Ad-hoc Study No.60

EVALUATION OF SOIL CONSERVATION PROGRAMMES IN THE CATCHMENT AREA OF CHAMBAL RIVER VALLEY PROJECT IN MANDSAUR DISTRICT, MADHYA PRADESH

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CHAPTER-I

INTRODUCTION

1.1 Soil Conservation in Catchment Area

Soil is one of the most important natural resources which goes in the production of crops. Its quality is the very base of the agricultural activities. This natural resource is subjected to small and big calamities like storms, floods and droughts.

Due to these calamities not only the quality of soil deteriorates but also complete removal of the upper layers takes place. These phenomena strike hard on the already depleted quality and quantity of soil, which is being used for centuries without adding to its structural improvement and fertility. Therefore, there is a necessity of adoption of soil and water conservation measures.

On account of erratic distribution of rainfall both in terms of time and area it has become necessary to harness the water in the rivers and tributaries by constructing dams. These dams not only provide irrigation water during lean months but also generate hydel power and enhance activities like fishing, small scale industries, etc.

However, irrigation dams have inherent problems and create some more on their commissioning. One of the problems is that of siltation in the reservoirs. This results in lowering of the capacity of the storage and thereby diminishing the irrigation potential. According to one estimate, it results in the loss of 2.83 lakh hectares of irrigation potential every year.

The loss on account of siltation and non utilization of irrigation potential is estimated at Rs.400 crores in the form of capital assets annually.

In order to contain such losses a Centrally Sponsored Scheme was launched.

1.2 Centrally Sponsored Scheme of Soil Conservation in the Catchment of River Valley Projects

The scheme covered 28 catchments of the country. The total catchment area was 69,473 thousand hectares. Of this area 22,464 thousand hectares or 32.33 per cent were termed as priority watershed area as these required immediate treatment.

The main objectives of the scheme were following.

1. To reduce siltation of the multipurpose reservoirs by increasing soil conservation measures in the catchment areas,
2. To prevent degradation of the catchment area and enhance its productivity through optimum land management,
3. To ensure adequate irrigation water to the command area and increase production, and
4. To provide employment opportunities in the extensive rural areas.

In this scheme the first task undertaken was the delineation and codification of priority watersheds. At the second stage identification of priority watersheds was done.

In fixing the priority, computed weighted sediment production potential method was used.

This index for a given watershed was computed by taking into account factors, such as topography of the catchment, channel system, status of erosion and proximity to the reservoir, as are available from aerial photographs and other sources. Watersheds were then ranked in descending order of weights of sediment

indices and grouped into "very high" "high" "medium" "low" and "very low" priority classes.

A total of 22,464 thousand hectares were demarcated as priority watershed area. Nagarjunsagar had the highest priority watershed area of 6,492.09 hectares, Pochampad had 3,773.95 hectares and Ukai had 2,743.90 hectares (Table 1.1)

1.2.1 Benefits of the Centrally Sponsored Scheme

The benefits were of two types.

Direct Benefits :

A. Protective/ecological benefits included

a) Area directly protected against ercsion such as gullying, wash off and sand casting

b) Protection to the existing production from eroding lands

c) Appreciation of value of land restored to new production system

d) Proportionate investment on dam and its commands protected/proportionate losses due to flood hazards likely to be reduced

e) Proportionate damage to crops etc. due to erosion of flood/drought, prevented

B. Productive benefits included

a) Additional rainfed crop production from catchment

b) Additional crop production from reclaimed land

c) Additional crop production from mini command irrigated through small erosion control/water harvesting structures

d) Production from utility trees such as cashew, sisal, grass etc., used to rehabilitate degraded lands

Table 1.1 Total area, priority watershed area and area treated in different catchments under the Centrally Sponsored Scheme of Soil Conservation in River Valley Projects- upto end of Sixth Plan (1984-85)

(Area in '000ha.)

S.No.	Name of the Catchment	Name of the State	Total Catchment Area	Priority Watershed Area	Area treated upto 1984-85
(1)	(2)	(3)	(4)	(5)	(6)
1.	Beas	Himachal Pradesh	1251	352.78	18.18
2.	Chambal	M.P., Rajasthan	2600	900.46	330.74
3.	Damanganga	Gujrat	182	90.27	3.84
4.	Damodar-Barakar	Bihar, W. Bengal	1819	912.03	271.06
5.	Dantiwada	Gujrat, Rajasthan	281	70.35	60.77
6.	Ghod	Maharashtra	364	54.45	18.28
7.	Gumti	Tripura	54	42.07	2.24
8.	Hirakund	M.P., Orissa	8320	1250.85	264.35
9.	Kangsabati	West Bengal	379	159.18	55.04
10.	Kundah	Tamil Nadu, Kerala	69	18.90	26.60
11.	Lower Bhawani	Tamil Nadu	374	218.32	10.68
12.	Machkund	A.P., Orissa	427	99.90	82.23
13.	Mahi Stage-II	Gujarat, M.P., Rajasthan	2548	1044.68	60.30
14.	Matatila	U.P., Madhya Pradesh	2106	636.10	70.13
15.	Mayurakshi	Bihar	137	76.07	43.30
16.	Nizamsagar	A.P., Karnataka, Maharashtra	2177	316.67	36.64
17.	Nagarjunasagar	A.P.,Karnataka, Maharashtra	21602	6492.09	53.69
18.	Pagladia	Assam	83	66.32	6.45
19.	Pochampad	A.P., Maharashtra	9107	3773.95	14.14
20.	Pohru	Jammu&Kashmir	186	62.49	9.15
21.	Ramganga	Uttar Pradesh	315	105.17	57.15
22.	Rangalimandira	Bihar, M.P., Orissa	2525	809.55	41.53
23.	Sukhna-Lake	Chandigarh	4	4.00	1.74
24.	Sutlej	Himachal Pradesh	1820	796.07	142.76
25.	Tawa	Madhya Pradesh	598	198.53	17.20
26.	Teesta	Sikkim,W.Bengal	1027	746.43	19.36
27.	Tungabhadra	Karnataka	2828	422.70	180.48
28.	Ukai	Gujarat, M.P.,	6240	2743.90	47.06

Indirect Benefits

a) Adoption of subsidiary vocation

b) Stability in production against drought/flood

c) Water security

d) Development of markets and roads etc.

e) Resettlement of landless families

Till 1984-85 an area of 1,936.09 thousand hectares was treated at an expenditure of Rs.181.35 crores. This area was the part of priority watershed area of 22,464 thousand hectares. It was remarked by experts that the rate of programme implementation was very slow and needed to be accelerated.

1.3 River Valley Projects in Madhya Pradesh

Of the 28 river valley projects in the country seven were fully or partially located in Madhya Pradesh. The total catchment area under these was 24,937 thousand hectares and the priority watershed area identified was 7,584 thousand hectares. Further, the area treated upto 1984-85 came to 831.31 thousand hectares. (Table 1.2)

Table 1.2 Total area, priority watershed area and area treated in different catchments under M.P.

(Area in '000 ha.)

Name of the catchment	Name of the state	Total catchment	Priority watershed area	Area treated till 1984-85
Chambal	M.P., Rajasthan	2,600	900.46	330.74
Hirakund	M.P., Orissa	8,320	1,250.85	264.35
Mahi Stage-II	Gujarat, M.P., Rajasthan	2,548	1,044.68	60.30
Matatila	U.P., M.P.	2,106	636.10	70.13
Rangalimandira	Bihar, M.P., Orissa	2,525	809.55	41.53
Tawa	M.P.	598	198.53	17.20
Ukai	Gujarat, M.P., Maharashtra	6,240	2,743.90	47.06
	Total :-	24,937	7,584.07	831.31

1.4 Chambal River

Of the various river valley projects concerning the state of Madhya Pradesh, Chambal was an important one. The total catchment area of this project was 2,600 thousand hectares. The priority watershed area was 900.46 thousand hectares and of this area 330.74 thousand hectares were treated till 1984-85.

River chambal takes origin in Vindhya ranges somewhere near Indore and flows northwards through the districts of Ujjain, Ratlam and Mandsaur all belonging to Madhya Pradesh.

In Mandsaur district, a dam is constructed across it. A big lake formed thereby is called Gandhi Sagar. The description of Gandhi Sagar appears in Chapter-III. From Mandsaur district the river flows to Chittorgarh district of Rajasthan.

In Chittorgarh, a lake called "Ranapratap Sagar" is formed. From Chittorgarh the river flows through Bundi & Kota districts of Rajasthan. Thereafter, it forms the district as well as state boundary between Morena (M.P.) and Sawai Madhopur district (Rajasthan). Ultimately it joins river Yamuna in Uttar Pradesh.

1.5 The Study

The Directorate of Economics, and Statistics, Ministry of Agriculture Govt.of India asked various Agro-Economic Research Centres to conduct a study on "Evaluation of Soil Conservation Programmes in a Selected Catchment area of a River Valley Project" in the respective states. This Centre was asked to conduct the study in the catchment area of "Chambal River Valley Project".

1.6 Objective

To avoid the siltation of the Gandhi Sagar reservoir various soil conservation measures were undertaken in the catchment area.

The objective of this study was to evaluate the soil conservation measures taken up by the Agriculture Department at the farmers level.

1.7 Selected Area

The district selected was Mandsaur the discription of the selected Mandsaur district is given in Chapter-II. In Mandsaur district three sub-watersheds, namely, C-14, C-19, and C-24 were selected for the study.

