Thar desert with a scientific backing from CAZRI. However, there is an urgent need that the reclamation and development of the Thar desert are undertaken as a National Project.



Training of farmers is one of the major tasks to ensure participation of community to adopt newer technology

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