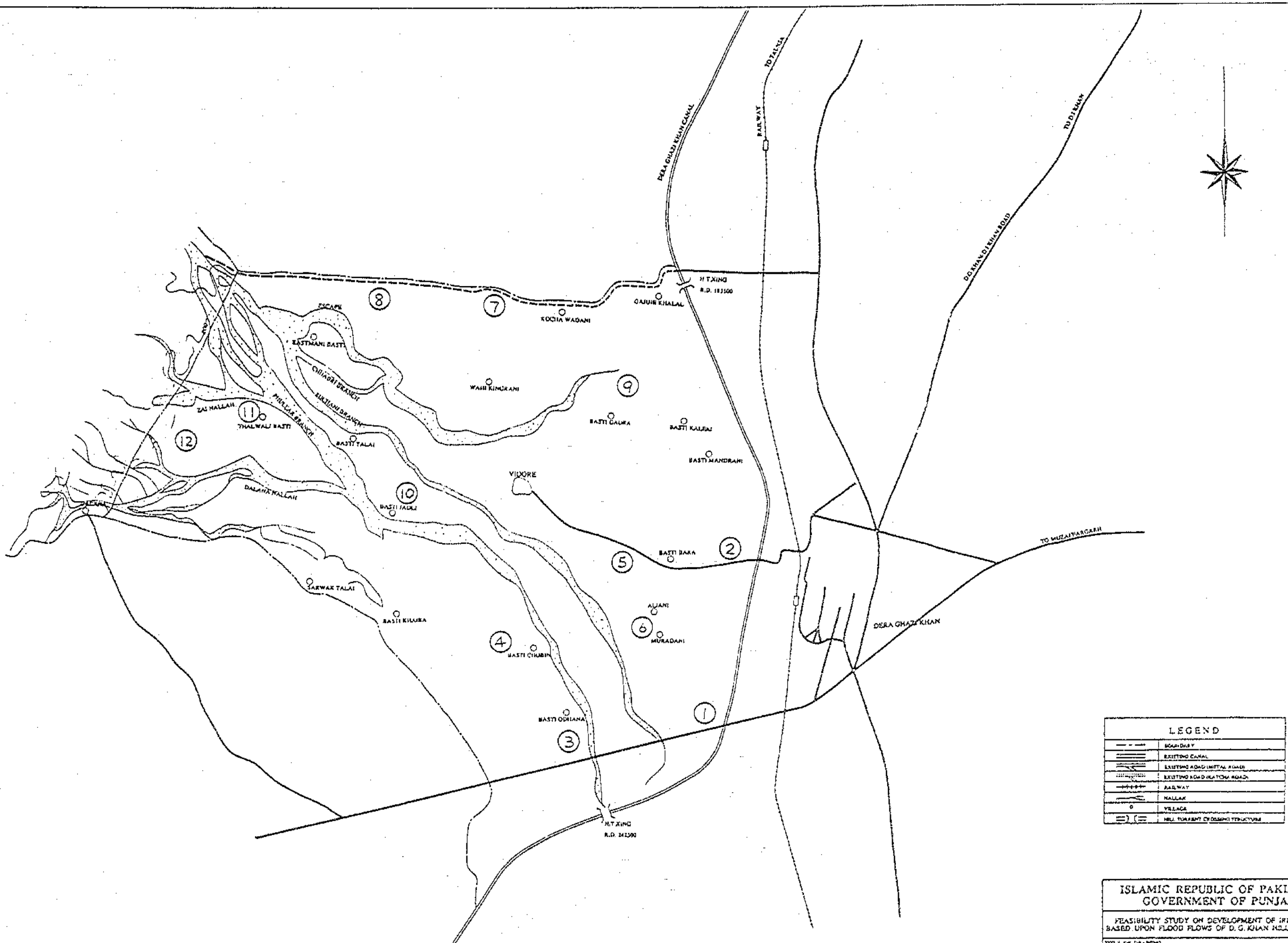
TABLE H-2. SOIL ANALYSIS DATA (SOIL PHYSICAL PROPERTIES)

Soil Series	Sample No.	Depth (cm)	Soil texture	Bulk Density (g/cc)	Hydraulic conductivity (cm/hour)	Soil moisture by volume Saturation (%)	1/3Bar (%)	15Bar (%)	AWA (%)
KATOHAR	P-1-1	10-20	Clay loam	1.72	0.001	40.87	34.55	26.00	8.5
	P-1-2	20-36	Sandy loam	1.49	0.325	43.15	38.18	15.00	23.2
	P-1-3	36-72	Loam	1.63	0.001	41.27	36.00	17.32	18.7
BOLAN	P-2-1	15-27	Sandy loam	1.52	0.002	41.00	34.20	16.21	18.0
	P-2-2	27-43	Clay loam	1.46	0.278	42.72	38.85	14.17	24.7
	P-2-3	43-66	Silt loam	1.27	0.780	28.18	18.18	6.17	12.0
HADWAR	P-3-1	05-30	Sandy clay loam	1.41	0.231	42.51	35.00	20.18	14.8
	P-3-2	30-77	Sand	1.21	0.590	41.33	31.80	18.18	13.6
	P-3-3	77-100	Loam	1.58	0.132	45.50	37.23	15.03	22.2
KUNDI	P-4-1	0-14	Clay loam	1.51	0.021	41.28	34.55	12.76	21.8
	P-4-2	14-44	Clay loam	1.61	0.001	41.18	36.18	25.45	10.7
	P-4-3	44-53	Sandy clay loam	1.68	0.001	41.90	36.25	24.82	11.4
CHATTER	P-5-1	00-03	Sandy loam	1.38	0.250	25.18	13.97	8.50	5.5
	P-5-2	03-72	Sand	1.31	0.200	27.24	19.17	9.23	9.9
	P-5-3	72-100	Loamy sand	1.28	0.190	27.00	19.15	9.00	10.2
KUNDI	P-6-1	00-15	Silty clay	1.82	0.001	41.27	36.15	19.20	17.0
	P-6-2	15-52	Clay	1.69	0.015	43.20	36.25	16.10	20.2
	P-6-3	52-100	Silty clay	1.61	0.010	48.26	38.40	28.12	10.3
KALLARWALA	P-7-1	00-20	Sand	1.21	0.590	31.12	20.18	7.10	13.1
	P-7-2	20-45	Loamy sand	1.41	0.080	38.40	30.12	12.00	18.1
	P-7-3	45-100	Sandy loam	1.61	0.100	36.00	28.28	15.18	13.1
KALLARWALA	P-8-1	00-10	Loamy sand	1.39	0.123	36.18	30.17	13.00	17.2
	P-8-2	10-55	Sandy loam	1.41	0.120	37.12	24.18	12.18	12.0
	P-8-3	55-100	Sandy loam	1.49	0.170	38.12	27.22	20.12	7.1
TALAI	P-9-1	00-20	Sandy loam	1.38	0.272	31.20	26.12	21.27	4.9
	P-9-2	20-62	Sand	1.27	1.500	34.18	31.25	12.18	19.1
	P-9-3	62-100	Sandy clay loam	1.78	0.021	42.12	39.27	24.17	15.1
KATOHAR	P-10-1	03-15	Clay loam	1.59	0.001	39.82	35.21	23.18	12.0
	P-10-2	15-32	Loam	1.51	0.002	43.18	39.12	25.20	13.9
	P-10-3	55-69	Clay loam	1.48	0.001	42.71	37.23	21.20	16.0
KATOHAR	P-11-1	02-22	Clay loam	1.70	0.001	40.15	32.15	22.18	10.0
	P-11-2	22-48	Clay loam	1.59	0.012	41.00	36.12	18.00	18.1
	P-11-3	48-70	Sandy loam	1.46	0.278	42.72	38.85	14.18	24.7
TALAI	P-12-1	00-22	Sand	1.52	0.303	27.18	18.18	8.11	10.1
	P-12-2	22-72	Sandy loam	1.28	0.390	31.18	24.18	15.18	9.0
	P-12-3	72-100	Sandy loam	1.21	0.500	27.18	17.24	12.10	5.1
Catchment-1	P-13-1	05-35	Sandy loam	1.42	0.213	43.15	40.00	15.12	24.9
	P-13-2	35-60	Sandy loam	1.38	0.175	42.00	38.00	14.20	23.8
Catchment-2	P-14-1	00-15	Loamy sand	1.38	0.821	37.14	30.21	8.21	22.0
	P-14-2	15-35	Loamy sand	1.23	0.160	30.65	22.22	8.00	14.2
	P-14-3	35-52	Loamy sand	1.48	0.080	31.21	27.22	14.00	13.2
Catchment-3	P-15-1	00-12	Loamy sand	1.30	0.260	25.18	14.77	8.20	6.6
	P-15-2	12-40	Sandy loam	1.28	0.390	30.00	18.00	9.44	8.6
	P-15-3	40-100	Loamy sand	1.35	0.590	30.18	26.18	19.18	7.0



ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF PUNJAB

FEASIBILITY STUDY ON DEVELOPMENT OF IRRIGATION BASED UPON FLOOD FLOWS OF D. G. KHAN HILL TORRENTS

TITLE OF DRAWING

JAPAN INTERNATIONAL COOPERATION AGENCY | DWG NO.

FIGURE H-1. LOCATION MAP OF TEST PITS IN PACHAD AREA

ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF PUNJAB

FEASIBILITY STUDY ON DEVELOPMENT OF IRRIGATION BASED UPON FLOOD FLOWS OF D.G. KHAN HILL TORRENTS

TITLE OF DRAWING

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE H-2. LOCATION MAP OF TEST PITS IN CATCHMENT AREA

ANNEX I. AGRICULTURE

ANNEX I.   AGRICULTURE

Page

CHAPTER I. CROP ACREAGE BY EACH ZONE IN THE STUDY AREA .... I - 1

CHAPTER II. FARM SURVEY IN THE STUDY AREA .... I - 4

CHAPTER III. MISCELLANEOUS .... I - 12

LIST OF TABLES

		Page
Table I - 1	Crop Acreage by Each Moza in the Study Area	I - 2
Table I - 2.	Farm Survey Results	I - 5
Table I - 3.	Labor Requirement	I - 13
Table I - 4.	Number of Livestock by Moza in the Study Area	I - 15
Table I - 5.	Estimated Additional Animal Production in the Study Area	I - 15

CHAPTER I. CROP ACREAGE BY EACH MOZA IN THE STUDY AREA

To estimate the crop acreage in the Study area, data from each Moza was collected for recent five years in D.G. Khan Tehsil office and figures were adjusted based on the field survey of the JICA Study Team. Final figures are shown in Table I - 1.

On the Table I - 1, H. TOR. means the cropped area irrigated by hill torrent water, and WELL means the cropped area irrigated by tubewells constructed privately by farmers. Tubewells are mainly used to irrigate Rabi crops such as wheat. And K. OTHERS means Kharif other crops such as green fodders, pulses, cotton etc. In the H. TOR. area, the main Kharif crop is green fodders, while in the WELL area, it is represented by cotton and green fodders.

TABLE I-1. CROP ACREAGE BY EACH MOZA IN THE STUDY AREA (1986-1990) AVERAGE (1/2)

(Unit: ha)

MOZA	1 BELA *	2 DALANA PATIZAI	3 WAHI KINGRANI	4 KOCHHA WADANI	5 VIDORE	6 NOOR WAH	7 DAGAR CHIT
JOWAR							
H.TOR.**	533	234	63	85	393	276	89
WELL ***	0	0	0	9	24	13	17
TOTAL	533	234	63	94	417	289	106
BAJRA							
H.TOR.	70	41	5	15	71	44	7
WELL	0	0	0	0	2	0	0
TOTAL	70	41	5	16	73	44	7
K.OTHERS							
H.TOR.	2	3	2	13	16	13	2
WELL	0	0	0	3	23	22	19
TOTAL	2	3	2	16	40	35	21
KHARIF TOTAL							
H.TOR.	605	278	70	114	480	332	98
WELL	0	0	0	12	50	36	37
TOTAL	605	278	70	126	530	368	134
WHEAT							
H.TOR.	4	5	1	5	32	14	29
WELL	0	0	0	27	179	56	134
TOTAL	4	5	1	32	210	70	163
GRAM							
H.TOR.	29	29	7	4	9	4	2
WELL	0	0	0	4	7	1	2
TOTAL	29	29	7	9	16	5	4
OILSEEDS							
H.TOR.	2	3	3	4	6	3	2
WELL	0	0	0	3	2	0	1
TOTAL	2	3	3	7	8	3	3
R.OTHERS							
H.TOR.	0	0	0	1	0	0	0
WELL	0	0	0	0	8	3	3
TOTAL	0	0	0	1	8	3	3
RABI TOTAL							
H.TOR.	35	37	11	14	47	21	33
WELL	0	0	0	34	196	60	140
TOTAL	35	37	11	49	242	81	173
TOTAL							
H.TOR.	640	315	81	128	527	353	131
WELL	0	0	0	46	246	96	177
TOTAL	640	315	81	175	772	449	307

* The figures for MOZA RAKH BELA is included in the figures for this MOZA

** H.TOR. means the cropped area irrigated by hilltorent water.

*** WELL means the cropped area irrigated by tubewells.

SOURCE: Figures were adjusted by JICA Study Team based on the data from D.G.Khan Tehsil Office.

TABLE I-1. CROP ACREAGE BY EACH MOZA IN THE STUDY AREA (1986-1990) AVERAGE (2/2)

(Unit: ha)

MOZA	8 CHABRI BALA GHARBI	9 CHORATTA PACHADH SHUMALI	10 CHORATTA PACHADH JANUBI	11 GADAI GHARBI	12 CHIT SARKANI	13 DALANA KHAS	1 - 13 TOTAL
JOWAR							
H.TOR.	43	155	41	80	0	133	2,124
WELL	2	49	10	76	5	0	205
TOTAL	45	204	51	156	5	133	2,329
BAJRA							
H.TOR.	8	31	2	6	0	14	313
WELL	0	6	1	6	0	0	17
TOTAL	8	37	3	12	0	14	330
K.OTHERS							
H.TOR.	5	1	0	2	0	1	61
WELL	0	15	4	38	2	0	128
CANAL							
TOTAL	5	16	5	40	2	1	189
KHARIF TOTAL							
H.TOR.	56	187	43	88	0	148	2,498
WELL	2	70	15	120	7	0	350
TOTAL	58	257	59	208	7	148	2,848
WHEAT							
H.TOR.	18	137	28	158	0	23	453
WELL	13	256	41	414	20	0	1,140
TOTAL	31	393	68	572	20	23	1,593
GRAM							
H.TOR.	8	30	5	19	0	9	156
WELL	1	9	1	6	0	0	31
TOTAL	9	39	6	25	0	9	187
OILSEEDS							
H.TOR.	4	16	2	11	0	1	57
WELL	2	5	1	3	0	0	16
TOTAL	6	21	3	14	0	1	73
R.OTHERS							
H.TOR.	0	0	0	1	0	0	1
WELL	2	40	6	2	1	0	65
TOTAL	2	40	6	3	1	0	66
RABI TOTAL							
H.TOR.	30	183	35	189	0	33	667
WELL	18	310	49	425	21	0	1,252
TOTAL	48	492	83	614	21	33	1,919
TOTAL							
H.TOR.	85	370	78	277	0	181	3,165
WELL	21	380	64	545	28	0	1,602
TOTAL	106	750	142	822	28	181	4,767

CHAPTER II. FARM SURVEY IN THE STUDY AREA

The farm survey in the Study Area (VIDORE HILL TORRENT) was conducted by the JICA Study Team during Phase I study. Some progressive farmers were selected for this survey and visited directly by staff of DDA (D.G. Khan Development Authority) whom the Study Team asked to hear the present agricultural conditions in the hill torrent irrigation area. The collected data are summarized in Table I - 2.

The survey also included the watershed area. However, the sampled and visited farm households were very little (only 12) because the area was extremely remote and unpopulated.

In the following tables, meanings of some marks are as follows:

(u) : The farm located in the upstream area of the Study Area.
(m) : The farm located in the middle stream area of the Study Area.
(d) : The farm located in the downstream area of the Study Area.
(H) : The farm located in Moza HAYATAN in the Watershad Area
(M) : The farm located in Moza MUD CHANDIA in the Watershad Area
(Z) : The farm located in Moza ZIARAT DADA MUSA in the Watershad Area

TABLE I-2. FARM SURVEY RESULTS (1/7)
HOUSEHOLD AND FARM SIZE

	Household Members			Farm Land (ha)				Land
Farm. No.	Total	Male	Female	Total	Net Sown	Fallow	C.Waste	Tenure
Pachad Area								
1 (u)	11	6	5	10	6		4	S.
2 (u)	9	6	3	20	10		10	S.
3 (u)	12	8	5	10	4		6	S.
4 (u)	14	8	6	12	6		6	S.
5 (u)	12	6	6	4	3		1	S.
6 (u)	8	6	2	2	1		1	S.
7 (u)	30	20	10	4	1.5		2.5	S.
8 (u)	2	1	1	4	2		2	S.
9 (u)	32	18	14	10	6		4	S.
10 (u)	7	3	4	4	2		2	S.
11 (m)	22	12	10	10	5		5	S.
12 (m)	20	12	8	25	12		13	S.
13 (m)	18	10	8	40	25		15	S.
14 (m)	16	8	8	6	3		3	S.
15 (m)	8	4	4	20	7		13	S.
16 (m)	24	13	11	20	8		16	S.
17 (m)	16	7	9	4	2		2	S.
18 (m)	13	3	10	10	2		8	S.
19 (m)	19	10	9	7	2.5		4.5	S.
20 (m)	9	6	3	5	2		3	S.
21 (d)	10	5	5	10	5		5	S.
22 (d)	4	1	3	22	10		12	S.
23 (d)	9	6	3	13	6		7	S.
24 (d)	8	4	4	15	6		9	S.
25 (d)	17	9	8	24	4		20	S.
26 (d)	17	9	8	12	9		3	S.
27 (d)	12	5	7	20	8	2	10	S.
28 (d)	20	10	10	10	3		7	S.
29 (d)	29	15	14	7	3		4	S.
30 (d)	24	15	9	21	4		17	S.
Total	452	246	207	381	168	2	215	
Avarage	15	8	7	12.7	5.6	0.1	7.2	
Tribal Area								
1 (H)	13	8	5	30	5	5	20	S.
2 (H)	4	2	2	15	2	5	8	S.
3 (H)	38	10	20	120	10	50	60	S.
4 (H)	4	1	3	40	13	11	16	S.
5 (M)	13	5	8	20	5		15	S.
6 (M)	18	11	7	40	5		35	S.
7 (M)	7	5	2	10	1	2	7	S.
8 (M)	12	8	4	16	2		14	S.
9 (Z)	7	3	4	15	5	2	8	S.
10 (Z)	29	15	14	10	5		5	S.
11 (Z)	6	2	4	2	1		1	S.
12 (Z)	10	5	5	6	1	1	4	S.
Total	161	75	78	324	55	76	193	
Average	13	6	7	27.0	4.6	10.9	16.1	