The detailed description of these sub-watersheds appears in Chapter-III.

All the three watersheds were in tehsil sitamau of Mandsaur district. While watershed No.C-14 had fifteen villages, watershed C-19 had ten villages and watershed C-24 had four villages.

1.8 Sample of Villages and Beneficiaries

Of the 29 villages, 12 villages were selected purposively. A random sample of 62 beneficiary farmers was drawn from the lists of beneficiaries of the villages.

1.9 Reference Year :-

The reference year of the data collected from the selected farmers was 1985-86.

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Chapter-II

Mandsaur District

Lying between latitudes 23°46' and 25°03' north and longitudes 74°43' and 75°57' east in the northern most corner of Indore division, Mandsaur district is situated in the extreme north west of the state. It is surrounded on three sides i.e. west, north and east by Chittorgarh, Bhilwara, Kota and Jhalawar districts of Rajasthan and on the south by Ratlam district of M.P. It takes its present name from the district headquarter town Mandsaur.

Mandsaur is the 19th largest district with 21.5 per cent of the state area and constitutes 2.32 per cent of the population of Madhya Pradesh. It ranks 17th in this respect.

2.1 Physical Features

The district can broadly be divided into two natural regions; the hilly tract, which lies in the north in Jawad, Manasa and Bhanpura tahsils and the typical plateau tract which covers the other parts.

2.2 Rivers

The Chambal river flowing from south to north in the west of the district forms its main river system. It drains into the bay of Bengal through river Jamuna. It rises in Mhow tehsil of Indore district from the Janapao spur of the Vindhyas.

Among important tributaries of Chambal, Siwana is in the south of the district. This river enters Mandsaur tahsil from the west. Somti, Tumar and Gir are tributaries of Siwana river meeting it from the south. Another river is Ratam.. This also enters Malhargarh tahsil from the west and flows north.

Khoki, Erda, Kaidi, Phalka are small rivers in the north of Manasa tahsil flowing to join the Gunjali river, itself a tributary of Chambal. The Orai and Bamani rivers drain the Jawad tahsil.

Climate

Mandsaur district has an average altitude of about 457 metres with parts in the north rising to an average height of 533 metres. The climate is equable with any other part of the Malwa plateau with a small period in the month of May being somewhat oppressively warm. But nights are by and large, pleasant even during May.

The year is divided into three seasons of more or less equal durations, namely, winter, summer and rainy season. December and January are the coldest months of the year. After January, temperature starts rising steadily till mercury touches highest levels in the month of May. From the month of June, mean maximum temperature starts declining from month to month till the month of August. After August the day temperature starts rising, so that mean maximum temperature in September and October is comparable or even more than the July temperature. On the other hand mean minimum temperature starts falling even during the months of September and October. This is the well known phenomenon of warmer days but cooler nights during September and October, the months witnessing transition from rainy to the cold season. After October the mean maximum temperature resumes its downward journey till the minimum levels of mercury are attained in the months December and January. The latter month is, however, slightly cooler than December.

Rainfall

The district gets its rainfall from the south west monsoon, which is spent of much of its moisture by the time it reaches the district. The district, therefore, receives moderate to low rainfall. The rains start sometime in the end of June, gain intensity in July and remain steady in August. The monsoon starts retreating in September, and in exceptional years apart, there is hardly any rainfall in the nonth of October. The downpour, however, is not uniformly distributed over time even in the months of July and August but takes place in bursts alternating with partial or general breaks. There is, however, not much variability of rainfall from place to place.

Average annual rainfall varied from a minimum of 746.8 mm. in the northern most Jawad, to a maximum of 890.6 mm. in Manasa. Garoth with 882.0 mm. Mandsaur with 869.0 mm. and Sitamau with 865.1 mm. of rainfall are not much different from Manasa. Neemuch (805.3mm.) and Suwasra (775.8 mm.) are more like Jawad as regards rainfall. The average for these seven stations which may appropriately be called the district average is 733.5 mm. The rainfall is adequate generally for the kharif or wet crops like jowar and cotton and the cultivation of dry crcps like wheat has the necessity of irrigation.

Population

The total population of the district as per the 1981 census was 12,63,399. Nearly 80 per cent (79.74) of it was rural and the remaining 20 per cent, (20.26) urban. Scheduled caste population formed a slightly higher proportion (15.59 per cent) of the total population (14.10 per cent). On the other hand the district had

a significantly lower proportion (5.20 per cent) of tribal population than that of the state as a whole (22.97 per cent).

The domination of the rural population was also reflected in the occupational distribution. As in the case of population, the proportion of workers engaged in agricultural occupation was 78.72 per cent (cultivators, 59.73 per cent and agricultural labourers, 18.99 per cent).

Agriculture

The district was predominantly agricultural. Land utilisation statistics showed that 57.27 per cent of the geographical area was net area sown. Another 20.63 per cent of the area was not available for cultivation and forest covered 11.23 per cent of the area. (Table 2.1)

Table 2.1 Land Utilisation, Mandsaur district, M.P.

S.No.	Particulars	Area (Hectares)	Percentage to geographical area
1.	Forest	1,06,271	11.23
2.	Land not available for cultivation	1,95,269	20.63
3.	Other uncultivated land excluding fallow	52,553	5.55
	A) Permanent pastures & grazing land		
	B) Land under miscellaneous tree crops and groves	609	0.06
4.	Cultivable waste land	43,854	4.63
5.	Total fallow land	5,983	0.63
6.	Net area sown	5,41,833	57.27
	Total geographical area	9,46,372	100.00

In the matter of irrigation the district had a larger percentage (17.50) of irrigated area to gross cropped area than that of the state average (12.90). The chief source of irrigation was wells. This commanded more than 90 per cent (92.30) of the irrigated area. Tanks (3.14 per cent) and other sources (3.69 per cent) were other minor sources of irrigation. (Table 2.2)

Table 2.2 Area irrigated by different sources, Mandsaur district, M.P.

Source	Area Hectares	Percentage to total
Canals	1,180	0.87
Tanks	4,281	3.14
Wells	1,25,849	92.30
Others	5,029	3.69
Total	1,36,339	100.00

Food crops dominated the cropping pattern of the district with as high as 79.28 per cent area under them. Among food crops cereals and millets occupied 40.67 per cent and pulses, 34.14 per cent. Of the cereal crops jowar and maize shared about equal percentage (15.10 and 15.72 respectively) while wheat covered 9.27 percent. Gram was the dominating pulse crop with 18.10 per cent area. Among non-food crops only groundnut, which constituted 4.90 per cent of gross cropped area, seemed important.(Table 2.3)

Table 2.3 Cropping pattern, Mandsaur district, M.P.

S.No.	Crop	Area in Hect.	Percentage to gross cropped area
1.	Jowar	1,17,618	15.10
2.	Maize	1,22,328	15.72
3.	Wheat	72,240	9.27
4.	Other cereals & millets	4,555	0.58
5.	Total cereals & Millets	3,16,741	40.67
6.	Gram	1,40,961	18.10
7.	Other Pulses	1,24,955	16.04
8.	Total Pulses	2,65,916	34.14
9.	Total Cereals & Pulses	5,82,657	74.81
10.	Sugarcane	1,244	0.16
11.	Total Spices	31,242	4.01
12.	Total Fruits & Vegetables	2,310	0.30
13.	Total Food Crops	6,17,453	79.28
14.	Groundnut	38,146	4.90
15.	Soybean	13,040	1.67
16.	Linseed	8,555	1.10
17.	Other Oilseeds	6,580	0.84
18.	Total Oilseeds	66,321	8.51
19.	Total Fibres	2,281	0.29
20.	Total Intoxicants	11,423	1.47
21.	Total Fodder	9,536	1.22
22.	Other Non - food crops	72,284	9.28
23.	Total Non-food crops	1,61,845	20.72
	Gross cropped area	7,79,298	100.00

Of the gross cropped area of 7,79,298 hectares 1,36,339 hectares or 17.50 per cent were irrigated. Of the irrigated area wheat occupied 47.91 per cent, spices 19.53 per cent. If we take into account the percentage to irrigated area to crop area sugarcane ranked first with 100 per cent irrigated area. Fruits and vegetables were irrigated to the extent of 95.02 per cent. Wheat was the third important irrigated crop with 90.43 per cent irrigation. Spices were irrigated to the extent of 85.26 per cent. A little over 50 per cent (53.71) of the area under fodder was irrigated. It can thus be observed that wheat spices, gram, sugarcane, fruits and vegetables and fodder were important irrigated crops/crop group. (Table 2.4)

Table 2.4 Irrigated area under different crops Mandsaur district, M.P.