TABLE I-2. FARM SURVEY RESULTS (2/7)
FARM CONDITIONS

Farm. No.	Farm Plots No.	Size (acre) Min.	Size (acre) Max.	Distance to Farm (km) Min.	Distance to Farm (km) Max.
Pachad Area					
1 (u)	4		8	2	4
2 (u)	5	3	8	0.3	1
3 (u)		2	8	0.5	1
4 (u)	4	3	10	1	2
5 (u)	7	1	4	0	1
6 (u)	4	1	3	0.4	2
7 (u)	2	3	8	0.5	2
8 (u)	7	1	4	2	3
9 (u)	6	2	7	0	2
10 (u)	4	2	4	0.5	1.5
11 (m)	3	5	12	0	1
12 (m)	7	2	10	0	4
13 (m)		1	8	0.25	2
14 (m)	4	1	4	0.2	1
15 (m)	15	5	25	0	5
16 (m)	9	2	10	0	3
17 (m)	4	1	4	0	1
18 (m)	7	1	7	0	2
19 (m)	7	1	8	0	1
20 (m)	6	2	5	0.25	3
21 (d)	4	1	3	0	1
22 (d)	7	1	10	0	2
23 (d)	5	1	4	0	1
24 (d)	5	1	6	0.5	2
25 (d)	5	15	28	0.5	5
26 (d)	7	4	6	0.25	2
27 (d)	6	6	8	1	4
28 (d)	8	1	10	0	3
29 (d)	3	2	16	0	1
30 (d)	4	10	19	1	2
Total	159	81	267	11.15	65.5
Avarage	5.7	2.8	8.9	0.4	2.2
Tribal Area					
1 (H)	10	1	15	0	2
2 (H)	8	1	4	0	3
3 (H)	70	1	5	0	15
4 (H)	9	2	60	0	4
5 (M)	20	2	10	0.25	2
6 (M)	20	1	20	0.25	2
7 (M)	7	1	5	0.25	2
8 (M)	6	2	5	0.25	2
9 (Z)	10	1	10	0.5	3
10 (Z)	12	1	5	0.25	2
11 (Z)	2	1	2	0	2
12 (Z)	6	1	0.5	0.25	3
Total	180	15	141.5	2.0	42
Average	15.0	1.3	11.8	0.2	3.5

TABLE I-2. FARM SURVEY RESULTS (3/7)
CROPPED AREA

Farm. No.	Total	Jowar	Bajra	Wheat	Gram	Oilseed	Cotton	Others
Pachad Area (ha)								
1 (u)	6	5.5				0.5		
2 (u)	9	8				1		
3 (u)	4	4						
4 (u)	5	4				1		
5 (u)	3	3						
6 (u)	1	1						
7 (u)	1.5	1.5						
8 (u)	2	2						
9 (u)	6	6						
10 (u)	2	2						
11 (m)	5	3		2				
12 (m)	12	9	1	1		1		
13 (m)	15	12	1	1		1		
14 (m)	3	3						
15 (m)	7	4		1	1	1		
16 (m)	8	5			3			
17 (m)	2	2						
18 (m)	2	2						
19 (m)	2.5	2			0.5			
20 (m)	2	2						
21 (d)	5	5						
22 (d)	10	10						
23 (d)	5	4		1				
24 (d)	6	6						
25 (d)	4	3		1				
26 (d)	9	2.5		4	2	0.5		
27 (d)	8	4	2	2				
28 (d)	3	3						
29 (d)	3	2		1				
30 (d)	4				1.5	2.5		
Total	155	120.5	4	14	8	8.5		
Avarage	5.2	4.0	0.1	0.5	0.3	0.3		
Tribal Area (ha)								
1 (H)	5	3		2				
2 (H)	2	2						
3 (H)	10	7		3				
4 (H)	13	13						
5 (M)	5	5						
6 (M)	5	3		2				
7 (M)	1	1						
8 (M)	2	2						
9 (Z)	5	3		2				
10 (Z)	5	4		1				
11 (Z)	1	1						
12 (Z)	1	1						
Total	55	45		10				
Average	4.6	3.8		0.8				

TABLE I-2. FARM SURVEY RESULTS (4/7)
CROPPING INTENSITY

Farm. No.	Total	Jowar	Bajra	Wheat	Gram	Oilseed
Pachad Area (%)						
1 (u)	60	55	0	0	0	5
2 (u)	45	40	0	0	0	5
3 (u)	40	40	0	0	0	0
4 (u)	42	33	0	0	0	8
5 (u)	75	75	0	0	0	0
6 (u)	50	50	0	0	0	0
7 (u)	38	38	0	0	0	0
8 (u)	50	50	0	0	0	0
9 (u)	60	60	0	0	0	0
10 (u)	50	50	0	0	0	0
11 (m)	50	30	0	20	0	0
12 (m)	48	36	4	4	0	4
13 (m)	38	30	3	3	0	3
14 (m)	50	50	0	0	0	0
15 (m)	35	20	0	5	5	5
16 (m)	40	25	0	0	15	0
17 (m)	50	50	0	0	0	0
18 (m)	20	20	0	0	0	0
19 (m)	36	29	0	0	7	0
20 (m)	40	40	0	0	0	0
21 (d)	50	50	0	0	0	0
22 (d)	45	45	0	0	0	0
23 (d)	38	31	0	8	0	0
24 (d)	40	40	0	0	0	0
25 (d)	17	13	0	4	0	0
26 (d)	75	21	0	33	17	4
27 (d)	40	20	10	10	0	0
28 (d)	30	30	0	0	0	0
29 (d)	43	29	0	14	0	0
30 (d)	19	0	0	0	7	12
Total Avarage	41	32	1	4	2	2
Tribal Area (%)						
1 (H)	17	10	0	7	0	0
2 (H)	13	13	0	0	0	0
3 (H)	8	6	0	3	0	0
4 (H)	33	33	0	0	0	0
5 (M)	25	25	0	0	0	0
6 (M)	13	8	0	5	0	0
7 (M)	10	10	0	0	0	0
8 (M)	13	13	0	0	0	0
9 (Z)	33	20	0	13	0	0
10 (Z)	50	40	0	10	0	0
11 (Z)	50	50	0	0	0	0
12 (Z)	17	17	0	0	0	0
Total Average	17	14	0	3	0	0

TABLE I-2. FARM SURVEY RESULTS (5/7)
CROP YIELD

Farm. No.	Jowar	Bajra	Wheat	Gram	Oilseeds
Pachad Area (kg/ha)					
1 (u)	1,100				1,000
2 (u)	1,250	1,150			900
3 (u)	1,300				
4 (u)	1,000				900
5 (u)	1,600				
6 (u)	1,200				
7 (u)	1,600				
8 (u)	1,400				
9 (u)	1,600				
10 (u)	1,500				
11 (m)	1,400		700		
12 (m)	1,300	1,200	1,000		900
13 (m)	1,100	1,000	900		1,000
14 (m)	1,200				
15 (m)	1,600		1,800	1,700	1,600
16 (m)	1,600			1,600	
17 (m)	1,600				
18 (m)	1,500				
19 (m)	1,600			1,500	
20 (m)	1,200				
21 (d)	1,000				
22 (d)	1,100				
23 (d)	1,050		1,000		
24 (d)	1,200				
25 (d)	1,600		1,200		
26 (d)	1,400		1,500	1,600	600
27 (d)	1,600	1,300	1,600		
28 (d)	1,300				
29 (d)	1,500		1,800		
30 (d)				1,400	1,200
Avarage	1,359	1,163	1,278	1,560	1,013
Tribal Area (kg/ha)					
1 (H)	800		800		
2 (H)	700				
3 (H)	800		800		
4 (H)	700				
5 (M)	1,400				
6 (M)	800		600		
7 (M)	1,000				
8 (M)	900				
9 (Z)	1,000		800		
10 (Z)	700		800		
11 (Z)	800				
12 (Z)	900				
Average	875		760		

TABLE I-2. FARM SURVEY RESULTS (6/7)
LIVESTOCK

Farm. No.	Cattle	Buffa-loes	Sheep	Goats	Horses	Donkeys (Mules)	Camels	Poultry
Pachad Area (Head)								
1 (u)	3			7		2		75
2 (u)	5	1		10	1		1	30
3 (u)	7			19				42
4 (u)	5			8		1		38
5 (u)	8			4			2	
6 (u)	3			16				
7 (u)	3		13	14			1	
8 (u)	4	1	14	20		1		12
9 (u)	4			8			4	
10 (u)	2		6	4			1	
11 (m)	12	1	9	8		1		90
12 (m)	7			7				22
13 (m)	10			17				48
14 (m)		2		11		1		65
15 (m)	4		5	8	1			12
16 (m)	10			40			1	6
17 (m)	2		15	20				6
18 (m)	2		2					
19 (m)	6	2		14		2		
20 (m)	4			5				
21 (d)	2							10
22 (d)	2			2				20
23 (d)	7			6				35
24 (d)	6			12				25
25 (d)	6	2					1	
26 (d)	8		35	20				20
27 (d)	6	3	12	10	2	2		18
28 (d)	12			13				
29 (d)	6		14	9			1	
30 (d)	8		7					10
Total	164	12	132	312	4	10	12	584
Avarage	5.5	0.4	4.4	10.4	0.1	0.3	0.4	19.5
Tribal Area (Head)								
1 (H)	17		65	30			2	10
2 (H)	2			12				
3 (H)	7		33	14	3			
4 (H)	4		90	60	2		1	15
5 (M)	6		35	65				60
6 (M)	7		110	28		2	1	125
7 (M)	4		15			1		4
8 (M)	9					1		60
9 (Z)	4		5		1			15
10 (Z)	14		25	35	1	2		15
11 (Z)	1		2	2	1			10
12 (Z)	3					1		10
Total	78		380	246	8	7	4	324
Average	6.5		42.2	30.8	1.6	1.4	1.3	32.4

TABLE I-2. FARM SURVEY RESULTS (7/7)
FARM INPUTS (Seeds)

Farm. No.	Jowar	Bajra	Wheat	Gram	Oilseed
Pachad Area (kg/ha)					
1 (u)	33				6
2 (u)	32	20			6
3 (u)	30				
4 (u)	32				6
5 (u)	25				
6 (u)	20				
7 (u)	20				
8 (u)	25				
9 (u)	22				
10 (u)	27				
11 (m)	30		100		
12 (m)	33	20	100		6
13 (m)	32	25	100		6
14 (m)	30				
15 (m)	24		100	20	7
16 (m)	25			20	
17 (m)	25				
18 (m)	25				
19 (m)	25			20	
20 (m)	27				
21 (d)	25				
22 (d)	30				
23 (d)	30		100		
24 (d)	30				
25 (d)	25		100		
26 (d)	25		100	50	8
27 (d)	30	30	100		
28 (d)	25				
29 (d)	25		100		
30 (d)				25	6
Total	787	95	900	135	51
Avarage	27	24	100	27	6
Tribal Area (kg/ha)					
1 (H)	25		100		
2 (H)	25				
3 (H)	25		100		
4 (H)	27				
5 (M)	25				
6 (M)	25		100		
7 (M)	25				
8 (M)	27				
9 (Z)	18		100		
10 (Z)	25		100		
11 (Z)	25				
12 (Z)	27				
Total	299		500		
Average	25		100		

CHAPTER III. MISCELLANEOUS

TABLE I-3. LABOR REQUIREMENT (PRESENT-CULTIVATION) (1/4)

Crops		Land Preparation d	Land Preparation Rs	Sowing d	Sowing Rs	Others Rs	Total Rs
Jowar	m			0.5	15	15	30
	a						
	t	2h	150				150
Bajra	m			0.5	15	15	30
	a						
	t	2h	150				150
K.Fodders	m			0.5	15	15	30
	a						
	t	2h	150				150
Wheat	m			0.5	15	15	30
	a						
	t	2h	150				150
Gram	m			0.5	15	15	30
	a						
	t	2h	150				150
Oilseed	m			0.5	15	15	30
	a						
	t	2h	150				150
R,Fodders	m			0.5	15	15	30
	a						
	t	2h	150				150

TABLE I-3. LABOR REQUIREMENT (PRESENT-HARVESTING) (2/4)

Crops		Harvesting d	Harvesting Rs	Threshing d	Threshing Rs	Others Rs	Total Rs
Jowar	m	20.0	600			15	615
	a			1.0	70		70
	t						
Bajra	m	20.0	600			15	615
	a			1.0	70		70
	t						
K.Fodders	m	18.0	540			15	555
	a						
	t						
Wheat	m	20.0	600			15	615
	a			1.0	70		70
	t						
Gram	m	18.0	540			15	555
	a			1.0	70		70
	t						
Oilseed	m	18.0	540			15	555
	a			1.0	70		70
	t						
R,Fodders	m	12.0	360			15	375
	a						
	t						

NOTE: m: mandays, a: animaldays, t: tractors, d: days, h: hours

TABLE I-3. LABOR REQUIREMENT (FUTURE-CULTIVATION) (3/4)

Crops		Land Preparation d	Land Preparation Rs	Sowing d	Sowing Rs	Others Rs	Total Rs
Jowar	m			0.8	24	24	48
	a						
	t	3.3h	247				247
Bajra	m			0.8	24	24	48
	a						
	t	3.3h	247				247
K.Fodders	m			0.8	24	24	48
	a						
	t	3.3h	247				247
Wheat	m			0.8	24	24	48
	a						
	t	3.3h	247				247
Gram	m			0.8	24	24	48
	a						
	t	3.3h	247				247
Oilseed	m			0.8	24	24	48
	a						
	t	3.3h	247				247
R,Fodders	m			0.8	24	24	48
	a						
	t	3.3h	247				247

TABLE I-3. LABOR REQUIREMENT (FUTURE-HARVESTING) (4/4)

Crops		Harvesting d	Harvesting Rs	Threshing d	Threshing Rs	Others Rs	Total Rs
Jowar	m	25.0	750			38	788
	a			1.3	90		90
	t						
Bajra	m	25.0	750			38	788
	a			1.3	90		90
	t						
K.Fodders	m	23.0	690			22	712
	a						
	t						
Wheat	m	25.0	750			38	788
	a			1.3	90		90
	t						
Gram	m	23.0	690			22	712
	a			1.3	90		90
	t						
Oilseed	m	23.0	690			22	712
	a			1.3	90		90
	t						
R,Fodders	m	15.0	450			31	481
	a						
	t						

TABLE I-4. NUMBER OF LIVESTOCK BY MOZA IN THE STUDY AREA

	NAME OF MOZA	CATTLE	BAFFALOES	SHEEP	GOATS	CAMELS	DONKEYS	POULTRY
1	BELA *	495	60	4,850	5,860	265	105	600
2	DALANA PATIZAI	237	0	600	3,021	511	59	320
3	WAHI KINGRANI	140	0	550	350	40	120	500
4	KOCHHA WADANI	48	0	126	63	8	38	126
5	VIDORE	708	105	2,482	1,335	55	200	4,500
6	NORWAR	233	51	3,300	2,000	145	60	300
7	DAGAR CHIT	92	7	51	53	5	0	238
8	CHABRI BALA GHARBI	116	5	283	58	3	11	216
9	CHORATTA PACHADH SHUMAI	540	96	2,891	1,392	49	28	3,490
10	CHORATTA PACHADH JANUBI	334	20	1,093	283	4	35	2,707
11	GADAI GHARBI	31	50	324	230	14	54	1,944
12	CHIT SARKANI	55	34	66	50	2	3	165
13	DALANA KHAS	228	6	1,365	1,619	109	47	322
	TOTAL	3,257	434	17,981	16,314	1,210	760	15,428

* MOZA RAKH BELA is included
SOURCE: Estimated by JICA Study Team based on the data from D. G. Khan Tehsil Office

TABLE I-5. ESTIMATED ADDITIONAL ANIMAL PRODUCTION IN THE STUDY AREA (IN 25 RETURN PERIOD POST PROJECT)

	Tons	ME(Mcal)/ton *	Total ME
	(a)	(b)	(a)x(b)
Jowar Stover	28,372	1,500	42,558,000
Bajra Stover	3,792	1,500	5,688,000
Wheat Straw	2,580	1,500	3,870,000
Green Fodders	1,922	500	961,000
Total			53,077,000 (c)

	ME/head/day	Annual ME	Head
	(d)	(e)=(d)x365	(c)/(e)
Cattle	25	9,125	5,817
Sheep	3	986	53,858

* ME : Metabolic Energy

ANNEX J. FLOOD / IRRIGATION

ANNEX J. FLOOD / IRRIGATION

		Page
CHAPTER I.	PRESENT FLOOD DAMAGE	J - 1
CHAPTER II.	RUNOFF VOLUME AT DARRAH POINT	J - 3
CHAPTER III.	IRRIGATED AREA	J - 7
3.1	Present Irrigated Area	J - 7
3.2	Proposed Irrigated Area	J - 9

LIST OF TABLES

		Page
Table J - 1.	Cost of Present Flood Damage	J - 2
Table J - 2.	Runoff Volume at Darrah Point (Present/Proposed)	J - 4
Table J - 3.	Runoff Volume at Darrah Point (Present/Case A)	J - 5
Table J - 4.	Runoff Volume at Darrah Point (Case B-1)	J - 5
Table J - 5.	Runoff Volume at Darrah Point (Case B-2)	J - 5
Table J - 6.	Probable Runoff Volume at Darrah Point	J - 6
Table J - 7.	Present Irrigated Area	J - 10
Table J - 8.	Proposed Irrigated Area (Case A)	J - 11
Table J - 9.	Proposed Irrigated Area (Case B-1)	J - 12
Table J - 10.	Proposed Irrigated Area (Case B-2)	J - 13

CHAPTER I. PRESENT FLOOD DAMAGE

TABLE J-1. COST OF PRESENT FLOOD DAMAGE

(Unit: million Rs)

Year	Return Period of Flood Peak Discharge	Pachad Area	D.G. Khan Canal – Indus River	Total
1973	3.91	-	-	-
1974	3.99	-	-	-
1975	14.43	10.50	10.25	20.75
1976	2.50	3.00	2.85	5.85
1977	1.24	-	-	-
1978	75.49	-	-	-
1979	2.77	-	-	-
1980	1.66	-	-	-
1981	1.14	-	-	-
1982	1.24	-	-	-
1983	7.07	-	-	-
1984	7.07		0.30	0.30
1985	1.74	2.00	0.50	2.50
1986	1.74	0.50	0.24	6.74
1987	2.07	-	-	-
1988	4.09	-	1.53	1.53
1989	1.19	0.00	0.20	0.20

CHAPTER II. RUNOFF VOLUME AT DARRAH POINT

The runoff volume is calculated in accordance with the water year of the irrigation planning, from June to May of the next year. The runoff volume of three rivers (Vidore, Zai and Dalana) was studied for nine years (from 1975 to 1983) under the present and the proposed conditions (refer to Table J-2). In Tables J-3 to J-5, the above runoff volume is summarized by seasons, the Kharif (from May to August) and the Rabi (from September to April of the next year). The probable runoff volume is shown in Table J-6.