S.No.	Crop	Cropped area	Irrigated area of the crop	Percentage to total Irrigated crop	Percentage of Irrigated area to cropped area
1.	Jowar	1,17,618	-	-	-
2.	Maize	1,22,328	1,628	1.19	1.33
3.	Wheat	72,240	65,327	47.91	90.43
4.	Other Cereals & Millets	4,555	1,269	0.93	27.86
5.	Total Cereals & Millets	3,16,741	68,224	50.03	21.54
6.	Gram	1,40,961	19,386	14.22	13.75
7.	Other Pulses	1,24,955	481	0.35	0.38
8.	Total Pulses	2,65,916	19,867	14.57	7.47
9.	Total Cereals & Pulses	5,82,657	88,091	64.61	15.12
10.	Sugarcane	1,244	1,244	0.91	100.00
11.	Total Spices	31,242	26,636	19.53	85.26
12.	Total Fruits & Vegetables	2,310	2,195	1.61	95.02
13.	Total Food Crops	6,17,453	1,18,166	86.66	19.14
14.	Groundnut	38,146	561	0.41	1.47
15.	Soybean	13,040	145	0.11	1.11
16.	Linseed	8,555	158	0.12	1.85
17.	Other Oilseeds	6,580	1,809	1.32	27.49
18.	Total Oilseeds	666,321	2,673	1.96	4.01
19.	Total Fibres	2,281	518	0.38	22.71
20.	Total	11,423	7	0.01	0.06
21.	Total Fodder	9,536	5,122	3.76	53.71
22.	Other Non-food Crops	72,284	9,853	7.23	13.63
23.	Total Non-food Crops	1,61,845	18,173	13.33	11.23
	Total	7,79,298	1,36,339	100.00	17.50

CHAPTER-III

GANDHISAGAR DAM AND SELECTED SUB WATERSHEDS

3.1 Gandhisagar Dam

Gandhisagar dam, a joint venture of Madhya Pradesh and Rajasthan State Governments, constructed in 1960, is the first dam in a series of three dams constructed across Chambal river. The other two are: Ranapratapsagar and Jawaharsagar. It was envisaged that 5,66,000 hectares of land in M.P. and Rajasthan would be irrigated.

The catchment area of Gandhisagar is bounded by Vindhya range in the scuth and Aravali range in the north-east, forming the shape of a fan. The catchment area of Gandhisagar was 23,025 square kilometres. It was drained by Chambal and its eight tributaries. Of the total catchment area 66.16 per cent was cultivated land, 4.28 per cent was culturable waste and 3.62 per cent was forest.(Table 3.1)

Table 3.1 Break up of land us in catchment of Gandhisagar

Particulars		Area (Hectares)	Percentage of total catchment area
(i)	Culturable waste and uncultivated land	98,700	4.28
(ii)	Cultivated land	15,23,200	66.16
(iii)	Forests	83,400	3.62
(iv)	Others	5,31,200	23.08
(v)	Lake area	66,000	2.86
	Total	23,02,500	100.00

Water spread at full reservoir level was 660 sq. kilometers.

3.2 Some Observations of Sedimentation in Gandhisagar

The average sedimentation index on the basis of first hydrographic survey carried out on Gandhisagar reservoir in 1975-76 worked out to 964 cubic metres per sq.km.per year which was about 270 per cent of the design value of 357 cubic metres per sq.km. per year and 192 per cent of the value obtained by indirect method i.e. 502.59 cubic metres per sq.km.per year. The reservoir, as a whole was losing its capacity at an average rate of 0.28 per cent, the average annual reduction in dead and live storage being 1.94 and 0.89 per cent respectively.

Taking the rate of sedimentation based on hydrographic survey to be more reliable, the inadequacy of the design assumption became all too apparent. This phenomenon was, however, not unique and was observed in the case of many other reservoirs of the country. It called for intensive soil conservation measures in the catchment area.

The experts opined that urgent remedial measures in the catchment area of Gandhisagar were needed to bring down the rate of siltation. They have also observed that the soil conservation programme already in hand of the State Agriculture Department should be reviewed and progress thereon should be monitored by the State Irrigation Department to ensure achievement of timely and effective results.

3.3 Soil Conservation Programme in Gandhisagar Watershed

The State as well as Central Government were aware of the siltation hazard to the reservoir and the soil conservation measures were already initiated. Administratively the project was divided into two parts: one being centrally sponsored programme

under river valley project to tackle the more vulnerable areas on priority basis which were in the vicinity of the reservoir and the other comprising soil conservation measures to be adopted in the upper catchment, to be financed by the State Govt.

There were two types of soil conservation methods adopted in the Gandhisagar catchment. The first type consisted of engineering methods of contour bunding and gully bunding used in the case of cultivated land. The second was afforestation in the case of unculturable land.

Contour bunding was taken up for the fields having moderate slope upto 1.5 per cent. For steeper contour gully bunding was considered more feasible.

The State Agriculture Department intended to protect the entire catchment area by means of soil conservation. Till this study 4,000 sq.km. of catchment was covered at a cost of Rs.244.0 lakhs. On completion of the programme which may take another 10 years or so, the rate of silting would be brought down substantially.

3.4 Selected Sub-watersheds

3.4.1 Location

The selected subwatersheds, as mentioned earlier, were located in Mandsaur district. All these belonged to Sitamau tehsil. These subwatersheds formed parts of the watershed chambal and sub catchment and catchment Chambal. Since the study was concerned with the siltation of Gandhisagar these were purposively selected from among those located above the Gandhisagar reservoir.

The general characteristics of the three subwatersheds are described below to be followed by those of the individual ones.

3.4.2 Climate

The climate of the area was semi-arid. The average rainfall was 816 mm. It occured mainly in the months of July and August. Winter rainfall was irregular.

The climatological observations recorded at tehsil headquarters Sitamau for the last 20 years were as follows.

1. Mean rainfall - 816 mm.
2. Maximum rainfall - 1562 mm. (1973)
3. Minimum rainfall - 418 mm. (1979)
4. Mean maximum temperature - 31.5^{o}C
5. Mean minimum temperature - 18.6^{o}C

3.4.3 Geology

The area lay at the junction of Malwa Plateau & Vindhya Ranges. It represented complex geological picture. Trap rock was the major formation of the area. The rocks exhibited a tendency towards spheroidal weathering which was typical in the case of basaltic rocks. These were rich in ferro-magnesium.

Soils of the area were developed from basaltic parent material. Following soil types were indentified.

1. Antralia	2. Baloda	3. Sarold
4. Harsaur	5. Kamliakheri	6. Gabapura
7. Pachdoria	8. Inahera	

Broadly speaking the soils had various shades of darkness and were developed from the decomposed rocks which were yellowish brown to dark greyish in colour.

3.4.4 Hydrology

The area was drained by small gullies and nallahs flowing from south to north-east or south to north direction. They met the Chambal river whose direction of flow was from south east to north west.

The soils had moderate to low infiltration capacity. They were quite erodable. Crop cover conditions during rains were not good, hence, heavy run off was expected. Gullies were formed due to long length of run. They were mostly located on lower catchment side of nallahs and river. The eroded soil particles (which were mostly fine) were transported through gullies, nallahs and small rivers to main chambal. This area adjoined the reservoir area hence the erosion had a very serious effect. The reconnaissance survey conducted by the "All India Soil and Land Use Survey Organisation" for demarcation of priority subwatersheds in the catchment of Gandhisagar Dam revealed extensive evidence of erosion hazards in the area. Observed sediment loss at a nearby silt and runoff gauging station was of the order of 0.37 hectare metre/sq.km. of the catchment area.

3.4.5 Sedimentation

Highest silt quantity per unit area was produced from both the banks of nallahs and rivers where intensive gully formation were met with. These areas were mostly government land or grass land. Next in order were the areas affected by sheet and rill erosion which were mostly spread over the cultivated area. Silt was also produced due to heavy rush of water from hills to nearby nallahs through cultivated area. This type of erosion was also located mostly in cultivated land. It was estimated that gullies and stream banks accounted for 60 per cent of delivery rate and

sheet and rill erosion about 40 per cent in the total sediment yield.

3.4.6 Vegetative Cover

Due to moderate rainfall and relatively high temperature dry deciduous zerophytic plants were of common occurrance. Prominent among the trees were : Dhakora or Palas, Babool and Kher.

Various types of grasses covered uncultivated area and hillocks but they were not allowed to develop due to constant and heavy grazing. There were no important timber trees in the area. There was only scrub jungle and was devoid of vagetation. Some cultivators grew grass for fodder on small fields.

The description of individual subwatersheds follows.

3.5 Subwatershed C/14 (Watershed of Meria Khadi Khal)

The subwatershed was located at a distance between 15 to 20 km. from the tehsil headquarters of Sitamau. The road from Sitamau to Jaora via Laduna passed through the watershed. The area was drained by medium gullies which formed into nallah which in turn drained into Chambal river.

The area of the watershed was 7,500 hectares. The slope of the area was such that a little less than 50 per cent of the area had 1 to 3 per cent slope and about 25 per cent each had slope range between 1 per cent and above 3 per cent. (Table 3.2)

The entire area was a broad plain of low relief having local differences in elevation. The gentle undulating land surface consisted of succession of low ridges with crests separated by shallow valleys.

Table 3.2 Slope range of the area under selected sub-watersheds

Slope range	C-14		C-19		C-24		Total	
	Hectares	Percentage to total	Hectares	Percentage to total	Hectares	Percentage to total	Hectares	Percentage to total
1. Upto 1 per cent	1,945.00	25.93	1,500.00	29.13	1,600.00	46.00	5,045.00	31.28
2. Between 1to3per cent	3,540.00	47.20	2,650.00	51.45	1,000.00	28.76	7,190.00	44.58
3. Above 3 per cent	2,015.00	26.87	1,000.00	19.42	878.00	25.24	3,893.00	24.14
Total	7,500.00	100.00	5,150.00	100.00	3,478.00	100.00	16,128.00	100.00

Table 3.3 Land use, selected sub watersheds

Particulars	C-14		C-19		C-24		Total	
	Hectares	Percentage to total	Hectares	Percentage to total	Hectares	Percentage to total	Hectares	Percentage to total
Agricultural land	5,260.00	70.13	3,300.00	64.08	2,450.00	70.44	11,010.00	68.28
Wasteland	1,125.00	15.00	835.00	16.21	515.00	14.81	2,475.00	15.34
Other land	1,115.00	14.87	1,015.00	19.71	513.00	14.75	2,643.00	16.38
Total	7,500.00	100.00	5,150.00	100.00	3,478.00	100.00	16,128.00	100.00

Of the total area of 7,500 hectares about 70 per cent was agricultural land. The remaining percentage was nearly equally shared by wasteland and other land.(Table 3.3) Again,of the total area 6,385 hectares or 85.13 per cent was severely affected by soil erosion and needed immediate remedial measures.(Table 3.4)

The crops grown were mainly jowar, maize and grourdnut. Opium and sugarcane were also grown in area having assured irrigation facilities.

The erosion problem consisted mainly of sheet and rill erosion in the upper reaches of the watershed. In the middle, gully formations were seen in addition to the sheet and rill erosion. The lower reaches had medium gullies.

The treatment of area according to the management plan would initially require complete protection of top land by bunding and diversion of the run off so that it would not rush from upper part to the lower reaches of the sub watershed. Thus, excessive erosion in areas down below would also be controlled automatically. Active gullies would be treated directly so as to stabilise the beds and minimise further erosion.

Subwatershed C/19

The subwatershed was located at a distance of about 15 km. from Sitamau tehsil headquarters. The road from Mandsaur to Suvasara passed through the sub watershed.

The subwatershed had mostly uniformly sloping topography. Small hillocks were located in the north east. The area was drained by medium gullies which formed into a nallah which in turn drained in Chambal river. The direction of main nallah was

Table 3.4 Details of area needing soil conservation measures, selected sub watersheds

Particulars	C-14			C-19		
	Total Area	Area needing soil conservation measures	Percentage of area needing soil conservation to total area	Total Area	Area needing soil Conservation measures	Percentage of area needing soil conservation to total area
Agricultural land	5,260.00	5,260.00	100.00	3,300.00	2,555.00	77.42
Wasteland	1,125.00	1,125.00	100.00	835.00	535.00	64.07
Other land	1,115.00	-	-	1,015.00	-	-
Total	7,500.00	6,385.00	85.13	5,150.00	3,090.00	60.00

Contd.....

Table 3.4 Continued.....

(Area- Hectares)

Particulars	C-24			Total		
	Area	Area needing soil conser-vation measures	Percentage of area needing soil conservation to total area	Area	Area needing soil conser-vation measures	Percentage of area needing soil conservation to total area
Agricultural land	2,450.00	785.00	32.00	11,010.00	8,600.00	78.11
Wasteland	515.00	515.00	100.00	2,475.00	2,175.00	87.88
Other land	513.00	-	-	2,643.00	-	-
Total	3,478.00	1,300.00	37.38	16,128.00	10,775.00	66.81

from south west to north east, whereas, the river Chambal flowed from south east to north west.

The drainage in main Chambal catchment was moderate. Surface run off was quite significant and flowed through a number of small streams and nallahs. The drainage density was 0.83 km. per sq.km.

The total area of the sub watershed was 5,150.00 hectares. The distribution of area according to slope range indicated that slightly more than half of the area had a slope between 1 to 3 per cent. Another 30 per cent area had a slope below 1 per cent and the rest of the area had above 3 per cent slope.(Table 3.2)

Agricultural land formed 64.08 per cent of the total area. Wasteland formed 16.21 per cent and other land, 19.71 per cent. (Table 3.3)

Of the total area of the sub-watershed 60.00 per cent needed soil conservation measures immediately. (Table 3.4)

Among the different engineering measures of soil and water conservation for cultivated land more important were bunding and construction of diversion channels. Gully control structures were also important. The total cost was estimated to be Rs.8.45 lakhs. (Table 3.5)

Table 3.5 Engineering measures of soil conservation proposed for agricultural land, Subwatershed C/19

S. No.	Engineering measure	Area (Hectares)	Cost/ hectare	Total cost Rs. lakhs
1.	Bunding	1,300	200	2.60
2.	Diversion Channels		50	0.65
3.	Compartmental bunding		50	-
4.	Bench terracing	55	200	1.10
5.	Gully control structures	1,200	300	3.60
6.	Maintenance of above works	-	-	0.50
	Total	2,555	-	8.45

Among the measures for wasteland development a check dam in gully control work was most important. The cost on this measure and the maintenance cost totalled up to Rs.0.46 lakhs.(Table 3.6)

Table 3.6 Engineering measures of soil conservation proposed for wasteland, subwatershed C/19

S.No.	Engineering measure	Area (Hectares)	Total cost (Rs. lakhs)
1.	Check dam in gully control work	535	0.46
2.	Maintenance	-	negligible
	Total	535	0.46

Thus the total cost of development of cultivated land and wasteland came to Rs.8.91 lakhs.

In addition, the cost on buildings and other items was estimated to be Rs.0.20 lakh and Rs.0.03 lakh making up the total cost to Rs.9.24 lakhs. (Table 3.7)

Table 3.7 Distribution of total cost of soil conservation, subwatershed C/19

S.No.	Item	Rs. (lakhs)	
1.	Engineering measures	8.91	(8.45+0.46)
2.	Equipments	0.10	
3.	Buildings	0.20	
4.	Other items	0.03	
	Total	9.24	

It was proposed to execute the entire work in a phased manner so that the work would be completed in 3 years.(Table 3.8)

Table 3.8 Schedule of soil conservation measures, subwatershed C/19

Year	Coverage (Hectares)			Total cost (Rs. lakhs)
	Agricultural land	Wasteland	Total	
I	815	200	1,015	2.77
II	820	200	1,020	2.97
III	920	135	1,055	3.17
Total	2,555	535	3,090	8.91

Management plan would begin with complete protection of top land by bunding and diversion of run off. It would also check excessive erosion of down slope. Active gullies would be treated directly so as to stabilise their beds and minimise further erosion.

As a result of these measures the agricultural production was expected to increase by 10 to 15 per cent. It was also anticipated that additional employment of 6.43 lakh man days would be created during the soil conservation measures and 1.77 lakh man days after the completion of measures.

These works, however, would require close cooperation and coordination between revenue and irrigation departments and panchayats.

Subwatershed C/24

Though the area was not a single point drain it drained directly in Gandhisagar reservoir and was marked as priority No.2.

The subwatershed had mostly uniformly sloping topography with flat topped hillocks on the west. The area was drained by medium gullies which formed into a nallah which drained in Chambal river.

The direction of nallah was from north to south east and from south east to north east, whereas, the river Chambal flowed from west to east.

The drainage density was 0.59 km.per sq.km. The area of the subwatershed was 3,478 hectares. The data on slope of subwatershed showed that 46.00 per cent of the area had less than 1 per cent slope. Another 28.76 per cent area had slope between 1 to 3 per cent and the remaining 25.24 per cent had more than 3 per cent slope. (Table 3.2)

Of the total area 70.44 per cent was agricultural land. Wasteland (14.81 per cent) and other land (14.75 per cent) shared about equal proportion. (Table 3.3)

The severely affected area formed 37.38 per cent of the total area, the lowest proportion among the selected 3 subwatersheds. (Table 3.4)

Among the different soil conservation measures proposed for cultivated land, bunding and construction of diversion channels were more important. Gully control structures and bench terracing were comparatively less important. The cost estimated for these measures was Rs.4.77 lakhs. (Table 3.9)

Table 3.9 Engineering measures of soil conservation proposed for agricultural land, subwatershed C/24

S. No.	Engineering measures	Area (Hectares)	Cost/hect. (Rs.)	Total cost (Rs. lakhs)
1.	Bunding	400	200	0.80
2.	Diversion Channels		100	0.40
3.	Gully control structures	285	400	1.14
4.	Bench terracing	100	2000	2.00
5.	Maintenance of above work	-	-	0.43
	Total	785	-	4.77

Of the measures proposed for wasteland development, gully control works and vegetative cover were relatively more important. The cost estimate on these measures came to Rs.1.36 lakhs.(Table 3.10)

Table 3.10 Engineering measures of soil conservation proposed for wasteland, subwatershed C/24

S.No.	Engineering measure	Area (Hectares)	Total cost (Rs. lakhs)
1.	Gully control works	515	0.52
2.	Vegetative measures	415	0.41
3.	Pasture development	100	0.30
4.	Maintenance of above	-	0.13
	Total	1030	1.36

Thus the total cost estimate for cultivated land and wasteland totalled up to Rs.6.13 lakhs. An amount of Rs.1.60 lakhs was provided for staff and office. Thus the total cost came to Rs.7.73 lakhs.

The work was expected to be completed in 5 years in a phased manner. (Table 3.11)

Table 3.11 Schedule of soil conservation measures, subwatershed C/24

Year	Coverage (Hectares)			Total cost (Rs. lakhs)
	Agricultural land	Wasteland	Total	
I	95	85	180	1.26
II	150	100	250	1.87
III	220	130	350	1.59
IV	200	100	300	1.56
V	120	100	220	1.45
Total	785	515	1300	7.73

Besides this an amount of Rs.0.43 lakh was provided for equipments, Rs.0.42 lakh for buildings and Rs.0.05 lakh for other items. Thus the total provision was Rs.8.63 lakhs. (Table 3.12).