TABLE J-2. RUNOFF VOLUME AT DARRAH POINT (PRESENT/PROPOSED)

(Unit: MCM)

Year	Present / Case A				CaseB-1				CaseB-2			
	Vidore	Zai	Dalana	Total	Vidore	Zai	Dalana	Total	Vidore	Zai	Dalana	Total
1975	161.10	3.45	17.06	181.61	152.65	2.94	12.97	168.56	147.49	2.94	12.97	163.40
1976	240.92	6.10	30.19	277.21	231.70	5.56	25.10	262.36	225.00	5.56	25.10	255.66
1977	96.26	1.95	9.61	107.82	89.32	1.61	7.03	97.96	85.61	1.61	7.03	94.25
1978	114.57	1.94	9.61	126.12	107.47	1.59	6.99	116.05	103.11	1.59	6.99	111.69
1979	78.15	1.59	7.87	87.61	72.18	1.28	5.57	79.03	68.49	1.28	5.57	75.34
1980	86.03	1.46	7.24	94.73	79.64	1.18	5.13	85.95	75.78	1.18	5.13	82.09
1981	96.29	1.86	9.26	107.41	89.78	1.51	6.60	97.89	85.46	1.51	6.60	93.57
1982	87.39	1.52	7.48	96.39	80.34	1.24	5.43	87.01	76.70	1.24	5.43	83.37
1983	144.39	2.62	12.98	159.99	134.23	2.12	9.27	145.62	128.51	2.12	9.27	139.90
Average	122.79	2.50	12.37	137.66	115.26	2.11	9.34	126.71	110.68	2.12	9.34	122.14

Note: Case A ; Proposed Runoff Volume
Case B-1 ; - do-
Case B-2 ; - do-

TABLE J-3. RUNOFF VOLUME AT DARRAH POINT (PRESENT/CASE A)

(Unit: MCM)

Year	Vidore			Zai			Dalana		
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
1975	100.440	60.660	161.100	2.070	1.380	3.450	10.242	6.818	17.060
1976	126.270	114.650	240.920	3.276	2.824	6.100	16.200	13.990	30.190
1977	70.605	25.655	96.260	1.395	0.555	1.950	6.900	2.710	9.610
1978	68.805	45.765	114.570	1.455	0.385	1.840	7.140	2.470	9.610
1979	47.970	30.180	78.150	0.930	0.660	1.590	4.605	3.265	7.870
1980	52.425	33.605	86.030	0.855	0.605	1.460	4.290	2.950	7.240
1981	55.755	40.535	96.290	1.095	0.765	1.860	5.415	3.845	9.260
1982	41.850	45.810	87.660	0.615	0.905	1.520	3.030	4.450	7.480
1983	107.325	37.065	144.390	2.055	0.565	2.620	10.140	2.840	12.980
Average	74.605	48.214	122.819	1.527	0.960	2.488	7.551	4.815	12.367

TABLE J-4. RUNOFF VOLUME AT DARRAH POINT (CASE B-1)

(Unit: MCM)

Year	Vidore			Zai			Dalana		
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
1975	93.920	58.730	152.650	1.730	1.210	2.940	7.730	5.240	12.970
1976	119.040	112.660	231.700	2.880	2.680	5.560	12.830	12.270	25.100
1977	65.910	23.410	89.320	1.160	0.450	1.610	5.120	1.910	7.030
1978	64.910	42.560	107.470	1.240	0.350	1.590	5.230	1.760	6.990
1979	44.280	27.900	72.180	0.740	0.540	1.280	3.260	2.310	5.570
1980	48.210	31.430	79.640	0.700	0.480	1.180	3.050	2.080	5.130
1981	52.320	37.460	89.780	0.880	0.630	1.510	3.860	2.740	6.600
1982	38.180	42.160	80.340	0.490	0.750	1.240	2.150	3.280	5.430
1983	100.090	34.140	134.230	1.650	0.470	2.120	7.190	2.080	9.270
Average	69.651	45.606	115.257	1.274	0.840	2.114	5.602	3.741	9.343

TABLE J-5. RUNOFF VOLUME AT DARRAH POINT (CASE B-2)

(Unit: MCM)

Year	Vidore			Zai			Dalana		
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
1975	90.550	56.940	147.490	1.730	1.210	2.940	7.730	5.240	12.970
1976	114.530	110.470	225.000	2.880	2.680	5.560	12.830	12.270	25.100
1977	63.490	22.120	85.610	1.160	0.450	1.610	5.120	1.910	7.030
1978	62.510	40.600	103.110	1.240	0.350	1.590	5.230	1.760	6.990
1979	42.030	26.460	68.490	0.740	0.540	1.280	3.260	2.310	5.570
1980	46.010	29.770	75.780	0.700	0.480	1.180	3.050	2.080	5.130
1981	49.780	35.680	85.460	0.880	0.630	1.510	3.860	2.740	6.600
1982	36.430	40.270	76.700	0.490	0.750	1.240	2.150	3.280	5.430
1983	95.780	32.730	128.510	1.650	0.470	2.120	7.190	2.080	9.270
Average	66.790	43.893	110.683	1.274	0.840	2.114	5.602	3.741	9.343

TABLE J-6. PROBABLE RUNOFF VOLUME AT DARRAH POINT

(Unit: MCM)

	Present / Case A				Case B-1				Case B-2			
	Vidore	Zai	Dalana	Total	Vidore	Zai	Dalana	Total	Vidore	Zai	Dalana	Total
Average	122.79	2.50	12.37	137.66	115.26	2.11	9.34	126.71	110.68	2.12	9.34	122.14
Return Period												
2 Years	107.54	2.00	9.88	119.42	100.01	1.64	7.17	108.82	95.80	1.64	7.17	104.61
5 Years	149.97	3.04	15.02	168.03	141.30	2.56	11.33	155.19	136.12	2.56	11.33	150.01
10 Years	186.39	4.07	20.19	210.65	177.12	3.52	15.64	196.28	171.23	3.52	15.64	190.39
25 Years	242.18	5.86	29.12	277.16	232.53	5.21	23.28	261.02	225.58	5.21	23.28	254.07

Note: Water year is from May to April.

CHAPTER III. IRRIGATED AREA

3.1 Present Irrigated Area

(1) Intake Conditions

The water intake by priority is given to the upper area according to the water rights system. The intake is carried out actively during the Kharif season because the irrigation water originates from flood flows in rivers.

(2) Irrigation Method

The basin irrigation (flood irrigation) is planned as the irrigation method. Planting is performed after the percolation of flooded water on fields.

(3) Irrigation Efficiency

In Vidore hill torrent, the irrigation water runs down in the river from Darrah to the intake site, and then the water is transferred from intake to on-farm through un-lined natural canal systems.

As for irrigation efficiencies, only conveyance (Ec) and field canal (Eb) efficiencies are considered because the basin irrigation is planned as irrigation method, as follows (refer to FAO Technical Paper No. 24):

Conveyance efficiency (Ec):	ratio between water received at intake and that released at Darrah, Ec = 0.65
Field canal efficiency (Eb):	ratio between water received at on-farm and that received at intake, Eb = 0.8
Overall efficiency (Ep):	Ep = Ec x Eb = 0.5

(4) Crop Water Requirement

Crop water requirements are determined based on the following studies:

Average flooded depth recorded

As the results of the field survey, the average flooded depth is 0.9 m in the Kharif and Rabi seasons.

Calculated crop water requirements

Reference crop evapotranspiration is computed using the Penman Method. And the crop water requirements are estimated based on the crop coefficients in accordance with the proposed cropping calendar in the Kharif and Rabi seasons. The calculation results are shown below:

Crop Water Requirements by Crops

(Unit: mm)

Kharif		Rabi		
Jowar	Bajra	Wheat	Gram	Oilseed
360	360	323	292	257

Total readily available moisture (TRAM)

Soil physical analyses are carried out on the items such as specific gravity, field capacity and, wilting point, etc. The analyses are conducted for the seven samples which are the major soil types in Vidore hill torrent. Available moisture (AM) and TRAM are calculated for respective soils, as follows:

TRAM of Soils

(Unit: mm)

Test Pit No.	Soils	TRAM
No.1, No.10, No.11	Katchor	51.0
No.2	Bolan	82.0
No.3	Hadwar	62.6
No.4, No.6	Kundi	97.0
No.5	Chatter	39.0
No.7, No.8	Kallarwala	59.0
No.9, No.12	Talai	32.4

Based on the above study, the crop water requirements are determined at the maximum value of 0.9 m.

(Unit: m)

Items		Crop Water Requirements
a)	Average Flooded Depth Recorded	0.9
b)	Calculated Crop Water Requirements (Maximum)	0.360
c)	TRAM (Maximum)	0.097

(5) Cropping Period

The planting of Kharif crops begins after one-month-flooding which originates from flood flows from May to August. The cropping period, from planting to harvesting, is planned at 5 months for Kharif crops. As for Rabi crops, they are planted after one-month-flooding which comes from flood flows from September to November. The cropping period is also planned at 5 months. The floods from December to April of the next year are counted as non-usable-floods in the Rabi season.

(6) Irrigation Area

The present irrigation areas are estimated by water balance study for nine years from 1975 to 1983 (refer to Table J-7).

3.2 Proposed Irrigated Area

The irrigatable areas are computed for the three cases by means of water balance study which is carried out for nine years from 1975 to 1983 (refer to Tables J-8 to J-10).

TABLE J-7. PRESENT IRRGATED AREA

(Unit:ha)

		Chhabri Branch	Suchani Branch	Phullar Branch	Zai Nallah	Dalana Nallah	Total
1975	Kharif	1,759	1,064	801	115	569	4,308
	Rabi	0	0	0	59	161	220
	Total	1,759	1,064	801	174	730	4,528
1976	Kharif	1,731	1,066	801	182	900	4,680
	Rabi	2	1	1	23	161	188
	Total	1,733	1,067	802	205	1,061	4,868
1977	Kharif	1,731	903	746	78	384	3,842
	Rabi	48	108	49	7	36	248
	Total	1,779	1,011	795	85	420	4,090
1978	Kharif	1,731	957	651	80	396	3,815
	Rabi	58	26	94	3	15	196
	Total	1,789	983	745	83	411	4,011
1979	Kharif	1,546	668	453	52	256	2,975
	Rabi	0	140	95	3	17	255
	Total	1,546	808	548	55	273	3,230
1980	Kharif	1,689	729	496	48	239	3,201
	Rabi	12	85	57	8	38	200
	Total	1,701	814	553	56	277	3,401
1981	Kharif	1,731	776	527	61	300	3,395
	Rabi	26	27	19	3	13	88
	Total	1,757	803	546	64	313	3,483
1982	Kharif	1,340	578	393	34	169	2,514
	Rabi	30	130	88	10	47	305
	Total	1,370	707	482	44	216	2,819
1983	Kharif	1,804	1,057	828	114	563	4,366
	Rabi	0	0	0	28	136	164
	Total	1,804	1,057	828	142	699	4,530
Average	Kharif	1,674	866	633	85	420	3,678
	(%)	43.1	22.3	16.3	2.2	10.8	94.7
	Rabi	20	57	45	16	69	207
	(%)	0.5	1.5	1.1	0.4	1.8	5.3
	Total	1,694	923	678	101	489	3,885
	(%)	43.6	23.8	17.4	2.6	12.6	100.0

TABLE J-8. PROPOSED IRRIGATED AREA (CASE A)

(Unit:ha)

		Chhabri Branch	Suchani Branch	Phullar Branch	Zai Nallah	Dalana Nallah	Total
1975	Kharif	2,232	2,232	2,232	137	683	7,516
	Rabi	885	885	388	71	161	2,390
	Total	3,117	3,117	2,620	208	844	9,906
1976	Kharif	2,806	2,806	2,662	218	1,081	9,573
	Rabi	585	446	1	23	161	1,216
	Total	3,391	3,252	2,663	241	1,242	10,789
1977	Kharif	1,569	1,569	1,569	93	460	5,260
	Rabi	187	187	187	9	43	613
	Total	1,756	1,756	1,756	102	503	5,873
1978	Kharif	1,529	1,529	1,529	97	476	5,160
	Rabi	223	223	223	3	18	690
	Total	1,752	1,752	1,752	100	494	5,850
1979	Kharif	1,066	1,066	1,066	62	307	3,567
	Rabi	223	223	223	4	19	692
	Total	1,289	1,289	1,289	66	326	4,259
1980	Kharif	1,165	1,165	1,165	57	286	3,838
	Rabi	136	136	136	9	45	462
	Total	1,301	1,301	1,301	66	331	4,300
1981	Kharif	1,239	1,239	1,239	73	361	4,151
	Rabi	44	44	44	3	15	150
	Total	1,283	1,283	1,283	76	376	4,301
1982	Kharif	924	924	924	41	202	3,015
	Rabi	209	209	209	11	55	693
	Total	1,133	1,133	1,133	52	257	3,708
1983	Kharif	2,385	2,385	2,385	137	677	7,969
	Rabi	582	444	276	33	161	1,496
	Total	2,967	2,829	2,661	170	838	9,465
Average	Kharif	1,657	1,657	1,641	102	504	5,561
	(%)	25.51	25.51	25.27	1.56	7.76	85.60
	Rabi	342	311	187	18	75	934
	(%)	5.27	4.79	2.88	0.28	1.15	14.40
	Total	1,999	1,968	1,829	120	580	6,495
	(%)	30.78	30.30	28.16	1.84	8.93	100.00

TABLE J-9. PROPOSED IRRIGATED AREA (CASE B-1)

(Unit:ha)

		Chhabri Branch	Suchani Branch	Phullar Branch	Zai Nallah	Dalana Nallah	Total
1975	Kharif	2,087	2,087	2,087	117	515	6,893
	Rabi	862	862	389	62	162	2,337
	Total	2,949	2,949	2,476	179	677	9,230
1976	Kharif	2,645	2,645	2,645	192	856	8,983
	Rabi	589	448	4	23	164	1,228
	Total	3,234	3,093	2,649	215	1,020	10,211
1977	Kharif	1,465	1,465	1,465	77	341	4,813
	Rabi	171	171	171	8	31	552
	Total	1,636	1,636	1,636	85	372	5,365
1978	Kharif	1,442	1,442	1,442	80	349	4,755
	Rabi	209	209	209	3	12	642
	Total	1,651	1,651	1,651	83	361	5,397
1979	Kharif	984	984	984	50	217	3,219
	Rabi	200	200	200	4	14	618
	Total	1,184	1,184	1,184	54	231	3,837
1980	Kharif	1,071	1,071	1,071	47	204	3,464
	Rabi	126	126	126	7	31	416
	Total	1,197	1,197	1,197	54	235	3,880
1981	Kharif	1,163	1,163	1,163	59	257	3,805
	Rabi	38	38	38	3	11	128
	Total	1,201	1,201	1,201	62	268	3,933
1982	Kharif	848	848	848	34	144	2,722
	Rabi	191	191	191	10	40	623
	Total	1,039	1,039	1,039	44	184	3,345
1983	Kharif	2,224	2,224	2,224	111	479	7,262
	Rabi	549	549	388	27	120	1,633
	Total	2,773	2,773	2,612	138	599	8,895
Average	Kharif	1,548	1,548	1,548	85	374	5,102
	(%)	25.75	25.75	25.75	1.42	6.23	84.90
	Rabi	326	310	191	16	65	909
	(%)	5.42	5.16	3.18	0.26	1.08	15.10
	Total	1,874	1,858	1,739	101	439	6,011
	(%)	31.17	30.91	28.93	1.68	7.31	100.00

TABLE J-10. PROPOSED IRRIGATED AREA (CASE B-2)

(Unit:ha)

		Chhabri Branch	Suchani Branch	Phullar Branch	Zai Nallah	Dalana Nallah	Total
1975	Kharif	2,012	2,012	2,012	117	515	6,668
	Rabi	841	841	389	61	162	2,294
	Total	2,853	2,853	2,401	178	677	8,962
1976	Kharif	2,545	2,545	2,545	192	855	8,682
	Rabi	1,351	450	72	23	164	2,060
	Total	3,896	2,995	2,617	215	1,019	10,742
1977	Kharif	1,411	1,411	1,411	77	341	4,651
	Rabi	166	166	166	7	31	536
	Total	1,577	1,577	1,577	84	372	5,187
1978	Kharif	1,389	1,389	1,389	79	349	4,595
	Rabi	203	203	203	3	13	625
	Total	1,592	1,592	1,592	82	362	5,220
1979	Kharif	934	934	934	50	218	3,070
	Rabi	194	194	194	4	15	601
	Total	1,128	1,128	1,128	54	233	3,671
1980	Kharif	1,022	1,022	1,022	47	205	3,318
	Rabi	117	117	117	8	32	391
	Total	1,139	1,139	1,139	55	237	3,709
1981	Kharif	1,106	1,106	1,106	59	258	3,635
	Rabi	36	36	36	3	11	122
	Total	1,142	1,142	1,142	62	269	3,757
1982	Kharif	810	810	810	33	143	2,606
	Rabi	181	181	181	9	40	592
	Total	991	991	991	42	183	3,198
1983	Kharif	2,128	2,128	2,128	111	480	6,975
	Rabi	525	525	389	27	119	1,585
	Total	2,653	2,653	2,517	138	599	8,560
Average	Kharif	1,484	1,484	1,484	85	374	4,911
	(%)	25.20	25.20	25.20	1.44	6.36	83.40
	Rabi	402	302	194	16	65	979
	(%)	6.83	5.12	3.29	0.27	1.09	16.60
	Total	1,886	1,786	1,678	101	439	5,890
	(%)	32.03	30.32	28.49	1.71	7.45	100.00

ANNEX K. WATERSHED MANAGEMENT

ANNEX K. WATERSHED MANAGEMENT

		Page
CHAPTER I.	WATERSHED MANAGEMENT PLAN	K - 1
CHAPTER II.	APPROACHES OF WATERSHED MANAGEMENT	K - 7
CHAPTER III.	RECOMMENDED ZONAL WATERSHED MANAGEMENT APPROACHES	K - 13
CHAPTER IV.	PROMOTION OF GRAZING THROUGH IMPROVEMENT OF VEGETATION	K - 19
CHAPTER V.	SEDIMENT	K - 21

LIST OF ATTACHMENTS

Page

1. FIGURES .... K - 23

2. VETIVER GRASS .... K - 27

CHAPTER I. WATERSHED MANAGEMENT PLAN

Watershed management aims to stabilize the households of the inhabitants in downstream areas through cutting down flood damage and reducing sediment in low reaches. It also aims to raise irrigation in the future.

Procedures to realize these objectives are as follows;

1st: Developing gentle and hilly area to grazing field by means of seeding of fodder plants and making water points and improving farmland through reducing soil erosion by grass hedges, earthen bunds, gully pluggings,

2nd: Stabilizing water course and decrease of sediment by construction of soil-saving check dams,

3rd: Improving irrigation through construction of dams and reservoirs.

There are two ways in watershed management to reduce runoff and erosion from farmland and grazing fields, one is vegetational methods such as seeding and planting of forage plants. The other is the use of structural methods such as construction of check dams, earthen bunds,gully pluggings, small impounding ponds and water points.

The watershed management approaches for this area should be combined with vegetational and structural approaches. Introduction of scheduled grazing will be the key to yield sufficient fodder and for bringing successful watershed management to the area.

The watershed is classified into five zones based on the geology, relief, land use, vegetation and river condition. The features of the area are confirmed in the field of this study. Relative relief is characterized by the difference between the highest and lowest points within each one kilometer square and average inclination for each square. The area divided by gradient for each zone is shown in following table.

AREA DIVIDED BY GRADIENT

(sq.km)

ZONE	1	2	3	4	5	TOTAL
LESS THAN 3 DEGREES	0	3	41	51	25	120
3 TO 6	1	27	55	37	73	193
6 TO 10	34	64	34	15	105	252
10 TO 15	78	29	8	7	47	169
15 TO 20	80	2	0	0	4	86
20 TO 25	36	0	0	0	0	36
25 TO 30	15	0	0	0	0	15
MORE THAN 30	6	0	0	0	0	6
TOTAL	250	125	138	110	254	877

The area for each zone is shown in the table below with the share of agricultural land, river area and cliff and eroded area.

AREA BY LAND USE

(sq.km)

ZONE	1	2	3	4	5	TOTAL
FARMING LAND	2	2	4	4	3	15
GRAZING FIELD	189	109	117	86	183	684
RIVER BED	31	10	10	18	25	94
ERODED & COLLAPSED	28	4	7	2	43	84
TOTAL	250	125	138	110	254	877

Zonal features are described below:

ZONE 1

Slopes are generally steep, 55 percent of this zone has a gradient of more than 15 degrees. In the western half, most of the slopes have been disrupted by geological factors.

Vegetational cover in this zone is well developed in high mountain slopes. Owing to this, considerable amounts of soil, kept in the opening of weathered rock layers grows plants. Some valleys on the eastern slope of Mt.Ek-Bai are covered densely with trees of 3 to 4 meters height because of seasonal grazing.

Structural methods are not suitable for this zone, because steep slopes make structures costly and make their life span short. No grass hedges are necessary in this area. It is fitting to plant local species of trees and grass in the valleys and depressed drain in the high portion of this zone.

<u>ZONE 2</u>

The Western half of this zone has several gorges and is on a foot hill continuing toward steep slopes in zone 1. This zone is composed of fan deposits and terrace gravel. Its Eastern half is a gentle plain with 1 to 2 kilometers width and is located between two elongated hills.