Table 3.12 Distribution of total cost of soil conservation, subwatershed C/24

S.No.	Item	Rs. lakhs
1.	Engineering measures	7.73
2.	Equipments	0.43
3.	Buildings	0.42
4.	Other items	0.05
	Total	8.63

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CHAPTER IV

IMPACT OF SOIL CONSERVATION MEASURES

In this chapter characteristics of selected 62 farms are described and the impact of soil conservation measures is studied with reference to two years viz. base year (1984-85) and current year (1985-86).

4.1 Selected Farms

The total area of selected 62 farms was 279.93 hectares, or 4.51 hectares per farm. The area of the selected farms did not change during the two reference years.

Of the total area of 279.93 hectares 75.21 per cent was cultivated land in the base year. The percentage increased to 80.94 in the current year. There was a decline in pasture from 11.86 per cent to 7.54 per cent. Uncultivated waste land also showed a decline from 12.64 per cent to 11.09 per cent.

Thus there was an increase in the proportion cultivated area and decline in wasteland. (Table 4.1)

Table 4.1 Land utilisation, selected farms

Particulars	Base year		Current year		Change	
	Area (Ha.)	Percentage to total	Area (Ha.)	Percentage to total	Area (Ha.) (+) or (-)	Percentage (+) or (-)
Cultivated land	210.54	75.21	226.58	80.94	(+) 16.04	(+) 7.62
Un-cultivated wasteland	35.37	12.64	31.03	11.09	(-) 4.34	(-) 12.27
Pastures	33.21	11.86	21.11	7.54	(-) 12.10	(-) 36.43
Orchards	0.81	0.29	1.21	0.43	(+) 0.40	(+) 49.38
Total	279.93	100.00	279.93	100.00	-	-

The total area (279.93 hectares) of the selected farms was also classified as : area free from erosion, and, area affected by erosion. It was observed that the area free from erosion included part of the cultivated area and entire area under pastures and orchards. The area affected by erosion was the remaining part of the cultivated area and the entire uncultivated wasteland.

The area free from erosion was 56.72 percent of total area in the base year. The percentage increased to 67.81 in the current year.Conversely the percentage of area affected by erosion decreased from 43.28 to 32.19. It was thus observed that during the two reference years the proportion of area free from erosion increased by about 11 per cent or in other words 11 per cent of the area was freed from erosion problem. (Table 4.2)

Table 4.2 Area free from erosion and affected by it

Particulars	Base Year		Current Year		Change	
	Area (Ha.)	Percentage to total	Area (Ha.)	Percentage to total	Area (Ha.) (+) or (-)	Percentage (+) or (-)
Area freefrom erosion						
1) Cultivated land	124.77	44.57	167.51	59.84	(+) 42.74	(+) 34.25
2) Pastures	33.21	11.86	21.11	7.54	(-) 12.10	(-) 36.43
3) Orchards	0.81	0.29	1.21	0.43	(+) 0.40	(+) 49.38
Sub Total	158.79	56.72	189.83	67.81	(+) 31.04	(+) 19.54
Area affected by erosion						
1) Cultivated land	85.77	30.64	59.07	21.10	(-) 26.7	(-) 68.87
2) Uncultivated land	35.37	12.64	31.03	11.09	(-) 4.34	(-) 12.27
Sub Total	121.14	43.28	90.10	32.19	(-) 31.04	(-) 25.62
Grand Total	279.93	100.00	279.93	100.00	-	-

The area affected by erosion in the base year was 121.14 hectares. As noted in table 4.2 this comprised 87.77 hectares of cultivated land and 35.37 hectares of uncultivated wasteland. While the cultivated land could further be classified as land affected by sheet and gully erosion that under uncultivated wasteland was the one which was badly affected and was unfit for cultivation.

The impact of soil conservation measures on the selected farms showed that the area affected by erosion in the base year was 121.14 hectares. It declined to 90.10 hectares in the current year or a decrease of 25.62 per cent.

Of the total eroded area in the base year 43.25 per cent was due to sheet erosion, 27.55 per cent due to gully erosion and 29.20 per cent was badly affected area. Of these categories the impact of soil conservation measures was most pronounced in the case of gully eroded area. The area affected by this kind of erosion 33.38 hectares in base year and decreased to just 4.86 hectares in the current year. Thus, the decrease was as high as 85.44 per cent.

In the case of badly affected area the decline was only 12.27 per cent. It was also observed that the area under sheet erosion increased slightly (3.47 per cent). This increase might be explained by the conversion of the area earlier categories as gully erosion in to sheet eroded due to soil conservation measures. (Table 4.3)

Table 4.3 Types of erosion and affected area under base and current year period

Item	Base year		Current year		Change in current year over base year	
	Area (Ha.)	Percentage to total	Area (Ha.)	Percentage to total	Increase/ Decrease area(ha)	Decrease area(%)
A.Cultivated land						
1) Sheet erosion						
a) Slightly sheet erosion	33.59	27.73	51.68	57.36	(+)18.09	(+)53.85
b) Moderately sheet eroded area	18.80	15.52	2.53	2.81	(-)16.27	(-)86.54
Sub Total of(1)	52.39	43.25	54.21	60.17	(+) 1.82	(+) 3.47
2. Gully erosion						
a) Minor Gully erosion	12.21	10.08	2.40	2.66	(-) 9.81	(-)80.34
b) Severe Gully erosion	21.17	17.47	2.46	2.73	(-)18.71	(-)88.38
Sub total of(2)	33.38	27.55	4.86	5.39	(-)28.52	(-)85.44
Total of(1)&(2)	85.77	70.80	59.07	65.56	(-)26.07	(-)31.13
B. Uncultivated wasteland (Badly affected area unfit for cultivation)	35.37	29.20	31.03	34.44	(-) 4.34	(-)12.27
Total land (cultivated + uncultivated) wasteland	121.14	100.00	90.10	100.00	(-)31.04	(-)25.62

The uncultivated wasteland was further classified in to four groups. Of the total area of 35.37 hectares of uncultivated wasteland 17.36 hectares or nearly 50 per cent (49.08 per cent) was badly eroded land in the base year. In the current year the area under this category nearly halved (8.55 hectares).(Table 4.4)

Table 4.4 Uncultivated wasteland selected farms

Items	Base year		Current Year		Change	
	Area hect.	%to total uncultivated wasteland	Area hect.	%to total uncultivated wasteland	Area Hect.	Percentage change
1. Badly Eroded	17.36	49.08	8.55	27.55	(-)8.81	(-)50.75
2. Steep Slope	10.11	28.58	15.39	49.60	(+)5.28	(+)52.22
3. Any other Reason	4.86	13.74	4.86	15.66	Nil	-
4. Barren/Stony/ Rocky	3.04	8.60	2.23	7.19	0.81	(-)26.64
Total uncultivated wasteland	35.37	100.00	31.03	100.00	(-)4.34	(-)12.27

4.2 Area benefitted by soil conservation measures

A total area of 77.12 hectares was benefitted due to soil conservation measures. Nearly half (51.44 per cent) of the area benefitted was due to bench terracing. Another 15.71 per cent of the benefitted area came under bunding operation. Still another 12.14 per cent of the benefitted area came under the pasture development measure.

The benefits occured due to various soil conservation measures included control of sheet erosion (32.88 per cent of the benefitted land), increased irrigated land and land under(31.40 per cent and area developed for pastures (12.14 per cent). (Table 4.5)

Table 4.5 Area benefitted by the soil conservation measures (Selected farmers)

(hectares)

Soil conservation measures	Benefits								
	Control of sheet erosion	Increased irrigated land under double crop	Pasture development	Popland Protection	Land levelling	Area improved for cultivation	Gully control	Area increase under irrigation	Total area
1. Benefiterracing	18.08	18.96	-	-	-	1.01	-	1.62	39.67 (51.44)
2. Bunding on top land	6.47	1.41	-	1.01	-	-	3.23	-	12.12 (15.71)
3. Pasture land development	-	-	9.36	-	-	-	-	-	9.36 (12.14)
4. Gully control	-	8.84	-	-	-	1.62	-	-	5.46 (7.08)
5. Diversion	0.80	-	-	4.05	-	0.61	-	-	5.46 (7.08)
6. Other measure	-	-	-	-	4.65	0.40	-	-	5.05 (6.55)
Total area	25.35 (32.88)	24.21 (31.40)	9.36 (12.14)	5.06 (6.56)	4.65 (6.03)	3.64 (4.71)	3.23 (4.18)	1.62 (2.10)	77.12 (100.00)

4.3 Change in Cropping Pattern :-

Agricultural production is the result of many factors and inputs, Soil conservation is one such factor which increases the fertility of the soil and enhances its water holding capacity. This results in higher productivity of crops. Besides, higher productivity the changed soil conditions allow the farmer to grow more than one crop or two crops in a year. For example, improved soil and water conditions allow to grow a crop in rabi seasons on which only kharif crop had been grown previously. In some cases other things remaining the same irrigation facilities during the summer season coupled with improved soil and water conservation measures offer scope for a crop in summer season also.

On the selected farms the change in cropping pattern was quite substantial. Firstly, the cash crops like til, sugarcane and berseem which did not find a place in the base year were grown in the current year. Secondly, the change in area under different crops showed that choice was clearly for more remunerative crops. While area under jowar, bajra and moong decreased that under wheat, tur, gram, groundnut, soybean and spices increased. The percentage increase in area was highest (732 per cent) in the case of fodder. In the case of spices the percentage increase was 213.59. However, the area under these crop groups itself was quite small. The percentage increase in the case of oilseeds was 100.22, that in the case of pulses, 66.44 and cereals, 18.10. The substantial increase in the area of pulses and oilseeds is a welcome sign. Among cereals, wheat made a tremendous progress by recording a hundred per cent increase in area.