Main rivers are about 50 to 220 meters wide with over- steep slopes of 50 to 100 meters height. The slopes of both banks of tributaries are composed of talus deposits with about a 30 degrees slope. The relief of this area is gentle and farmland which has several to tens of hectares is developed along main perennial rivers and the main crops planted are jowar and bajra in summer and wheat in winter. Mini-sized farmlands enclosed with stone walls have developed in tributaries.

Recommended methods in this area are as follows:

1) Provision of grass hedges with earthen bunds and V- shaped ditches in a grazing yard on gentle slopes,
2) Provision of dense grass hedges on steep slopes of talus protecting against erosion,
3) Provision of gully pluggings on fringes of farmland facing the watercourse to stop development of gully erosion.

<u>ZONE 3</u>

The geological structure of this zone is asymmetrical anticline. The relief is mostly gentle reflecting underlying strata. Highly erodible reddish clay and clay stone are exposed in places of this zone.

Though there are perennial rivers in this zone, water flowing in deep valleys can not be utilized. Inhabitants suffer from lack of water for domestic use and irrigation. Available tributaries flow only after heavy rainfall.

The open cut uranium mining area excavates 3 kms to north- south and 8 kms to east-west in a southern part of this area.

The following methods are recommended for this zone.

1) Provision of earthen bunds and grass hedges for enlarging cultivable area,
2) Provision of grass hedges with bunds and V-shaped ditches in moderate slope grazing fields,
3) Provision of ponds for small drainage basins with soil and water conservation works,
4) Provision of gully plugging on fringes of farm land facing water courses to stop development of gully erosion,
5) Provision of water points for grazing livestock.

ZONE 4

Most of this area has a moderate slope comprised of fan deposit, such as gravel and cobbles. The ground surface, covered with sub-angular boulders and cobbles, is resistant to erosion, but run- off is extreme. Vegetation is formed only on highly weathered base rocks and on fine alluvial materials. Gully erosion is developed along heritage of gravelly plain.

The following structures are recommended to be constructed in this zone.

1) Provision of earthen bunds and grass hedges for developing production of fodder on gravelly plain,
2) Provision of gully plugging on the fringe of farmland facing watercourses to retard development of gully erosion,
3) Provision of water points for grazing livestock.

ZONE 5

The geological structure and relief are symmetric on both sides of Zinda Pir syncline which trends north-north-east toward south-south-west. Eastern and western flanks of the syncline are composed of Neogene weak sedimentary rocks and are severely eroded. Valleys with various widths and depths have developed along the strike because of alternating beds of sandstone, shale and limestone. No vegetation sprouts in some portions underlain by extremely weak clay stone and shale because of their severe and fast erosion. However, farmers have built various kinds of earthen bunds and gully pluggings for the purpose of making farmland by harvesting water and sediment.

The following structures are recommended to be constructed in this zone.

1) Provision of earthen bunds and grass hedges for enlarging farmland,
2) Provision of grass hedges with earthen bunds and V- shaped ditches in moderate slope grazing field,
3) Provision of small check dams for harvesting water and sediment for several tens of hectares of drainage basins,
4) Provision of gully pluggings on the fringe of grazing fields confronting to watercourses to reduce gully erosion,
5) Provision of water points in grazing fields distant from perennial flow.

In addition to these approaches, seeding is recommended 25 sq.kms in each of the zones 2, 3 and 5, respectively and 43 sq.kms in zone 4 for raising vegetation and promoting grazing. Structural methods are applied to projected seeding areas and flat areas. Proposed seeding areas are 35 sq.kms in zone 2, 36 sq.kms in zone 3, 29 sq.kms in zone 4, 31 sq.kms in zone 5 on gentle slopes except in watercourses and eroded areas.

The areas for the above mentioned approaches are listed in the Table.

RECOMMENDED WATERSHED MANAGEMENT APPROACHES

		ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
Earthen	Type A	none	860	none	none	none
bund	Type B	none	98	none	229	none
(nos)	Type C	none	none	1,200	none	1,000
Grass strips	(km)	none	1,325	630	252	543
Gully plugging	(nos)	none	980	1,000	780	840
Water points	(nos)	none	none	15	12	35
Ponds	(nos)	none	none	6	none	none
Seeding	(has)	none	6,000	6,100	7,100	5,500

AREA FOR WATERSHED MANAGEMENT

(sq.km)

ZONE	1	2	3	4	5
TOTAL AREA	250	125	138	110	254
COLLAPSED & ERODED AREA	28	4	7	2	43
RIVER/HILL TORRENT AREA	31	10	10	18	25
POTENTIAL AREA	191	111	121	90	186
WATERSHED MGT. AREA					
GRASS HEDGES	none	34	27	41	42
EARTHEN BUND	none	36	36	29	31
GULLY PLUGGING	none	36	36	29	31
POND	none	none	30	none	none
IMPROVED AREA	none	70	63	70	73
SEEDING AREA	none	60	61	71	55
SELF REGENERATION	191	49	56	16	128

IMPROVED AREA includes GRASS HEDGE and EARTHEN BUND.

The order of priority for the implementation of approaches are zone 2, 3, 4, 5. A part in zone 5 is necessary to take immediate action against critical erosion.

Zone 2 has priority due to following reasons:

- Most of this zone has flat or moderate slopes.
- Rivers in this area have useful perennial flow.
- Far-reaching effects will be expected because of existing farmland and high population.

Though there are wide and gentle areas in zone 3 and 4 , difficulties lie in the steady shortage of water.

CHAPTER II. APPROACHES OF WATERSHED MANAGEMENT

Exposure of weak rocks without soil and vegetational cover causes extremely short lag between the beginning of rain fall to the peak of runoff and produces a large quantity of sediment. Under such circumstances, structural approaches like dam construction are costly and their life span will be short. Structural approaches will be effective when peak flood discharge and sediment are reduced by means of watershed management works.

The following approaches, illustrated in attached figures, are available for the first step of watershed management to improve the natural condition in the area.

1) Non-structural method

a) Grass hedges and strips

Grass hedges and grass strips work to remove soil from water mixed with sediment. If grass hedges or strips are adopted, natural terrace will be developed by trapped soil. According to the data in the Philippines terraces of Vetiver grass hedges have reached a height of about 50 centimeters within 3 years. Other data shows that soil loss from plots decreased by 30 percent with Leucaena hedges and 60 percent with Vetiver hedges against across slope cultivation. Surface runoff decreased 15 percent with Leucaena and 33 percent with Vetiver from that of across slope cultivation.

Non-structural methods like grass hedges and strips are only simple work and moreover they will be free from maintenance after sprouting.

Typical utilization of grass hedges to the watershed management is as follows:

- Contour hedges and strips

  Contour hedges: These are single lines of grass, such as Vetiver grass, which retain much of the soil but allow the water to pass. The interval of lines depends on the slope.

  Grass strips: A grass strip of about 1 m width is left uncultivated along the contour. The interval of strips and width of uncultivated strips depends on the slope.

- Reinforcement of structures

  Earthen bunds and/or stone walls are reinforced by root system of planting grass.

  These methods are illustrated in the attached papers.

- Vetiver grass plantation

  Preparation works for the Vetiver grass plantation are outlined below.

- Preparation for nursery

Nos. of transplanting slips	:	62,500 slips/ha
Transplanting of slips	:	104 labors/ha
Maintenance of nursery	:	16 labors/ha

- Preparation of planting pieces

Removing clumps	:	417 labors/ha
Tearing & cutting	:	417 labors/ha

- Weights of planting pieces : 2 tons/10,000 slips
  1.26 cum/10,000 slips

- Transplanting

Contour planting(every 20cm)	:	60 meters/labor.day

The attached papers are chosen from the booklet titled below on Vetiver grass published by World Bank.

World Bank, Vetiver Grass (Vetiveria zizanioides)
A method of vegetative Soil and Moisture Conservation
2nd edition, New Delhi, April 1988

b) Seeding of forage plants

Harvested soil and water by earthen bunds or grass hedges is utilized for seed beds of forage plants. Grown plants will work by reducing the impact of raindrops and slowing down the runoff of water, besides they will feed livestock in the area. Seeded areas need to be enclosed at least two years after seeding. A three-year rotation cycle of grazing, enclosing two years and releasing one year, is recommended for seeding areas.

2) Structural method

a) Earthen bunds

Earthen bunds conserve soil and water by reducing erosion and runoff. Collected soil layers covering gravelly or rock exposed ground will retain available moisture for plants and productive land will be generated. Embankment of 0.5 to 3 meters height will be built in depressed watercourses to store runoff water and deposit soil particles.

The table below shows the calculated length and volume of embankment, and water surface area at full water level with the assumptions below:

- Top width of embankment is 0.5 meter.
- Slope is 2:1 on both side.
- Gradient of ground surface ranges from 1 to 6 degrees.
- Height of embankment ranges from 1 to 3 meters.

DIMENSION OF EARTHEN BUND

Slope height (Degrees)	Embankment (m)	Top length (m)	Reservoir area (sq.m)	Storage capacity (cu.m)	Embankment volume (cu.m)
1	1	115	3,300	1,100	86
	2	229	13,100	8,700	687
	3	344	29,600	29,600	2,064
2	1	57	800	270	43
	2	115	3,300	2,200	345
	3	172	7,400	7,400	1,032
3	1	38	360	120	29
	2	76	1,400	930	228
	3	114	3,200	3,200	684
4	1	29	210	70	22
	2	57	800	530	171
	3	86	1,800	1,800	516
5	1	23	130	40	17
	2	46	530	350	138
	3	69	1,200	1,200	414
6	1	19	90	30	14
	2	38	360	240	114
	3	57	810	810	342

The drainage area for a bund to store runoff from its drainage basin is computed by the following formula:

$A = 1000 \cdot Q / f / R$

where A: Area of drainage basin in sq.km
Q: Discharge in cu.m
R: Total rainfall in mm
f: Runoff coefficient (0.9)

Assuming R is 20 mm for 5-year return period and f is 0.9, the formula can convert as below,

$A = 55.5 \cdot Q$

Excess runoff will release through the spillway to avoid collapse of bunds. The height and length of bunds are determined by the gradient of the ground. Typical gradients of each zone for designing are

Zone 2: 1 and 6 degrees,
Zone 3: 2 degrees,
Zone 4: 1 degree,
Zone 5: 2 degrees.

Earthen bund will store the amount equivalent to runoff by 10 mm rainfall. The discharge capacity of the spillway is flooded by a 10-year return period rainfall. Suppose water level in pond is full during flooding. Let the time of concentration be 10 minutes because the drainage area ranges from 5 to 10 hectares.

The intensity of a 10-minute rainfall by 10-year return period is determined as follows. Intensity of daily rainfall by 10- year return period is 50 mm per hour.

1-hour rainfall(R1) = 6 x (R24/24) = 6 x (50/24) = 12.5 mm/hr
10-min rainfall = 1.8 x R1 = 1.8 x 12.5 = 22.5 mm/hr

Peak flood discharge by the drainage area is shown in the following table computed by the Rational Formula.

$$Q=f \cdot R \cdot A/3.6$$

FLOOD DISCHARGE FOR BUND SPILLWAY

drainage area (has)	peak flood discharge (c.m.s.)
1	0.056
2	0.113
3	0.169
5	0.281
10	0.563

b) Gully plugging

Gully pluggings are settled in gullies developed in heritage around plain area within about 300 meters from its edge.

The average size of the gully is measured at 5 meters in width, 1.5 meters in depth and 100 meters in length. Gully pluggings are made by dry stone works with soil cover on the upstream slope. One gully plugging will be provided for every one hectare.

c) Water points

Drinking water is one of the basic requirements for grazing livestock and lack of water may disturb proper utilization of grazing fields. Water points will be located at intervals of 4 km in flat areas and every 400 to 800 m on sloped areas. Water points are distributed every 4 sq.km in watercourse and existing farmland except in eroded and collapsed land areas . A water point stores 750 cubic meters of water. The storage capacity is decided by the following data.

- Number of livestock in 4 sq.km : 365 Animal units
- Demand of water per day : 5 liters/ head

- Service period : 1 year

d) Ponds

Ponds are planned in zone 3 where water for inhabitants and livestock and for irrigation is short except during flood season. In order to store water being almost full every year, assume rainfall of 10 mm per day, which may be expected every year, for storage capacity calculation of ponds. Area of the drainage basin is 1.3 to 2.4 sq.km for storage capacity of 10,000 cu.m with assumption on runoff coefficient of 0.7. Judging from relief in drainage basin, average storage of ponds is estimated at 30,000 cum each with 4 to 6 sq.km of drainage basin.

Peak flood discharge is estimated as below. Let rainfall intensity be that of 25-year return period which is 69 mm (R24) per day. Time of concentration is estimated at 40 minutes using the following values.

- Length of channel : 5 km
- Average slope of river bed : 0.003
- Velocity of flood : 2.1 m/sec

Rainfall intensity in 40 minutes (R40) is calculated 20 mm/hr adopting the formula below.

$$R40 = 1.2 \times R1, \qquad R1 = 6 \times (R24/24)$$

Peak flood discharge (Qp) is estimated by the Rational Formula. Let the discharge basin be 5 sq.km, and rainfall intensity be 20 mm/hr

$$Qp = f \cdot R \cdot A/3.6 = 0.7 \times 20 \times 5/3.6 = 19.5 \text{ c.m.s.}$$

Embankment for 30,000 cum pond must be 5 meters high considering the water depth of 3 meters, overflow depth during floods of 1.5 meters and freeboard of 0.5 meters. The total embankment volume is estimated at 3,000 cum.

The type of spillway is a masonry flume chute with an overflow wall. The width and length of the flume are 12 meters and 160 meters, respectively.

CHAPTER III. RECOMMENDED ZONAL WATERSHED MANAGEMENT APPROACHES

1) Zone 1

No approaches will apply to this zone because of the geography and actual vegetation.

2) Zone 2

The following approaches are proposed in this zone for watershed management works.

AREA BY WATERSHED MGT. APPROACHES ZONE 2

		AREA BY GRADIENT(in DEGREES)				
		Less than 3	3 to 6	6 to 10	More than 10	Total
TOTAL AREA	(sq.km)	3	27	64	31	125
POTENTIAL AREA	(sq.km)	3	24	57	27	111
PROTECTED BY						
EARTHEN BUND	(sq.km)	3	24	9	none	36
	(nos.)	49	571	338	none	958
GULLY PLUGGING	(sq.km)	1	7	17	11	36
	(nos.)	27	191	463	299	980
WATER POINTS	(nos.)	none	none	none	none	none
POND	(nos.)	none	none	none	none	none
GRASS HEDGES	(sq.km)	none	none	34	none	34
	(km)	none	none	1,325	none	1,325
SEEDING	(sq.km)	1	24	35	none	60
SELF REGENERATION	(sq.km)	none	none	22	27	49
AGRICULTURAL	(sq.km)	2	none	none	none	2

a) Earthen bunds

The Western half of zone 2 is constituted of a gravelly plain with about 6 degrees gradient and its area is 23 sq.km wide. In this part, earthen bund of 2 m height and 38 m length will be made every 2.66 hectares with capacity equivalent to the total runoff of 10 mm rainfall. A total number of 860 earthen bunds will be necessary. The Eastern half is about 12 sq.kms wide composed of weathered

Tertiary sedimentary rocks. A total number of 98 earthen bunds will be provided for every 12.24 hectares. The bunds are 1 m high and 115 m long in dimension, with a capacity equivalent to 10 mm rainfall.

b) Grass hedges

In the western part, contour planting of grass hedges will be made every 19 m in horizontal distance. The total length of grass hedges will be 1210 km in this part.

In the eastern part, grass hedges will be 119 m apart horizontally and total length will be 115 km.

The number of planting pieces is 6.63 million slips and the area for the nursery is 1.8 hectares.

c) Gully pluggings

Total protecting area where gullies are developed is 980 hectares. One gully plugging will be built for every one hectare.

d) Water points

Main rivers, which flow throughout the whole year, run two to four kilometers apart in this area. No water point is necessary because main rivers provide adequate drinking water for livestock.

3) Zone 3

The following measures are recommended in zone 3.

AREA BY WATERSHED MGT. APPROACHES ZONE 3

		AREA BY GRADIENT(in DEGREES)				
		Less than 3	3 to 6	6 to 10	More than 10	Total
TOTAL AREA	(sq.km)	41	55	34	8	138
POTENTIAL AREA	(sq.km)	36	48	30	7	121
PROTECTED BY						
EARTHEN BUND	(sq.km)	36	none	none	none	36
	(nos.)	1,200	none	none	none	1,200
GULLY PLUGGING	(sq.km)	9	14	13	none	36
	(nos.)	252	392	364	none	1,008
WATER POINTS	(nos.)	none	9	6	none	none
POND	(nos.)	4	2	none	none	6
GRASS HEDGES	(sq.km)	none	27	none	none	27
	(km)		630			
SEEDING	(sq.km)	32	29	none	none	61
SELF REGENERATION	(sq.km)	none	19	30	7	56
AGRICULTURAL	(sq.km)	4	none	none	none	4

a) Earthen bunds

Most of this zone is composed of fan deposit with 1 to 2 degrees gradient and 36 sq.kms width.

Earthen bunds of 1 m height and 57 m length with a capacity for storing runoff by 10 mm rainfall will be provided every 3 hectares. A total number of 1,200 earthen bunds will be built.

b) Grass hedges

Contour grass hedges will be planted every 57 m in horizontal distance. The total length of grass hedges will be 630 kms and the number of planting pieces will be 3.15 million slips with 1.8 hectares of nursery.

c) Gully pluggings

The total number of gully pluggings will be 1,008 in the area where gullies have been developed.

d) Water points

Fifteen water points will be built for every 4 sq.kms, except along main perennial rivers.

e) Ponds

Six ponds will be built for village inhabitants and livestock across watercourses in the zone.

4) Zone 4

The following measures are recommended in zone 4.

a) Earthen bunds

Most of the 29 sq.km wide area is composed of a gravelly slope of 1 degree in gradient. Earthen bunds of 1 m height and 115 m length will be provided every 12 hectares with a capacity equivalent to runoff by 10 mm rainfall. The total number of earthen bunds will be 237.

b) Grass hedges

Contour grass hedges will be planted every 114 m in horizontal distance. The total length of grass hedges will be 252 km and the number of planting pieces will be 1.26 million slips with 0.34 hectares of nursery.

c) Gully pluggings

The total number of gully pluggings will be 812 in the area where gullies have been developed.

d) Water points

Twelve water points will be built every 4 sq.km for every 50 sq.km area except along main perennial rivers.

AREA BY WATERSHED MGT. APPROACHES ZONE 4

		AREA BY GRADIENT(in DEGREES)				
		Less than 3	3 to 6	6 to 10	More than 10	Total
TOTAL AREA	(sq.km)	51	37	15	7	110
POTENTIAL AREA	(sq.km)	42	30	12	6	90
PROTECTED BY						
EARTHEN BUND	(sq.km)	29	none	none	none	29
	(nos.)	237	none	none	none	237
GULLY PLUGGING	(sq.km)	12	9	3	5	29
	(nos.)	336	252	84	140	812
WATER POINTS	(nos.)	5	5	2	none	12
POND	(nos.)	none	none	none	none	none
GRASS HEDGES	(sq.km)	10	30	1	none	41
	(km)	61	184	7	none	252
SEEDING	(sq.km)	39	30	2	none	71
SELF REGENERATION	(sq.km)	none	none	10	6	16
AGRICULTURAL	(sq.km)	3	none	none	none	3

5) Zone 5

The following measures are recommended in zone 5.

a) Earthen bunds

Tertiary sedimentary rocks conform zone 5. Relief appears serrated in most of this area. Areas of 31 sq.km with averages of 2 degrees slope will be provided with earthen bunds which are 1 m high and 57 m long, every 3 hectares. Capacity is equivalent to runoff by 10 mm rainfall.

b) Grass hedges

Contour grass hedges will be planted 57 m apart in horizontal distance. The total length of grass hedges will be 543 km and the number of planting pieces will be 2.72 million slips with 0.7 hectares of nursery.

c) Gully pluggings

The total number of gully pluggings will be 868 in the area where gullies have been developed.

d) Water points

Twelve water points will be built every 4 sq.km for every 250 sq.km area except along main perennial rivers. The total number will be 62.

AREA BY WATERSHED MGT. APPROACHES ZONE 5

		AREA BY GRADIENT(in DEGREES)				
		Less than 3	3 to 6	6 to 10	More than 10	Total
TOTAL AREA	(sq.km)	25	73	105	51	254
POTENTIAL AREA	(sq.km)	18	54	77	37	186
PROTECTED BY						
EARTHEN BUND	(sq.km)	15	16	none	none	31
	(nos.)	500	533	none	none	1,033
GULLY PLUGGING	(sq.km)	5	16	10	none	31
	(nos.)	140	448	280	none	868
WATER POINTS	(nos.)	1	4	7	none	12
POND	(nos.)	none	none	none	none	none
GRASS HEDGES	(sq.km)	none	38	4	none	42
	(km)	none	491	52	none	543
SEEDING	(sq.km)	15	40	none	none	55
SELF REGENERATION	(sq.km)	none	14	77	37	128
AGRICULTURAL	(sq.km)	3	none	none	none	3

CHAPTER IV. PROMOTION OF GRAZING THROUGH IMPROVEMENT OF VEGETATION

Production of forage will be enlarged through enriching vegetation in the watershed by regulated grazing. The grazing method at present is not restricted all year except in the high portion of zone 1 where grazing is not available in winter because of cold weather. Though native species of grass called Gorkha(Lasiurus sindicus) are dotted in areas of unrestricted grazing, dry yield of forage production is estimated at an extremely low value of about 150 to 350 kg/ha, as a result of over-grazing and shortage of moisture for growing of plants. In order to increase forage production, artificial reseeding of Dhaman(Cenchrus ciliaris) mixed with Gorkha(Lasiurus sindicus) is recommended in addition to the introduction of 3-year rotational grazing. This procedure may bring 4 to 6 tons of dry yield of forage.

To check the increase of forage yield in improved areas by grass hedges and earthen bunds through the increase capacity for livestock in watershed areas, the following information is provided.

For the purpose of calculation of feeding capacity, the "animal unit" is introduced instead of specified livestock. Nine kilograms of dried forage will be consumed by one animal unit a day. One animal unit consumes 3,285 kilograms of dried forage a year. The number of heads of specified livestock can be calculated using the following conversion factor.

CONVERSION FACTOR FOR ANIMAL UNIT

Kind of livestock	Equivalent animal unit
Cattle	1.0
Sheep	0.2
Goat	0.3
Camel	1.7

Dry yield of forage in each zone at present is estimated below.

DRY YIELD IN WATERSHED AREA AT PRESENT

Zone (sqkm)	Area (tons/ha)	Dry yield (tons)	Dry yield
1	175	0.75	13,125
2	88	0.25	2,188
3	83	0.20	1,660
4	83	0.20	1,660
5	148	0.15	2,220
Total	577		20,853

Capacity for livestock in the watershed area is estimated at 6,348 animal units under present conditions.

Enclosed grazing and seeding of feeding plants increases forage dry yield through improvements in soil and moisture conditions. The table below shows the dry yield estimation in an increased area.

DRY YIELD WITH WATERSHED MANAGEMENT

Zone	Grazing method	Area (sq.km)	Dry yield (tons/ha)	Dry yield (tons)
1	Traditional	175	0.75	13,125
	Rotational	0	0.00	0
2	Traditional	28	0.25	688
	Rotational	20	4.00	8,000
3	Traditional	22	0.20	440
	Rotational	60	4.00	8,133
4	Traditional	12	0.20	240
	Rotational	71	4.00	9,467
5	Traditional	93	0.15	1,395
	Rotational	55	4.00	7,333
Total		577		48,821

Livestock capacity in the area will be 14,862 animal units in the future. Capacity reaches about 2.3 times that of actual circumstances. For example, capacity for sheep in the area is estimated at about 25,000 heads at present and about 59,000 in the future.

CHAPTER V. SEDIMENT

Sediment from Vidore watershed area is estimated at 1,100 cubic meters per square kilometer yearly.

Watershed management reduces this sediment. Grass hedges, or strips, trap sediment effectively. In this section, the amount of sediment after watershed approaches is estimated.

Zonal sediment per square kilometer, estimated by Ezaki's formula, are shown in the Table.

ZONAL SEDIMENT AT PRESENT

Zone	Area (sq.km)	Sediment (cum/sqkm/yr)	Sediment (cum/yr)
1	253	500	126,500
2	126	1,000	126,000
3	139	1,000	139,000
4	111	800	88,800
5	248	1,825	452,600
Total	877	1,064	932,900

It is reported that vegetational cover reduces erosion by 90 to 95 percent on bare surfaces. In this case, vegetational cover with grass hedges or earthen bunds in the developed area is assumed to cut down 95 percent of sediment.

Vegetation on developed portions will filter soil particles when runoff containing sediment from upper slopes passes through the portions. It is assumed that sediment will decrease by 90 percent. It is also assumed that the upper slopes will be protected by the developed areas.

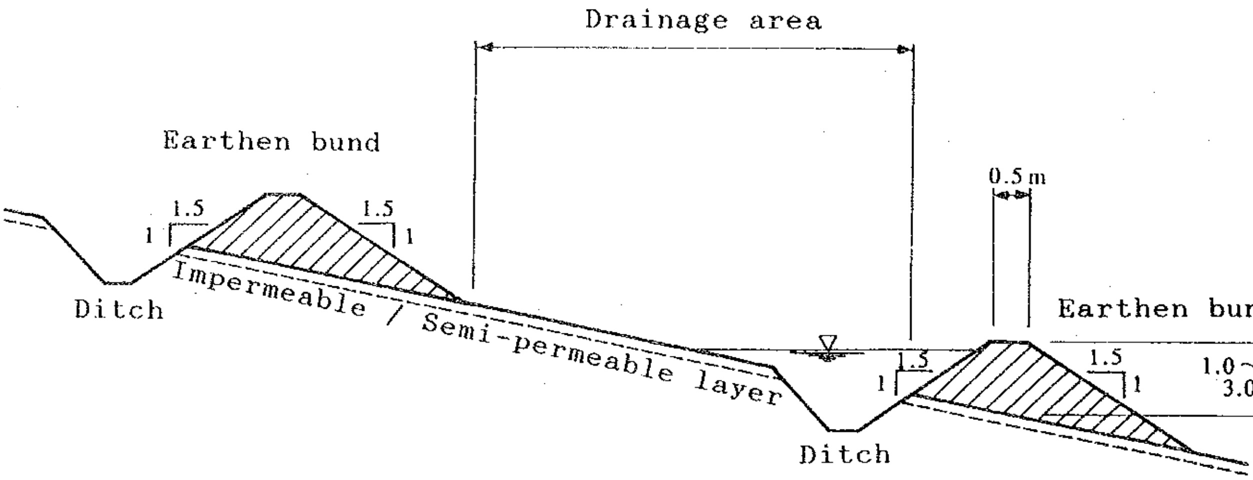
The estimated amount of sediment is shown in following table.

SEDIMENT ESTIMATE AFTER WATERSHED MANAGEMENT

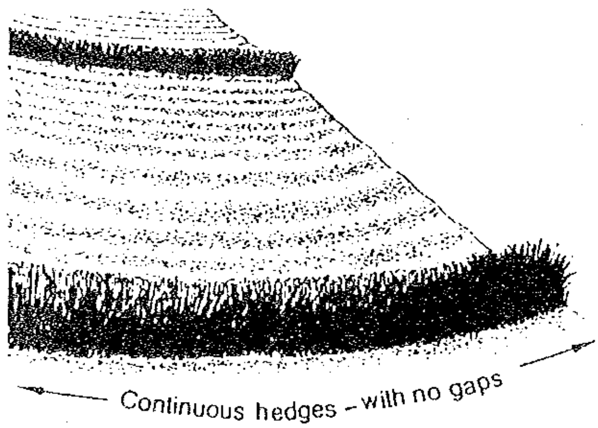
Zone		Area (sq.km)	Sediment (cum/sq.km)	Sediment (cum)
1	NO MEASURE	253	500	126,500
2	NO MEASURE	6	1,100	6,600
	PROTECTED	60	110	6,600
	DEVELOPED	60	55	3,300
3	NO MEASURE	17	1000	17,000
	PROTECTED	61	100	6,100
	DEVELOPED	61	50	3,050
4	PROTECTED	40	38	1,500
	DEVELOPED	71	19	1,331
5	NO MEASURE	138	1,800	248,400
	PROTECTED	55	180	9,900
	DEVELOPED	55	90	4,950
Total	NO MEASURE	454		400,000
	PROTECTED	216		24,100
	DEVELOPED	247		12,631
				436,731

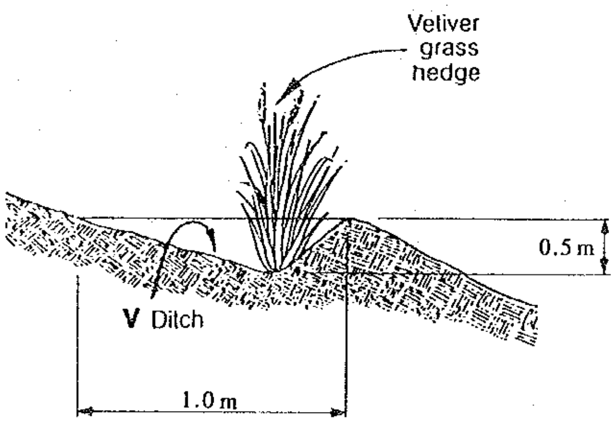
ATTACHMENT 1.　FIGURES

1. EARTHEN BUND

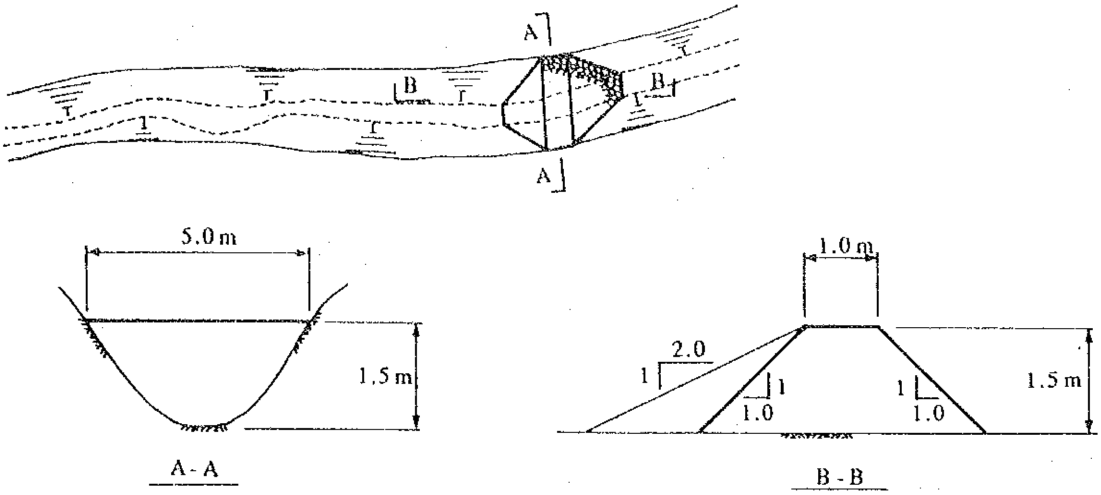


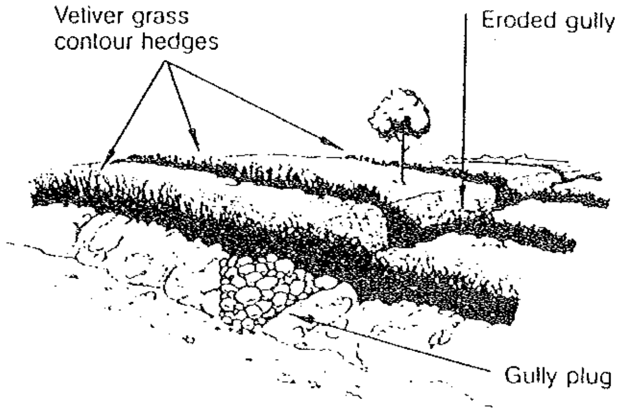
2. GRASS HEDGE



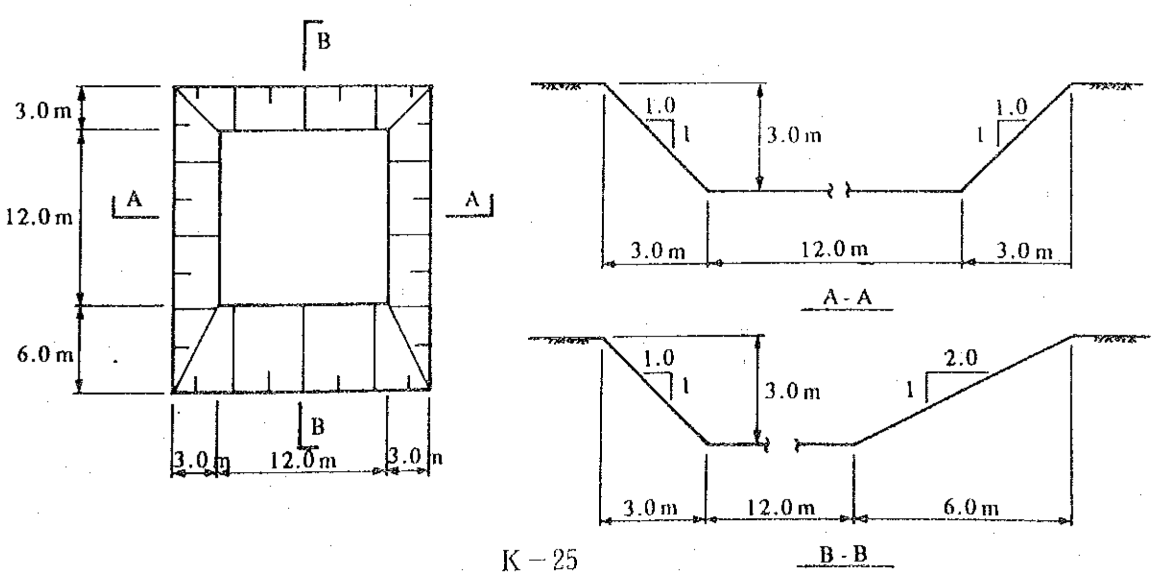


3. GULLY PLUGGING



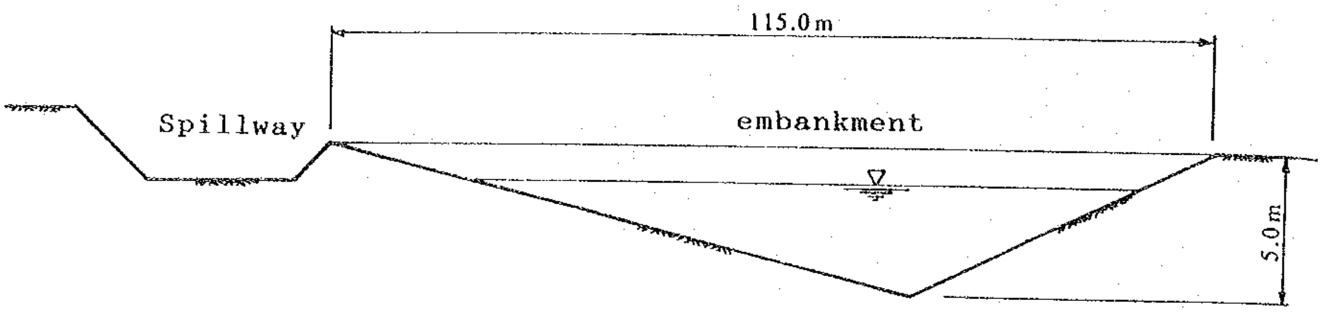


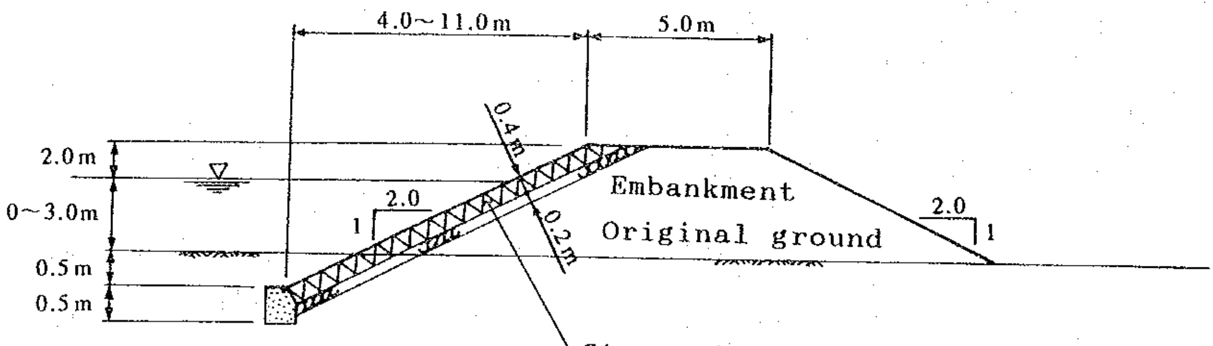
4. WATER POINT



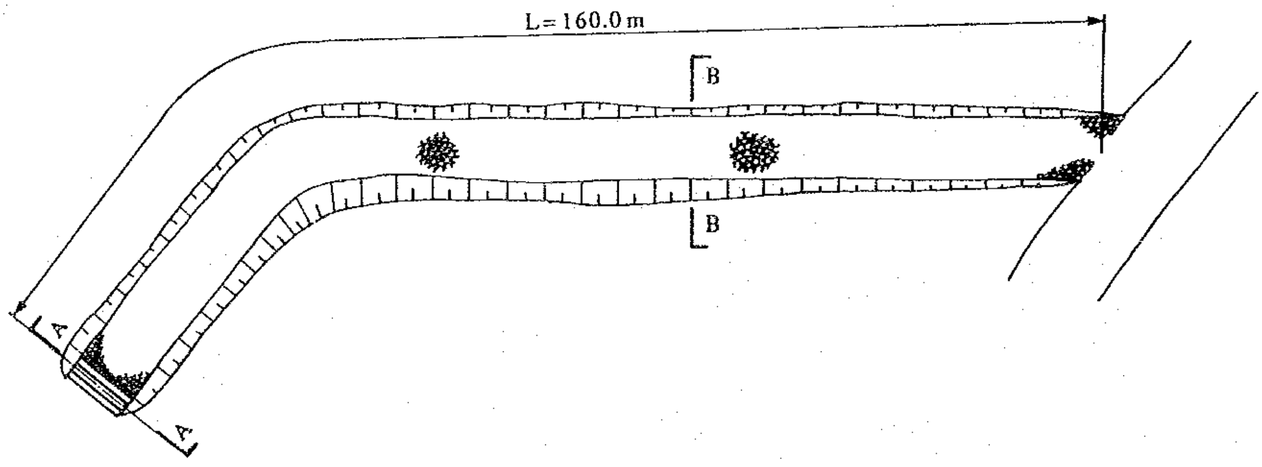
5. POND

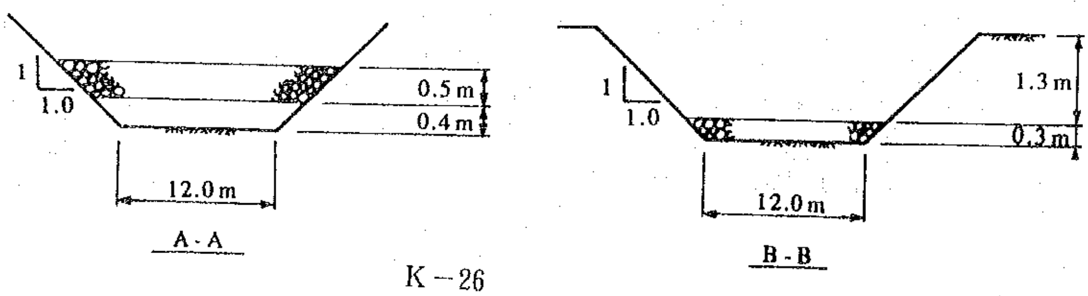
EMBANKMENT





SPILLWAY





ATTACHMENT 2. VETIVER GRASS

The following papers on "Vetiver grass" are selected from the publication of the World Bank titled:

Vetiver Grass (Vetiveria zizanioides)
A Method of Vegetative Soil and Moisture Conservation
(2nd edition)

VETIVERIA

Of the 10 species of coarse perennial grasses in the tropics of the "old world", belonging to the tribe Andropogoneae, V. zizanioides, has proven ideal for vegetative soil conservation measures.