Table 4.6 Change in Cropping pattern (selected farmers)

Crops	Base year (hectares)	Current year (hectares)	Change from base year to current year increase(+) decrease(-)	Percentage change from base year to current year increase(+) decrease(-)
Jowar	77.74	63.86	- 13.08	- 18.00
Bajara	14.32	11.02	- 3.30	- 23.05
Maize	55.25	58.81	+ 3.56	+ 6.44
Wheat	49.05	98.21	+ 49.16	+100.22
Total Cereals	196.36	231.90	+ 35.54	+ 18.1
Tur	4.44	6.06	+ 1.62	+ 36.49
Moong	10.72	8.66	- 2.06	- 19.22
Urid	31.68	42.49	+ 10.81	+ 34.12
Gram	18.55	51.63	+ 33.08	+178.33
Total Pulses	65.39	108.84	+ 43.45	+ 66.44
Total Foodgrain	261.75	340.74	+ 78.99	+ 30.17
Groundnut	4.42	10.58	+ 6.16	+139.37
Til	-	0.81	+ 0.81	+ 81.00
Soybean	4.85	7.17	+ 2.32	+ 47.83
Total Oilseeds	9.27	18.56	+ 9.29	+100.22
Sugarcane	-	5.14	+ 5.14	+ 5.14
Opium	1.40	2.56	+ 1.16	+ 82.86
Methi	5.68	16.78	+ 11.10	+195.42
Corriendum	-	0.20	+ 0.20	+ 20.00
Chillies	0.50	2.40	+ 1.90	+380.00
Total Spices	6.18	19.38	+ 13.20	+213.59
Cotton	3.96	2.02	- 1.94	- 48.99
Fodder : Chari	0.40	0.60	+ 0.20	+ 50.00
Barseem	-	2.73	+ 2.73	+273.00
Total Fodder	0.40	3.33	+ 2.93	+732.50
Gross cropped area	282.96	391.37	+ 108.41	+ 38.31

The soil conservation measures offered an apportunity to to bring the farmers in more area under rabi crops. In the case of few farmers it gave an opportunity to grow summer crops. Lastly, there was a conclusive evidence of an increase in the gross cropped area to the extent of 38.31 per cent.

Thus soil conservation measures on the selected farms resulted in both qualitative as well quantitative betterment of the cropping pattern.

4.4 Change in farming practices

The changes in farming practices included a, change in cultivated area b, change in irrigated area c, change in area under new crops d, increase in area under more remunerative crops.

Forty per cent of the selected 62 farmers reported that the cultivated area on their farms increased. Area increased per farm was 0.508 ha.

The area under irrigation was reported to be increase on 48 per cent of the selected farmers. The irrigated area increased was 92.43 hectares or 1.49 ha per farm. The source of irrigation was mainly river. This source contributed 61.90 per cent of the total increased irrigated area. Wells and tube wells contributed about equal percentage.

Another impact of soil conservation programme was introduction of new crops. Twenty six per cent of the farmers reported to have introduced new crops on an area of 37.73 hectares. The new crops so introduced were mainly wheat (28.90 Per cent), gram (23.06 per cent), urid (18.24 per cent), spices (9.02 per cent) and soybean (7.45 per cent) etc. Another 8 per cent farmers had increased area on more remunerative crops. The crops included wheat and

Table 4.6 Changes in farming practices due to soil conservation programme

Particulars	Area (ha.)	Percentage to total
a) Cultivated area increased: (40 per cent)	31.52 (0.508/Farm)	
b) Area increased under irrigation (48 per cent)	92.43 (1.49/Farm)	100.00
Well	17.79	19.25
River	57.21	61.90
Tube well	17.43	18.85
c) Area introduced under new crops (26 per cent)	37.73	100.00
Wheat	10.90	28.90
Gram	8.70	23.06
Urid	6.88	18.24
Spices	3.40	9.02
Soybean	2.81	7.45
Sugarcane	1.92	5.05
Tur	1.50	3.97
Maize	0.81	2.14
Jowar	0.40	1.06
Opium	0.40	1.06
Barseem	0.01	0.02
d) Area increased under specific crop (8 per cent)	4.86	100.00
Wheat	2.00	41.16
Gram	0.41	8.43
Jowar	0.20	4.11
Maize	0.61	12.55
Groundnut	0.42	8.65
Urid	0.20	4.11
Sugarcane	1.00	20.58
Opium	0.02	0.41

Difference in yield levels

As on effect of soil conservation measures is the yields of all the crops increased. The increased was more pertinent in the case of Rabi crops as compared to Kharif crops. The maximum increase was recorded in opium (93.0 per cent) followed by Gram (84.2 per cent) and urid (74.4 per cent). Wheat recorded an increase of 33.8 per cent. Among the kharif crops, maize (43.3 per cent) Groundnut (31.9 per cent) and Jowar (25.0 per cent) benefitted. (Table)

Table 4.7 Effect of Soil Conservation Programme on yield levels of the major crops

Crops	Before (kg./ha.)	After (kg./ha.)	% change over period
1. Wheat	874	1169	33.8
2. Gram	437	805	84.2
3. Jowar	620	775	25.0
4. Bajara	635	701	10.5
5. Maize	432	619	43.3
6. Urid	82	143	74.4
7. Groundnut	458	604	31.9
8. Opium	250	483	93.0

Employment gain in the soil conservation works

The benefit of soil conservation programme was also the gainful employment created forteen persons of nine families got an average employment of 187 days in a year. The wages earned amounted to 187.1 or an average of approximately Rs.10.0 per day.

The soil conservation measures have been very well received by the beneficiaries and all of them have strongly suggested in favour of their continuance in future also.

CHAPTER-V

SUMMARY AND CONCLUSIONS

5.1 Soil, the most natural resource of crop production is subjected to calamities like storms, floods and droughts. These calamities deteriorate not only fertility but also most productive upper layer of the soil. Therefore, there is a necessity of soil and water conservation as an integral part of agricultural development programme.

Soil erosion results in the lowering of the storage capacity of the irrigation dams/reservoirs which were built with the idea of providing irrigation facilities to the rainfed areas. It is estimated that 283 lakh hectares of irrigation potential is lost every year due to erosion and siltation.

The loss on account of siltation and non utilisation of irrigation potential is estimated at Rs.400 crores in the form of capital assets annually.

In order to contain such losses a centrally sponsored scheme was launched which covered 28 catchments of the country.

The main objectives of the scheme were :

1. To reduce siltation of the multipurpose reservoirs by increasing soil conservation measures in the catchment areas
2. To prevent degradation of the catchment area and enhance its productivity through optimum land management.
3. To ensure adequate irrigation water to the command area and increase production, and,
4. To provide employment opportunities in the extensive rural areas.

Out of 28 river valley projects in the country seven were fully or partially located in Madhya Pradesh. These projects covered 24,937 thousand hectares of catchment area and 7,584 thousand hectares of priority watershed area. Of the seven projects, Chambal River Valley Project is one of the important projects with 2,600 thousand hectares of watershed area and 900.46 thousand hectares of priority area. Till 1984-85, 330.74 thousand hectares of priority watershed area was treated by soil conservation measures.

This study was undertaken to evaluate the soil conservation measures taken up by the agriculture department at the farmer's level. The beneficiaries were selected from three sub watersheds namely C-14, C-19 and C-24 of Chambal River Valley Project of Mandsaur district of Madhya Pradesh.

Of the 29 villages, 12 were selected purposively. A random sample of 62 farmers was drawn from the list of beneficiaries of the villages. The reference year was 1985-86.

5.2 Mandsaur district is situated in the north west of the State. Chambal forms the main river system of the district which flows from south to north.

The district has an average altitude of about 457 metres. The average rainfall is 730 mm. Agriculture had a predominant role in the economy of the district and 57.27 per cent of the geographical area was net sown area. Another 20.63 per cent was not available for cultivation purposes. Forest area covered 11.23 per cent of the total area.

The district had 17.5 per cent of the gross cropped area under irrigation. Wells were the chief source of irrigation commanding more than 92 per cent of the total area irrigated.

Wheat, gram, paddy and millets were the dominant food crops which together commanded 75 per cent of the cropped area. Among non food crops, groundnut (4.9 per cent) was important.

5.3 Gandhisagar dam was constructed jointly by Madhya Pradesh and Rajasthan Governments in 1960 with the objective to provide irrigation to drought prone area of both the states. The total catchment area was 23,025 sq.km. Of this, 66.16 per cent was cultivated area, 4.28 per cent was culturable waste and 3.62 per cent was forest land.

According to hydrographic survey conducted during 1975-76 Gandhisagar dam was losing its water holding capacity at an average rate of 0.28 per cent due to siltation. The average annual reduction in dead and live storage was 1.94 and 0.89 per cent respectively. On the basis of this report the soil water management experts recommended an urgent remedial measure in the catchment area of Gandhisagar to bring down the rate of siltation. On this advice the State Government's Agriculture department started a protection plan for entire catchment area by adopting some soil and water conservation measures. Till 1985-86, a total of 40,000 sq.km. of catchment area was covered at a cost of Rs. 244.0 lakhs to bring down the siltation in the reservoir.