Vetiveria zizanioides (L) Nash (2n = 20) KHUS, VETIVERGRASS, KHUSKHUS, a densely tufted, awnless, wiry, glabrous, perennial grass, is a "shy breeder" and is considered sterile - no rhizomes, no stolons, propagated by root divisions, or slips. The plant grows in large clumps from a much-branched "spongy" root stock with erect culms 0.5-1.5 m high. The leaf blades are relatively stiff, long and narrow - up to 75 cms long and 8 mm or less in width, glabrous, but "downward rough" along the edges. Panicles 15-30 cm long, narrow, acute, appressed, awnless, one sensile, and hermaphrodite, somewhat flattened laterally, with short sharp spines, 3 stamens and 2 plumose stigmas; the other spikelet pedicelled and staminate. Some cultivated forms seldom flower Fig 1.

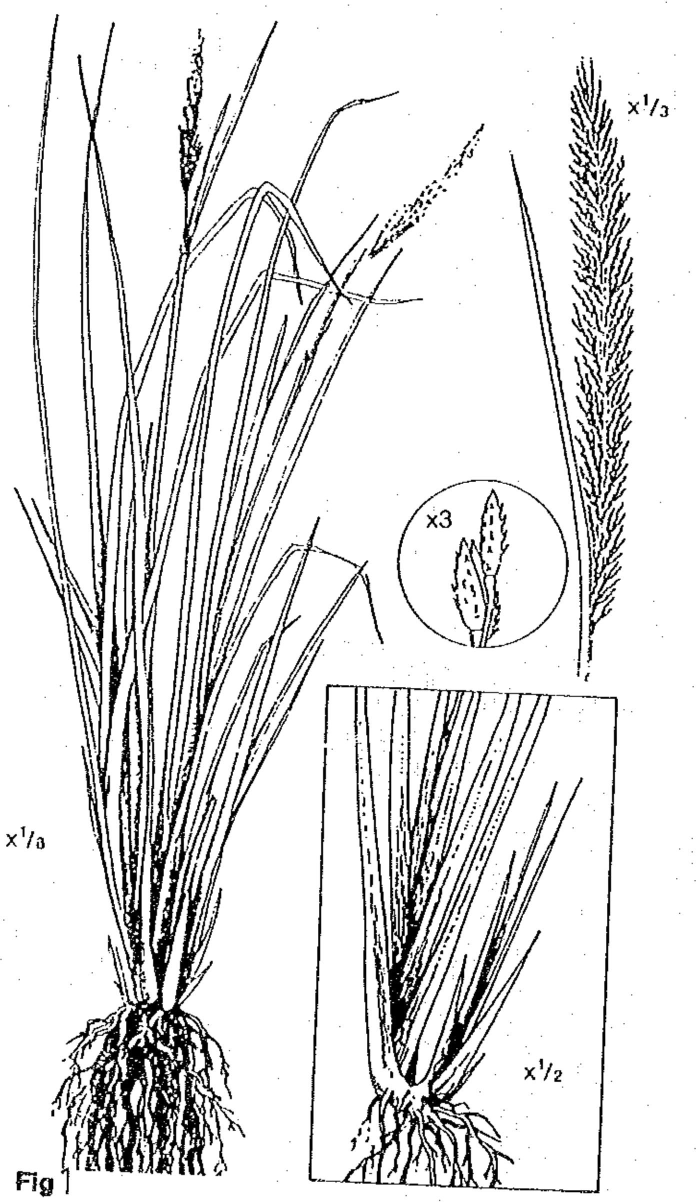
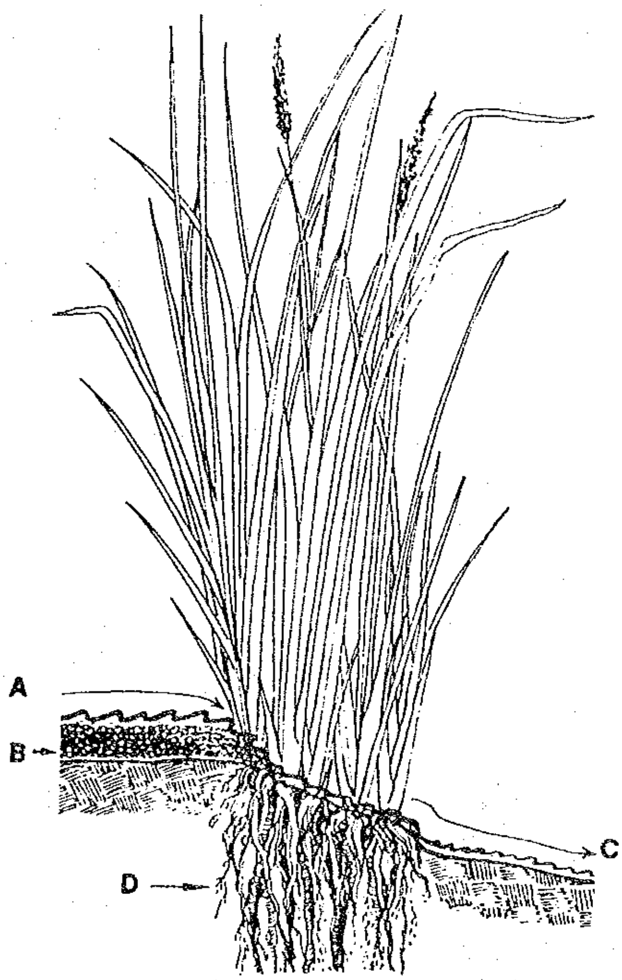


Fig 1

Fig 2 illustrates the essential functions of a vegetative hedge being used as a contour soil conservation measure. Here, Vetiver grass has been established and is acting as a filter to runoff, using its leaves and stems, etc. to filter the silt out of the runoff water, slow it down, and take the erosive power out of it as it oozes through the hedge and moves on down the slope. In Fig 2 A shows the silt-loaded runoff being slowed down by the plant; B shows the silt dropping out of the water behind the plant; and C shows the "siltless" water continuing on down the slope at greatly reduced speed. D shows the dense spongy root system that binds the soil together to a depth of up to 3 m. It forms a dense of roots underground on the contour. These act like reinforcing steel in concrete, protecting the soil under the plant from rilling,gullying and tunneling. These same roots, because they contain a strong aromatic oil, are repellent to rats and other pests.

Fig 2

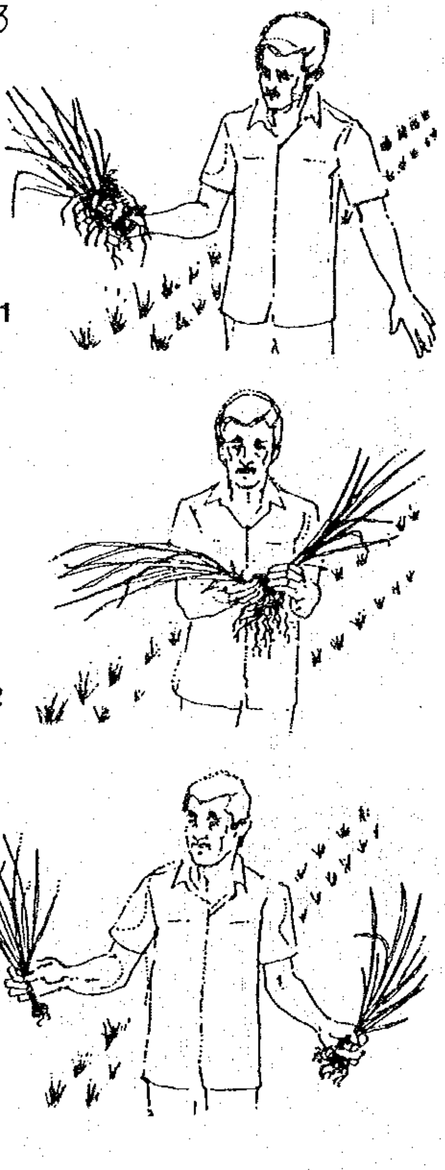


The next few pages should clearly illustrate how Vetiver grass is taken from the nursery and planted in the field. It will also discuss our experience in handling the planting material, the best time to plant and what to expect after the grass is planted.

Fig 3 shows the extension worker removing a "clump" of Vetiver grass from the nursery.This has to be dug out with a spade or fork. The root system of this plant is massive and very strong, and the grass cannot be pulled out by hand. In Step 1 he has removed a large clump; in Step 2 tears a "handful" of the grass, roots and all, from this clump; Step 3 shows the resulting piece, or root division, or slip, that will form the planting material used in the field.

Vetiver nurseries are easy to establish if the planting material can be obtained. The best nursery sites are at the inlets to small dams or tanks. Here the slips are planted as "hedges" across the stream, one meter apart. The water on its way to the dam "irrigates" the Vetiver grass which, in turn, removes the silt.

Fig 3



Step 1

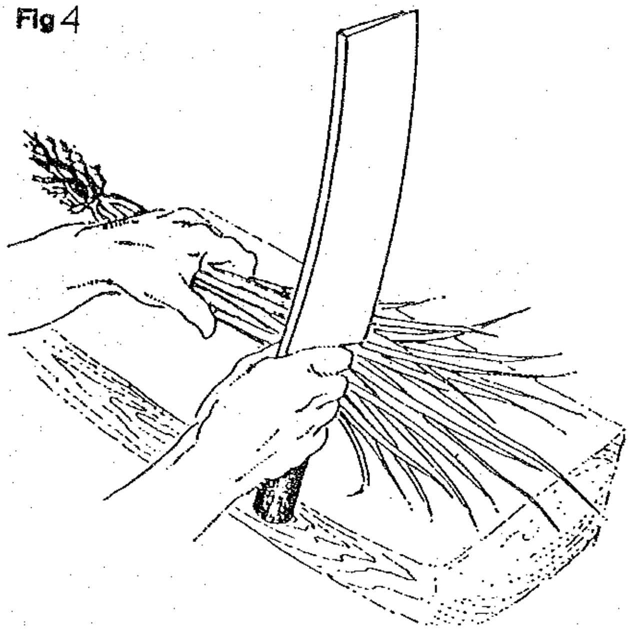
Step 2

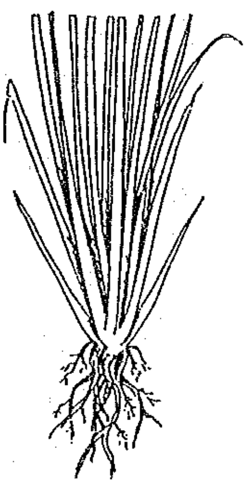
Step 3

Once the Vetiver grass clumps have been removed from the nursery and root divisions torn off them, then, prior to transporting them to the field, he farmer cuts the tops off about 20 cms from the base. Below the base, roots of 8 - 10 cms in length should be left on the plant. Fig 4 shows the farmer using a block of wood and a simple knife (cane knife, machete, cutlass or panga), to cut the slip down to the size for planting. The finished "planting piece" is shown in Fig 5.

Though Vetiver grass can be planted from single tillers if planting material is scarce, this practice is not recommended in the field, as it takes too long for a single tiller to form a hedge. The reason for cutting the tops off the planting material is to cut down the transpiration level of the slip once it is planted, to prevent it from drying out, thus giving it a better chance of survival. Slips planted in the nursery can be fertilized with DAP (diammonium phosphate) to encourage first tillering. This would help also in the field. DAP could be dibbled into the planting furrow prior to planting the slips.

Fig 4





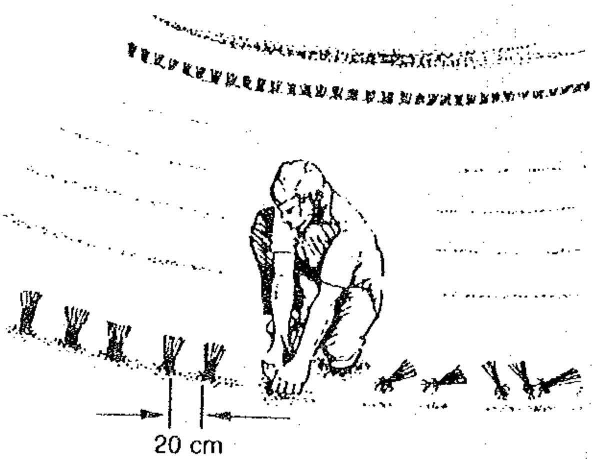
x¼

Fig 5

Fig 6 shows the farmer planting the Vetiver slips in the field. This is best done at the beginning of the wet season. They are planted somewhat like rice seedlings as follows: Make a hole in the furrow that has already been ploughed to mark the contour; push the slip in to this, being careful not to bend the roots upwards; then firm the slip into the soil. Twenty centimeters from that slip ,on the same contour furrow, plant the next slip, and if planted well, the slips can withstand up to one month of dry weather and still survive. Only a single row of slips needs to be planted, but, of course , if ample planting material is available,then the slips could be planted as a continuous line touching each other. Using this method, they would form a hedge more rapidly. Here, once again, it must be emphasized that for this, or any vegetative system to work, it must form a hedge; otherwise the system cannot act as a filter, and would be almost useless. Fig 7 shows the sort of situation that must be avoided - planting the slips too far apart. In this case, they would take too long to form a hedge, and would give the farmer little protection. Also a very important point is that the hedge must hold the soil,fertilizer and moisture against the Vetiver grass, giving it the extra support it needs to help it survive the worst droughts.

In arid areas of less than 299 mm of rainfall, an effective Vetiver hedge across the contour would intercept the runoff and retain moisture at the base of the hedge thus benefitting it with the equivalent of possibly 1000 or more mm of rainfall, guaranteeing the hedge's viability.

Fig 6



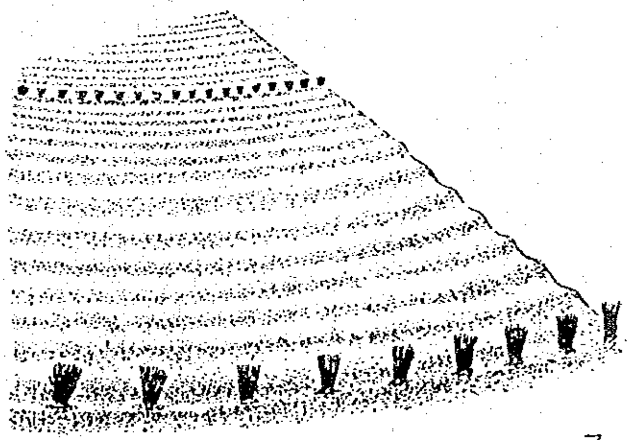
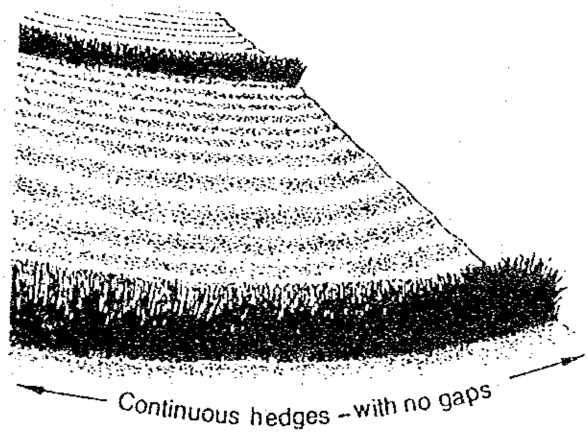


Fig 7

Fig 8 illustrates the essential point of a vegetative system, and that is, it must form a hedge to be effective. It is unlike the constructed system of soil conservation banks, which are effective immediately following construction, but wear out, break down or simply "burst" in heavy rainstorms. The vegetative system takes from two to three growing seasons to establish as a dense hedge capable to withstanding torrential cloudbursts while still protecting the soil. You must understand that the plants need protection and maintenance/gap filling during the first and second, and possibly the third season. Then they can stand on their own as a hedge with no further maintenance.

In the first, and certainly in the second season, it may be possible for extension workers to show the farmers the silt being trapped behind the plant as they are establishing, as shown by A in Fig 9. It is an essential task of the extension worker to explain this system to the farmer.

Fig 8



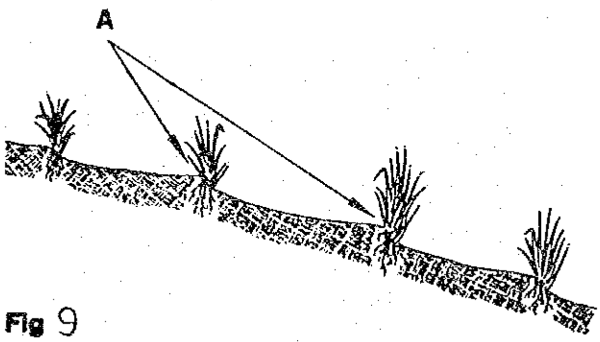


Fig 9

OTHER PRACTICAL USES

The following few pages give additional uses for Vetiver grass that have been noted in some other countries. Fig 10 shows a typical paddy field with its earth banks constructed by the farmer to contain irrigation water at the correct level. In many cases, wind, causing lap erosion, and rat/crabs, etc., making holes in these banks, can cause their breakdown. This leads to a major erosion problem, not to mention the los of expensive irrigation water, which in some systems is irreplaceable. The farmer could lose his crop.

In Fig 11, Vetiver has been planted on the tops of the banks to stabilize them. Vetiver grows well under these conditions, does not suffer from the occasional inundation, and has the added advantage that the essential oil in its roots acts as a deterrent to rodents. The Vetiver, growing so close to the rice has no effect on its yields as its roots go straight down and not out into the crop. Each year the Vetiver can be safely cut right back to ground level - if it should start to have any shading effect.

Fig 10

Fig 11

Fig 12 shows in detail how the trees and the Vetiver are planted in the contour V-ditches. Using this system enables trees such as olives to be planted without the need for irrigation in the first three years of establishment. The collection of runoff in these contour trenches has the effect of doubling or tripling the amount of annual rainfall. The runoff from the inter-rows between the trees is held in the trench and, ultimately, behind the vetiver hedge, and it has time to soak right into the soil at the base of the trees.There is little chance of waterlogging since there is usually sufficient drainage on the slopes to take care of that. Once dry season set in, and after the Vetiver hedges have properly established, Vetiver grass can be cut down to ground level and its leaves used as a mulch at the base of the fruit trees to help retain stored moisture Fig 13.The benefit of using Vetiver for this purpose is that its leaves harbor few insects and last very well as a mulch. Forest trees should also be planted by the same method. Where this has been done, the results have been quite spectacular: over 90% survival of the seedlings as compared with 30%, during the 1987 drought in Andha Pradesh in India.

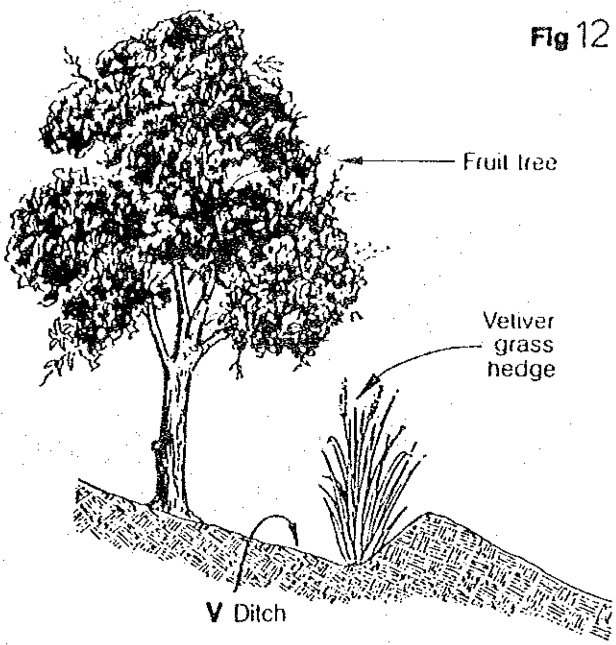


Fig 12

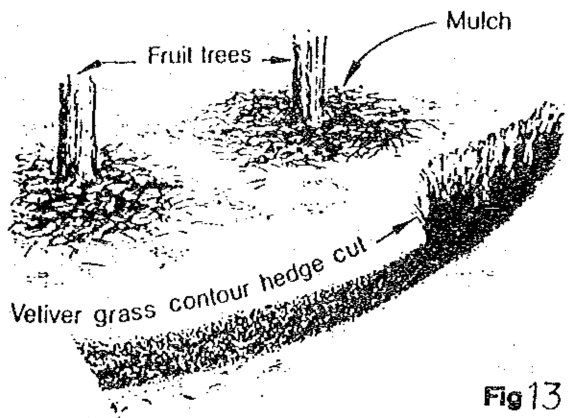
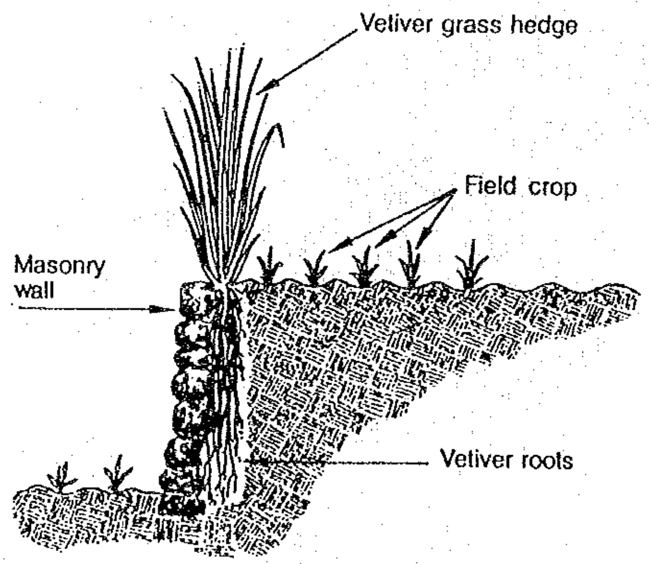


Fig 13

Fig 14 illustrates how the Vetiver would support a masonry terrace without impending the essential drainage between the stones. In heavy storms, the water cascades down the slopes and over the top of the masonry terraces. This causes most of the major drainage, according to the farmers, especially if this water gets a chance to concentrate into a stream. It is anticipated that once Vetiver hedges are established, they will take most of the erosive power out of this runoff and should certainly protected the edge of the terrace.

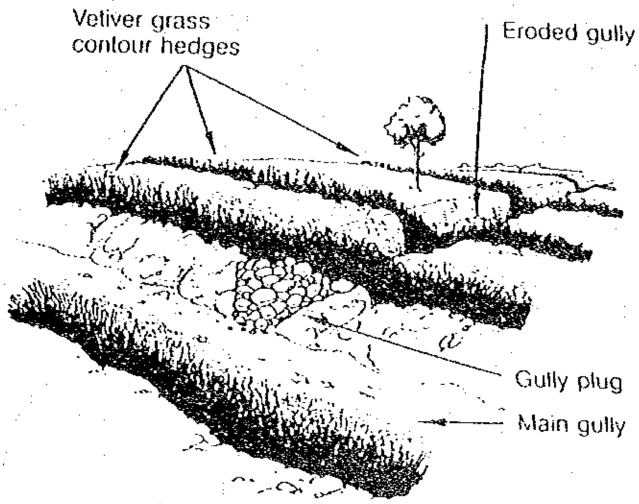
In Fig 14 it can be seen that the masonry risers are very vulnerable since they are simply stones carefully stacked on top of each other and are usually two to three meters high. Vetiver grass has a very strong, penetrating root system, capable of protecting the whole rock-face.Its roots will easily penetrate to the bottom of the risers.

Fig14



The use of Vetiver grass in wasteland development has yet to be tested, but there is absolutely no reason why it should not be successful as the initial stabilizing plant. VETIVERIA ZIZANIODES, in the Sahel of Africa and in Bharatpur in Central India, has survived as the climax vegetation for hundreds of years under extreme conditions of constant fires and droughts. V.zizanioides, planted as contours in wasteland areas, would reap the benefit of extra runoff and "harvest" organic matter as it filters the runoff water through its hedges. It should prove to be a very useful means of commencing the stabilization of these areas. The foothills of the Shivaliks being very young geologically, are highly erodible; by planting Vetiver contour hedges around these slopes and then across the short erosion valleys, these areas could possibly be stabilized. It would require a masonry "plug" at the end of the system to allow silt to build up and give the grass a basis of establishment. The same would apply to normal gullies shown in Fig 16. Once established the grass would terrace these gullies.

Fig 15



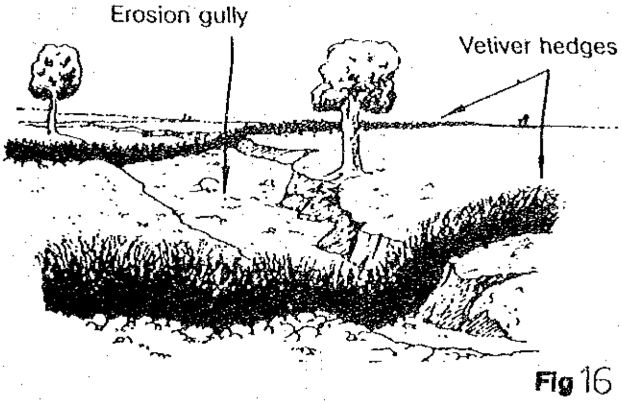


Fig 16

ANNEX L. PROJECT FACILITIES

LIST OF FIGURES

		Page
Figure L - 1.	Crossing Section at M - No. 1 + 730.0	L-1
Figure L - 2.	Crossing Section at M - No. 1 + 745.4	L-2
Figure L - 3.	Typical Section of Dispersion	L-3
Figure L - 4.	Crossing Section at S - No. 3 + 40.0	L-6
Figure L - 5.	Crossing Section at S - No. 3 + 55.1	L-7
Figure L - 6.	Typical Section of Dispersion	L-8

ANNEX L. PROJECT FACILITIES

1. Dispersion Structure - I

(1) High Water Level at Upstream

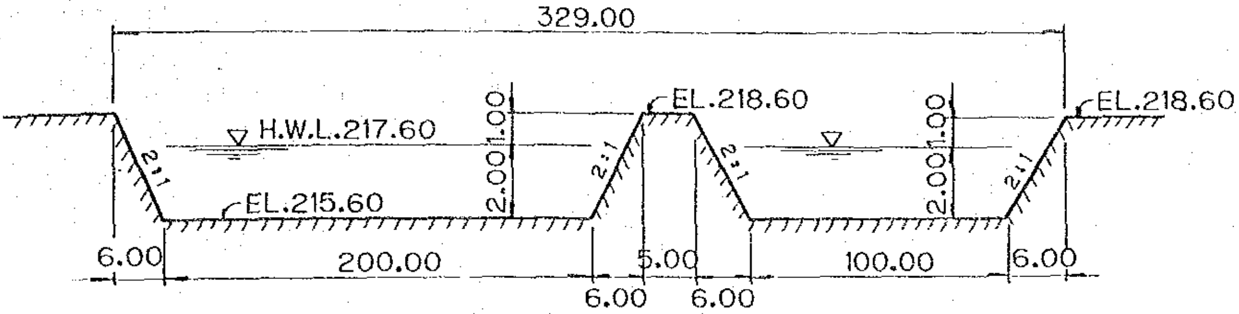


Figure L - 1. Crossing Section at M-No.1+730.0

Chhabri-Suchani branch

$$A_1 = \frac{1}{2}(200.0 + 208.0) \times 2.0$$
$$= 408.00 sq \cdot m$$
$$P_1 = 200.0 + 4.47 \times 2$$
$$= 208.94 m$$
$$R_1 = \frac{408.00}{208.94}$$
$$= 1{,}953 m$$
$$n_1 = 0.050$$
$$I_1 = \frac{1}{110}$$
$$V_1 = \frac{1}{n_1} \cdot R_1^{\frac{2}{3}} \cdot I_1^{\frac{1}{2}}$$
$$= \frac{1}{0.05} \times 1{,}953^{\frac{2}{3}} \times (\frac{1}{110})^{\frac{1}{2}}$$
$$= 2.98 m/s < V_a = 3.0 m/s$$
$$Q_1 = A_1 \cdot V_1 = 408.00 \times 2.98$$
$$= 1{,}216 cms \doteqdot 1{,}197 cms$$

Phullar branch

$$A_2 = \frac{1}{2}(100.0 + 108.0) \times 2.0$$
$$= 208.00 sq \cdot m$$
$$P_2 = 100.0 + 4.47 \times 2$$
$$= 108.94 m$$
$$R_2 = \frac{208.00}{108.94}$$
$$= 1{,}909 m$$
$$n_2 = 0.050$$
$$I_2 = \frac{1}{110}$$
$$V_2 = \frac{1}{n_2} \cdot R_2^{\frac{2}{3}} \cdot I_2^{\frac{1}{2}}$$
$$= \frac{1}{0.05} \times 1{,}909^{\frac{2}{3}} \times (\frac{1}{110})^{\frac{1}{2}}$$
$$= 2.93 m/s < V_a = 3.0 m/s$$
$$Q_2 = A_2 \cdot V_2 = 208.00 \times 2.93$$
$$= 609 cms \doteqdot 598 cms$$

(2) High Water Level at Downstream

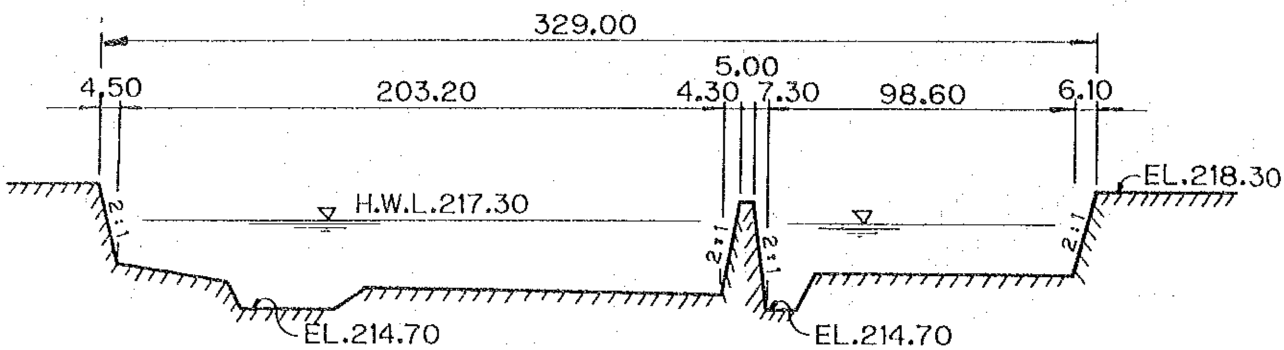


Figure L - 2. Crossing Section at M-No.1+745.4

Chhabri-Suchani branch

$A_1 = 405.06 sq \cdot m$

$P_1 = 210.20 m$

$R_1 = \dfrac{405.06}{210.20}$

$= 1,927 m$

$n_1 = 0.050$

$I_1 = \dfrac{1}{110}$

$V_1 = \dfrac{1}{0.05} \times 1,927^{\frac{2}{3}} \times (\dfrac{1}{110})^{\frac{1}{2}}$

$= 2.95 m/s < V_a = 3.0 m/s$

$Q_1 = 405.06 \times 2.95$

$= 1,195 cms \fallingdotseq 1,197 cms$

Phullar branch

$A_2 = 203.80 sq \cdot m$

$P_2 = 108.48 m$

$R_2 = \dfrac{203.80}{108.48}$

$= 1,879 m$

$n_2 = 0.050$

$I_2 = \dfrac{1}{110}$

$V_2 = \dfrac{1}{0.05} \times 1,879^{\frac{2}{3}} \times (\dfrac{1}{110})^{\frac{1}{2}}$

$= 2.91 m/s < V_a = 3.0 m/s$

$Q_2 = 203.80 \times 2.91$

$= 593 cms \fallingdotseq 598 cms$

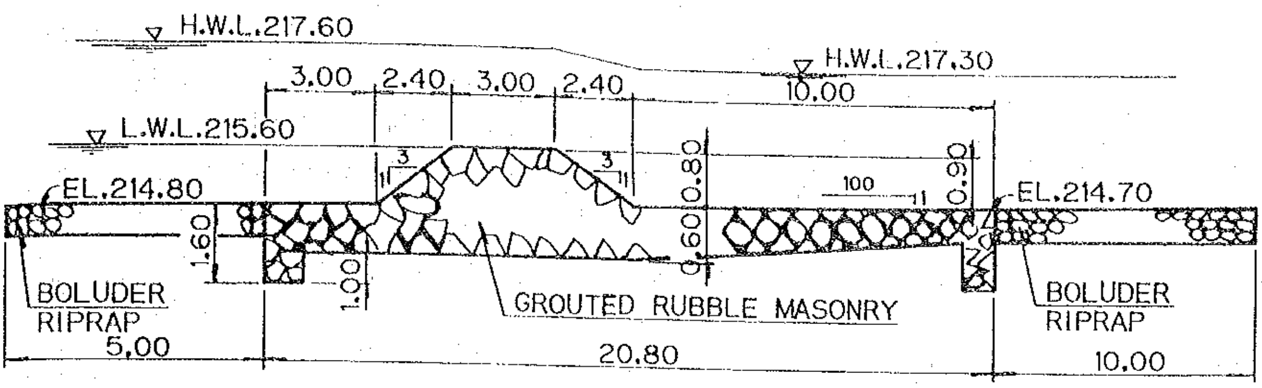


Figure L - 3. Typical Section of Dispersion

(3) Length of Rear Apron

- By Bligh's Method:

$$L_a = 0.6 \times C \times \sqrt{D}$$

where, L_a: length of rear apron (m)

C: Bligh's percolation coeff. (coarse sand) 12

D: dam-up height EL215.6-EL214.7=0.9m

$$L_a = 0.6 \times 12 \times \sqrt{0.9} = 6.8m$$

Therefore, design length is adopted as 10.0m.

(4) Piping and Thickness of Rear Apron

a) Piping

- By Bligh's Method:

$$L' = C \times D$$

where, L': Bligh's line-of-creep length (m)

$$L' = 12 \times 0.9 = 10.8m$$

Design creep length

L=1.60+1.00+20.80=23.40m>L'=10.8m

- By Lane's Method

$$L' = C' \times D$$

where, L': Lane's weighted-creep length (m)
C': Lane's weighted-creep ratio (coarse sand) 5
D: dam-up height 0.9m

$$L' = 5 \times 0.9 = 4.5m$$

Design creep length

$$L = 1.60 + 1.00 + \frac{1}{3} \times 20.80 = 9.53m > L' = 4.5m$$

b) Thickness

- Uplift at point A

$$h_u = \frac{L - L_A}{L} \times D$$

where, h_u: uplift at point A (m)
L: Total creep length 23.40m
L_A: Creep length at point A (m) 1.60+1.00+10.80=13.40m
D: dam-up height 0.9m

$$h_u = \frac{23.40 - 13.40}{23.40} \times 0.90 = 0.38m$$

- Thickness at point A

$$T_A \geq \frac{4}{3} \times \frac{h_u}{\gamma - 1}$$

where, T_A: thickness at point A (m)
γ: unit weight of apron 2.3(t/cum)

$$T_A \geq \frac{4}{3} \times \frac{0.38}{2.3 - 1} = 0.39m$$

Therefore, design thickness at point A is adopted as 0.6m.

(5) Length of Riprap

The length of riprap is determined by hydraulic jump. However, this weir is submerged overflow. Then, the length of riprap is determined by Bligh's Method.

$$L_t = 0.67C\sqrt{D \times q}$$

where, L_t: total length of rear apron and riprap (m)

C: Bligh's percolation coeff. 12

D: dam-up height $0.9m$

q: unit design discharge $2.98m/s \times 2.0m = 5.96cum/s/m$

$$L_t = 0.67 \times 12\sqrt{0.9 \times 5.96} = 18.6m$$

$$L_R = L_t - L_a = 18.6 - 10.0 = 8.6m$$

Therefore, design length of rear riprap is adapted as $10.0m$, length of front riprap is adopted as $5.0m$.

(6) Size of Riprap

The size of riprap is related to the bottom velocity and can be determined from Berrt's formula which was reproduced from the U.S.B.R. Manual, Hydraulic Design.

$$V_b = 2.57\sqrt{d}$$

where, V_b: bottom velocity in feet/second (submerged over flow) $2.95m/s = 9.68ft/s$

d: weighted mean diameter of riprap materials in inches

$$d = (\frac{V_b}{2.57})^2 = (\frac{9.68}{2.57})^2 = 14.2inch = 36.1cm$$

Therefore, design diameter of riprap is adopted as $40cm$.