All the three selected sub watersheds namely C-14, C-19, and C-24 belonged to Sitamau tehsil of Mandsaur district. Since the study was concerned with the siltation of Gandhisagar reservoir these watersheds were purposively selected for the study.

The area was drained by small gullies and nullah flowing from south to north direction. The soils had moderate to low infiltration capacity and were quite erodable during summer and rainy seasons.

Gully formation followed after rill and sheet erosion was observed as the major soil erosion problem of the area. It was estimated that of the total sediment yield, gullies and stream banks accounted for 60 per cent delivery rate and the remaining percentage (40 per cent) was shared by sheet and rill erosion.

A total 7,500.00 thousand hectares of area was covered by the sub watershed C-14. The entire area was a broad plain of low relief having local differences in elevation. Of the total area 70.13 per cent was under agricultural land followed by wasteland (15.00 per cent) and other land area (14.87 per cent). About 85 per cent of the total area was badly affected and required immediate soil conservation measures. In the upper reaches of the watershed sheet and rill erosion were the major erosion problems while in the middle and lower reaches gully and medium gully formation was the main reason of erosion.

Total area of the watershed C-19 was 5,150 hectares with uniformly plain topography. Of the total area agricultural land occupied 64.08 per cent followed by wasteland 16.21 per cent and other land 19.71 per cent respectively. Out of the total area 60 per cent was severely affected by soil erosion and needed remedial measures.

To minimise the erosion problem in agricultural land a programme at a cost of Rs. 8.45 lakh was estimated for bunding and construction of diversion channel Rs. 0.45 lakh

was estimated for wasteland development for the construction of check dams in gully control works. A plan was also envisaged to increase the agricultural production by 10 to 15 per cent alongwith a plan to generate additional employment of 6.43 lakh man days during the soil conservation measures and 1.77 lakh man days after the completion of measures.

A total area of 3,478 thousand hectares was under watershed C-24. Of this, agricultural land shared 70.40 per cent wasteland 14.81 per cent and other land, 14.75 per cent.

A plan of Rs. 4.77 lakhs was prepared to construct the diversion channels, bench terracing work and bunding operation and another worth Rs. 1.36 lakhs was chalked for wasteland development work.

5.4 During the two reference years 1984-85 and 1985-86 the total cultivated area increased by 7.62 per cent while the waste land declined by 12.27 per cent. It was also observed that during the same period nearly 11 per cent area was freed from soil erosion problems.

The impact of soil conservation measures on the selected farms showed that the area affected by erosion in the base year was 121.14 hectares. It declined to 90.1 hectares in the current year or a decrease of 25.62 per cent.

Of the total eroded area gully erosion was the single most important erosion problem and after soil conservation measures the area affected by it decreased by 85.44 per cent.

In the case of uncultivated wasteland a negative change (-12.27 per cent was observed in the eroded area.

A total area of Rs. 77.12 hectares was benefitted due to soil conservation measures. Bench terracing, bunding and pasture development were the main activities. The benefits accured due to various soil conservation measures included control of sheet erosion (32.86 per cent of the benefit area). Increased irrigated land under cropping (31.4 per cent) and area developed for pastures (12.14 per cent) were other benefits.

Improved soil and water condition due to soil conservation measures offered scope for growing crops in rabi season on which only kharif crops were grown previously. Farmers started growing more remunerative crops like wheat, sugarcane, oilseeds etc. Minor millets, like jowar, bajara and moong were replaced by remunerative crops. Fodder reported the highest percentage increase in the area (732), followed by spices (214) oilseeds (100) pulses (66) and cereals (18).

The soil conservation measures offered an opportunity to the farmers to bring in more area under rabi crops and in few cases under summer crops also. Thus, the gross cropped area increased by 38.31 per cent.

There was a conclusive evidence in the change in farming practices. Cultivated area increased by 0.508 hectare per farm. Irrigated area increase was 92.43 hectares.

Rivers were the main source of irrigation and contributed 61.9 per cent of the total irrigated area. The crops like wheat, gram, urid, spices and soybean found more area.

The effect of soil conservation measures on yield levels was positive. All the crops showed higher yield levels. The maximum yield increase was recorded in opium (93.0 per cent) followed by gram (84.2 per cent), urid (74.4 per cent) and wheat (33.8 per cent). Among the kharif crops, maize (43.3 per cent) groundnut (31.9 per cent) and jowar (25.0 per cent) benefitted.

The another benefit of soil conservation programme was the creation of gainful employment. Fourteen persons of nine families got an average employment of 187 days in a year. The wages earned amounted to Rs. 1871 or an average of approximately Rs. 10.00 per day.

Thus, it could be concluded that the soil conservation measures on the selected farms were very well received and resulted in both qualitative as well as quantitative betterment of farming.

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ANNEXURE-I

Salient Features

(1)	Name of dam	:	Gandhisagar Dam
(2)	Name of state in which located	:	Madhya Pradesh
(3)	Name of District	:	Mandsaur
(4)	Latitude - $24^{\circ}.44'$ N & Longitude- $75^{\circ}.33'$E		
(5)	Location	:	About 30 km from Jhalawar Road Railway Station on Western Railway.
(6)	Catchment Area	:	23,025 km^2
(7)	Details of Dam		
	(a) Type	:	Straight Gravity Masonry Dam
	(b) Bength of Dam	:	51.4m
	(c) Height of Dam	:	62.2m
	(d) Area submerged at M.W.L. 400 m.	:	660km^2
(8)	Year of completion	:	1960

(9) Total area under Chambal Valley Project in M.P.

State	District	Area	No.of watersheds
Madhya Pradesh	1. Mandsaur 2. Ratlam 3. Ujjain 4. Indore	55,68,000 ha.	54

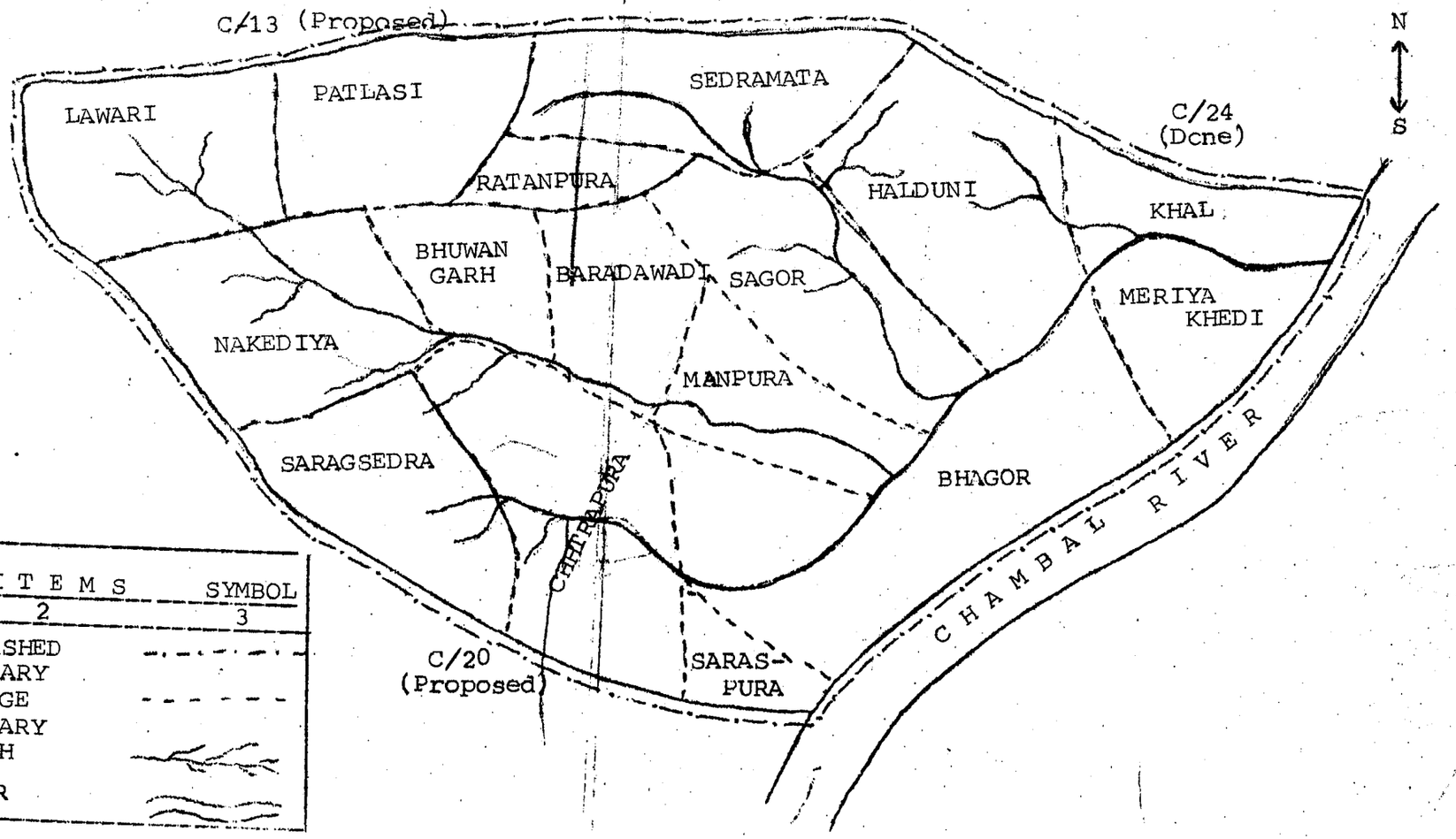
(10) Progress of Expansion of Programme

Yearwise details about watersheds included/saturated (Mandsaur district only)

Year	No.of watersheds in which work was started
1975-76	10
1978-79	3
1979-80	8
1980-81	8
1981-82	1
1982-83	6
1983-84	15
1984-85	3

CHAMBAL PROJECT

WATER SHED MANAGEMENT PLAN FOR WATER SHED
OF MERIYA KHEDI KHAL SUB CATCHMENT OF MAIN CHAMBAL
WATER SHED No. C/14
AREA : 7500.061

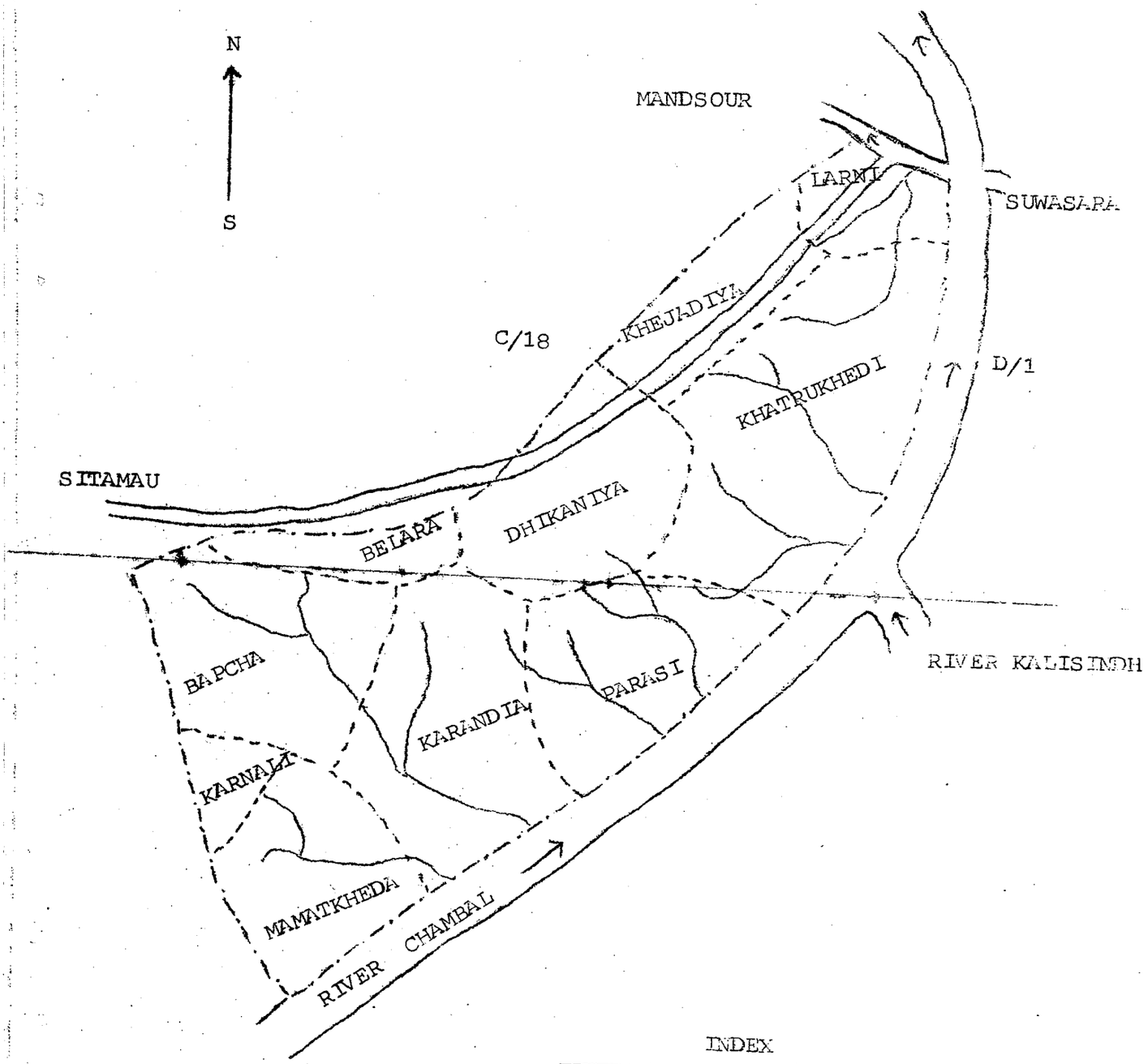


S.No.	ITEMS	SYMBOL
1	2	3
1.	WATERSHED BOUNDARY	
2.	VILLAGE BOUNDARY	
3.	NALLAH	
4.	RIVER	

CHAMBAL PROJECT

WATERSHED MANAGEMENT PLAN FOR WATERSHED OF CHAMBAL RIVER IN THE SUB CATCHMENT OF MAIN CHAMBAL RIVER WATER SHED NO. C/19

Area 415o.514 HECTOR



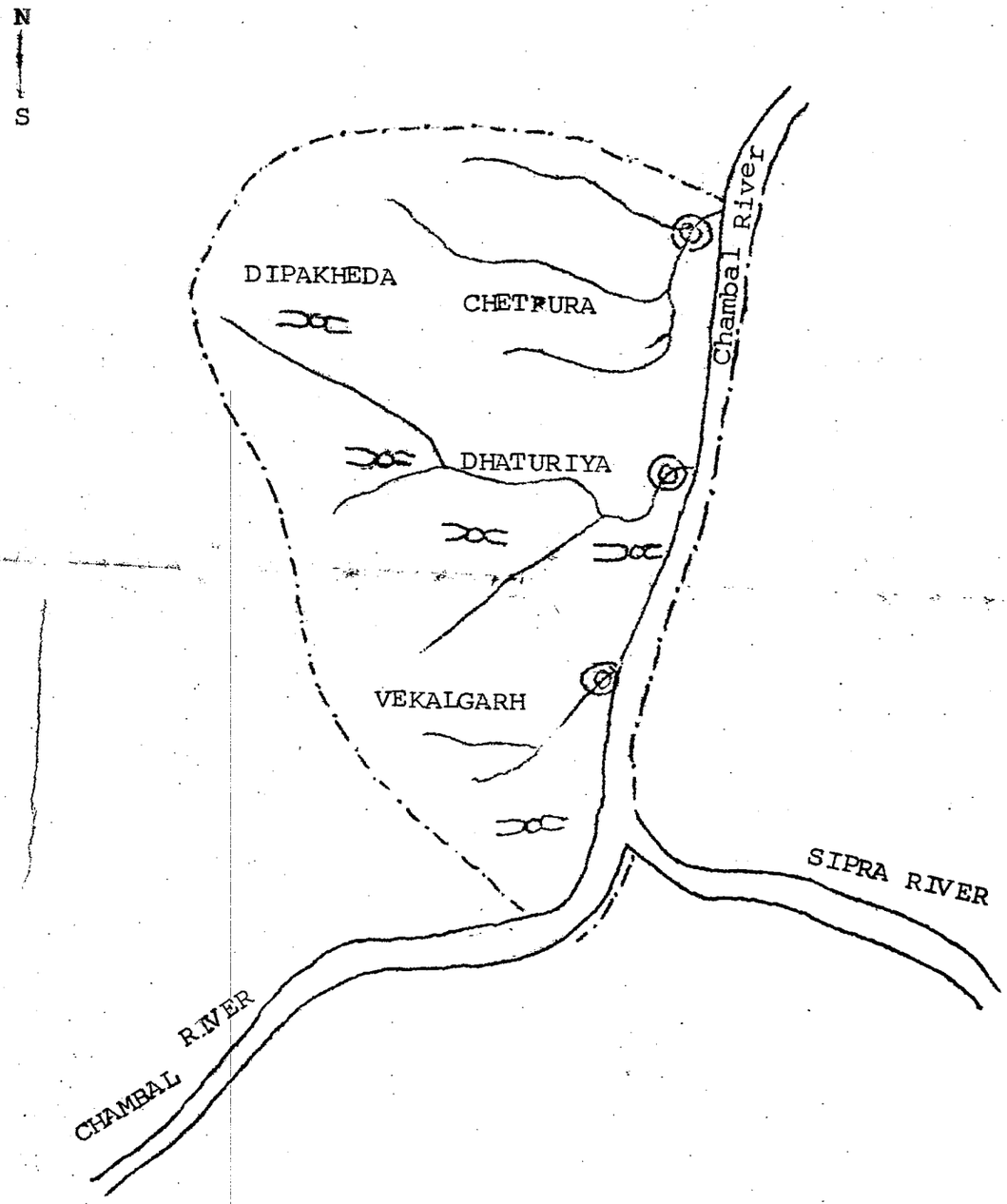
INDEX

S.No.	ITEM	SYMBOLE
1.	WATERSHED BOUNDARY	
2.	VILLAGE BOUNDARY	
3.	NALLA	
4.	RIVER	

CHAMBAL PROJECT

WATER SHED PLAN FOR SUB WATER SHED NO.C/24
SUB CATCHMENT OF CHAMBAL RIVER

AREA : 3478 HECT



S.No.	I T E M S	SYMBOL
1.	RIVER & NALLAS	
2.	SILT DETENTION TANK	
3.	WATER SHED BOUNDARY	
4.	SEDIMENT MONITORING ST	
5.	NALLAS	