2. Dispersion Structure - II

(1) High Water Level at Upstream

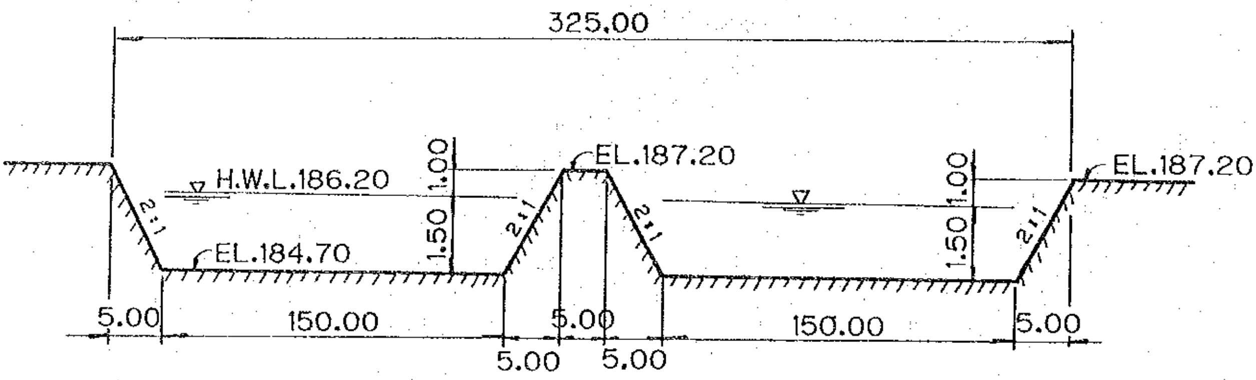


Figure L - 4. Crossing Section at S-No.3+40.0

$$A = \frac{1}{2}(150.0 + 156.0) \times 1.50 \times 2.0$$
$$= 459.00 sq \cdot m$$
$$P = (150.0 + 3.35 \times 2) \times 2$$
$$= 313.40 m$$
$$R = \frac{459.00}{313.40}$$
$$= 1,465 m$$
$$n = 0.030$$
$$I = \frac{1}{250}$$
$$V = \frac{1}{n} \circ R^{\frac{2}{3}} \cdot I^{\frac{1}{2}}$$
$$= \frac{1}{0.030} \times 1,465^{\frac{2}{3}} \times (\frac{1}{250})^{\frac{1}{2}}$$
$$= 2.72 m/s < V_a = 3.0 m/s$$
$$Q = A \cdot V = 459.00 \times 2.72$$
$$= 1,248 cms \fallingdotseq 1,197 cms$$

(2) High Water Level at Downstream

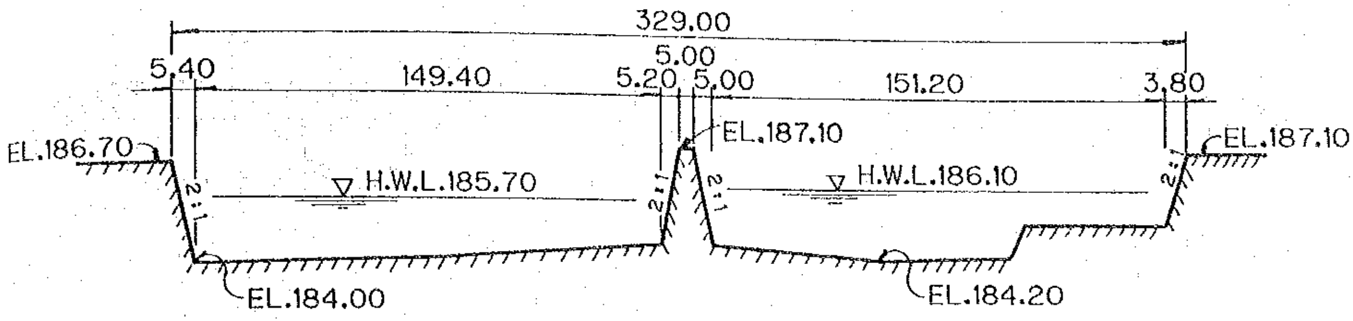


Figure L - 5. Crossing Section at S - No.3+55.1

Chhabri branch

$A_1 = 231.83 sq \cdot m$

$P_1 = 156.49 m$

$R_1 = \frac{231.83}{156.49}$

$= 1,481 m$

$n_1 = 0.030$

$I_1 = \frac{1}{250}$

$V_1 = \frac{1}{0.030} \times 1,481^{\frac{2}{3}} \times (\frac{1}{250})^{\frac{1}{2}}$

$= 2.74 m/s < V_a = 3.0 m/s$

$Q_1 = 231.83 \times 2.74$

$= 635 cms \fallingdotseq 599 cms$

Suchani branch

$A_2 = 231.86 sq \cdot m$

$P_2 = 156.54 m$

$R_2 = \frac{231.86}{156.54}$

$= 1,481 m$

$n_2 = 0.030$

$I_2 = \frac{1}{250}$

$V_2 = \frac{1}{0.030} \times 1,481^{\frac{2}{3}} \times (\frac{1}{250})^{\frac{1}{2}}$

$= 2.74 m/s < V_a = 3.0 m/s$

$Q_2 = 231.86 \times 2.74$

$= 635 cms \fallingdotseq 599 cms$

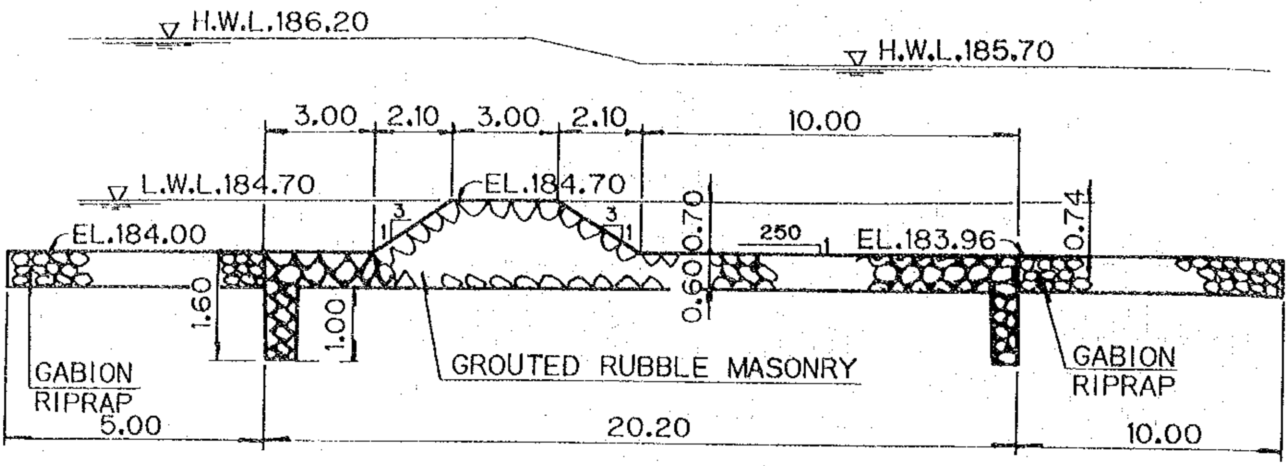


Figure L - 6. Typical Section of Dispersion

(3) Length of Rear Apron

- By Bligh's Method:

$$L_a = 0.6 \times C \times \sqrt{D}$$

where, L_a: length of rear apron (m)
C: Bligh's percolation coeff. (fine sand) 15 .
D: dam-up height EL184.70-EL183.96=0.74m

$$L_a = 0.6 \times 15 \times \sqrt{0.74} = 7.7m$$

Therefore, design length is adopted as 10.0m.

(4) Piping and Thickness of Rear Apron

a) Piping

- By Bligh's Method:

$$L' = C \times D$$

where, L': Bligh's line-of-creep length (m)

$$L' = 15 \times 0.74 = 11.1m$$

Design creep length

$$L = 1.6 + 1.0 + 20.2 = 22.8m > L' = 11.1m$$

- By Lane's Method

$$L' = C' \times D$$

where, L': Lane's weighted-creep length (m)
C': Lane's weighted-creep ratio (fine sand) 7
D: dam-up height 0.74m

$$L' = 7 \times 0.74 = 5.18m$$

Design creep length

$$L = 1.60 + 1.00 + \frac{1}{3} \times 20.20 = 9.33m > L' = 5.18m$$

b) Thickness

- Uplift at point A

$$h_u = \frac{L - L_A}{L} \times D$$

where, h_u: uplift at point A (m)
L: Total creep length 22.8m
L_A: Creep length at point A (m) 1.6+1.0+10.2=12.8m
D: dam-up height 0.74m

$$h_u = \frac{22.80 - 12.80}{22.80} \times 0.74 = 0.32m$$

- Thickness at point A

$$T_A \geq \frac{4}{3} \times \frac{h_u}{\gamma - 1}$$

where, T_A: thickness at point A (m)
γ: unit weight of apron 2.3(t/cum)

$$T_A \geq \frac{4}{3} \times \frac{0.32}{2.3 - 1} = 0.33m$$

Therefore, design thickness at point A is adopted as 0.6m.

(5) Length of Riprap

The length of riprap is determined by hydraulic jump. However, this weir is submerged overflow. Then, the length of riprap is determined by Bligh's Method.

$$L_t = 0.67C\sqrt{D \times q}$$

where, L_t: total length of rear apron and riprap (m)

C: Bligh's percolation coeff. 15

D: dam-up height 0.74m

q: unit design discharge $2.72m/s \times 1.5m = 4.08cum/s/m$

$$L_t = 0.67 \times 15\sqrt{0.74 \times 4.08} = 17.5m$$

$$L_R = L_t - L_a = 17.5 - 10.0 = 7.5m$$

Therefore, design length of rear riprap is adapted as 10.0m, length of front riprap is adopted as 5.0m.

(6) Size of Riprap

The size of riprap is related to the bottom velocity and can be determined from Berrt's formula which was reproduced from the U.S.B.R. Manual, Hydraulic Design.

$$V_b = 2.57\sqrt{d}$$

where, V_b: bottom velocity in feet/second (submerged over flow) 2.72m/s=8.92ft/s

d: weighted mean diameter of riprap materials in inches

$$d = (\frac{V_b}{2.57})^2 = (\frac{8.92}{2.57})^2 = 12.0inch = 30.5cm$$

Therefore, design diameter of riprap is adopted as 40cm. However boulder for riprap is not exist around the site of dispersion structure-II. The riprap is adopted gabion.

ANNEX M. PROJECT COST

LIST OF TABLES

		Page
Table M - 1.	Breakdown of Dispersion Structure - I	M - 1
Table M - 2.	Breakdown of Dispersion Structure - II	M - 2
Table M - 3.	Breakdown of Separating Dike	M - 3
Table M - 4.	Breakdown of Distribution Structure	M - 4
Table M - 5.	Breakdown of Road	M - 5
Table M - 6.	Breakdown of Watershed Management (Case B-1)	M - 6
Table M - 7.	Breakdown of Watershed Management (Case B-2)	M - 7
Table M - 8.	Disbursement Schedule for the Project Cost (Case A)	M - 8
Table M - 9.	Disbursement Schedule for the Project Cost (Case B-1)	M - 9
Table M - 10.	Disbursement Schedule for the Project Cost (Case B-2)	M - 10

TABLE M-1. BREAKDOWN OF DISPERSION STRUCTURE - I

No.	Description		Qty's	Unit	Total		F.C		L.C	
					Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)
1.	Weir									
	Excavation	(Back hoe)	1,800	cu.m	56.5	101.7	43.7	78.7	12.8	23.0
	Excavation	(Bulldozer)	17,200	"	70.5	1,212.6	54.0	928.8	16.5	283.8
	Backfill	(Labour)	1,700	"	18.9	32.1	2.1	3.6	16.8	28.5
	Grouted Rubber Masonry		6,070	"	1,158.8	7,033.9	224.9	1,365.1	933.9	5,668.8
	Boulder Riprap		2,700	"	353.4	954.2	88.2	238.1	265.2	716.1
	Sub-Total					9,334.5		2,614.3		6,720.2
2.	Left Dike									
	Excavation	(Back hoe)	1,300	cu.m	56.5	73.5	43.7	56.8	12.8	16.7
	Backfill	(Labour)	700	"	18.9	13.2	2.1	1.5	16.8	11.7
	Embankment	(Bulldozer)	13,800	"	44.4	612.7	34.5	476.1	9.9	136.6
	Plain Concrete		110	"	1,158.9	127.5	421.8	46.4	737.1	81.1
	Stone Pitching	(Top)	1,470	"	454.5	668.1	0	0	454.5	668.1
	Stone Pitching	(Spawl)	730	"	142.9	104.3	0	0	142.9	104.3
	Sub-Total					1,599.3		580.8		1,018.5
3.	Right Dike									
	Excavation	(Back hoe)	900	cu.m	56.5	50.9	43.7	39.3	12.8	11.6
	Backfill	(Labour)	500	"	18.9	9.5	2.1	1.1	16.8	8.4
	Embankment	(Bulldozer)	10,500	"	44.4	466.2	34.5	362.3	9.9	103.9
	Plain Concrete		80	"	1,158.9	92.7	421.8	33.7	737.1	59.0
	Stone Pitching	(Top)	1,060	"	454.5	481.8	0	0	454.5	481.8
	Stone Pitching	(Spawl)	530	"	142.9	75.7	0	0	142.9	75.7
	Sub-Total					1,176.8		436.4		740.4
4.	Separating Dike									
	Excavation	(Back hoe)	2,000	cu.m	56.5	113.0	43.7	87.4	12.8	25.6
	Backfill	(Labour)	1,100	"	18.9	20.8	2.1	2.3	16.8	18.5
	Embankment	(Bulldozer)	7,300	"	44.4	324.1	34.5	251.9	9.9	72.2
	Plain Concrete		180	"	1,158.9	208.6	421.8	75.9	737.1	132.7
	Stone Pitching	(Top)	1,910	"	454.5	868.1	0	0	454.5	868.1
	Stone Pitching	(Spawl)	950	"	142.9	135.8	0	0	142.9	135.8
	Sub-Total					1,670.4		417.5		1,252.9
	Total					13,781.0		4,049.0		9,732.0
5.	Contingency					1,378.1		404.9		973.2
	Grand Total					15,159.1		4,453.9		10,705.2

TABLE M-2. BREAKDOWN OF DISPERSION STRUCTURE - II

No.	Description		Qty's	Unit	Total		F.C		L.C	
					Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)
1.	Weir									
	Excavation	(Back hoe)	1,700	cu.m	56.5	96.1	43.7	74.3	12.8	21.8
	Excavation	(Bulldozer)	11,900	"	70.5	839.0	54	642.6	16.5	196.4
	Backfill	(Labour)	1,500	"	18.9	28.4	2.1	3.2	16.8	25.2
	Grouted Rubber Masonry		5,660	"	1,158.8	6,558.8	224.9	1,272.9	933.9	5,285.9
	Boulder Riprap		2,700	"	589.9	1,592.7	242.8	655.6	347.1	937.1
	Sub-Total					9,115.0		2,648.6		6,466.4
2.	Left Dike									
	Excavation	(Back hoe)	7,400	cu.m	56.5	418.1	43.7	323.4	12.8	94.7
	Backfill	(Labour)	4,100		18.9	77.5	2.1	8.6	16.8	68.9
	Embankment	(Bulldozer)	41,200	"	44.4	1,829.3	34.5	1,421.4	9.9	407.9
	Plain Concrete		670	"	1,158.9	776.5	421.8	282.6	737.1	493.9
	Stone Pitching	(Top)	10,370	"	454.5	4,713.2	0	0	454.5	4,713.2
	Stone Pitching	(Spawl)	5,190	"	142.9	741.7	0	0	142.9	741.7
	Sub-Total					8,556.3		2,036.0		6,520.3
3.	Right Dike									
	Excavation	(Back hoe)	3,500	cu.m	56.5	197.8	43.7	153.0	12.8	44.8
	Backfill	(Labour)	2,000	"	18.9	37.8	2.1	4.2	16.8	33.6
	Embankment	(Bulldozer)	11,500	"	44.4	510.6	34.5	396.8	9.9	113.8
	Plain Concrete		320	"	1,158.9	370.8	421.8	135.0	737.1	235.8
	Stone Pitching	(Top)	4,550	"	454.5	2,068.0	0	0	454.5	2,068.0
	Stone Pitching	(Spawl)	2,270	"	142.9	324.4	0	0	142.9	324.4
	Sub-Total					3,509.4		689.0		2,820.4
4.	Separating Dike									
	Excavation	(Back hoe)	4,100	cu.m	56.5	231.7	43.7	179.2	12.8	52.5
	Backfill	(Labour)	2,300	"	18.9	43.5	2.1	4.8	16.8	38.7
	Embankment	(Bulldozer)	18,000	"	44.4	799.2	34.5	621.0	9.9	178.2
	Plain Concrete		370	"	1,158.9	428.8	421.8	156.1	737.1	272.7
	Stone Pitching	(Top)	4,440	"	454.5	2,018.0	0	0	454.5	2,018.0
	Stone Pitching	(Spawl)	2,220	"	142.9	317.2	0	0	142.9	317.2
	Sub-Total					3,838.4		961.1		2,877.3
	Total					25,019.1		6,334.7		18,684.4
5.	Contingency					2,501.9		633.5		1,868.4
	Grand Total					27,521.0		6,968.2		20,552.8

TABLE M-3. BREAKDOWN OF SEPARATING DIKE

No.	Description		Qty's	Unit	Total		F.C		L.C	
					Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)
1.	Earth Work									
	Excavation	(Back hoe)	11,500	cu.m	56.5	649.8	43.7	502.6	12.8	147.2
	Backfill	(Labour)	6,400	"	18.9	121.0	2.1	13.5	16.8	107.5
	Embankment	(Bulldozer)	32,200	"	44.4	1,429.7	34.5	1,110.9	9.9	318.8
	Sub-Total					2,200.5		1,627.0		573.5
2.	Concrete Work									
	Plain Concrete		1,030	cu.m	1,158.9	1,193.7	421.8	434.5	737.1	759.2
	Sub-Total					1,193.7		434.5		759.2
3.	Stone Masonry									
	Stone Pitching	(Top)	9,890	cu.m	454.5	4,495.0	0	0	454.5	4,495.0
	Stone Pitching	(Spawl)	4,950	"	142.9	707.4	0	0	142.9	707.4
	Sub-Total					5,202.4		0		5,202.4
	Total					8,596.6		2,061.5		6,535.1
4.	Contingency					859.7		206.2		653.5
	Grand Total					9,456.3		2,267.7		7,188.6

TABLE M-4. BREAKDOWN OF DISTRIBUTION STRUCTURE

No.	Description	Qty's	Unit	Total		F.C		L.C	
				Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)
1.	Chhabri Branch Canals	9.94	km						
	Excavation (Back hoe)	46,900	cu.m	56.5	2,649.8	43.7	2,049.5	12.8	600.3
	Embankment (Bulldozer)	23,700	"	44.4	1,052.3	34.5	817.7	9.9	234.6
	Dressing Slope	65,500	sq.m	1.6	104.8	0	0.0	1.6	104.8
	Sub-Total				3,806.9		2,867.2		939.7
2.	Suchani Branch Canals	11.88	km						
	Excavation (Back hoe)	45,600	cu.m	56.5	2,576.4	43.7	1,992.7	12.8	583.7
	Embankment (Bulldozer)	36,600	"	44.4	1,625.0	34.5	1,262.7	9.9	362.3
	Dressing Slope	76,200	sq.m	1.6	121.9	0	0.0	1.6	121.9
	Sub-Total				4,323.3		3,255.4		1,067.9
3.	Phullar Branch Canals	7.15	km						
	Excavation (Back hoe)	48,900	cu.m	56.5	2,762.8	43.7	2136.9	12.8	625.9
	Embankment (Bulldozer)	11,800	"	44.4	523.9	34.5	407.1	9.9	116.8
	Dressing Slope	48,300	sq.m	1.6	77.3	0	0	1.6	77.3
	Sub-Total				3,364.0		2,544.0		820.0
	Total				11,494.2		8,666.6		2,827.6
4.	Contingency				1,149.4		866.7		282.8
	Grand Total				12,643.6		9,533.3		3,110.4

TABLE M-5. BREAKDOWN OF ROAD

No.	Description	Qty's	Unit	Total		F.C		L.C	
				Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)	Rate (Rs)	Amount ('000 Rs)
1.	V-1 Road	13.00	km						
	Embankment (Bulldozer)	39,200	cm.m	44.4	1,740.5	34.5	1,352.4	9.9	388.1
	Dressing Slope	29,100	sq.m	1.6	46.6	0	0.0	1.6	46.6
	Asphaltic Con. Wearing	6,000	"	85.0	510.0	30.0	180.0	55	330.0
	Asphaltic Con. Binding	8,000	"	145.0	1,160.0	50.0	400.0	95	760.0
	Base Course	7,500	cu.m	180.0	1,350.0	20.0	150.0	160	1,200.0
	Sub-Base Course	10,000	"	155.0	1,550.0	15.0	150.0	140	1,400.0
	Sub-Total				6,357.1		2,232.4		4,124.7
2.	V-2 Road	1.20	km						
	Embankment (Bulldozer)	3,700	cu.m	44.4	164.3	34.5	127.7	9.9	36.6
	Dressing Slope	2,700	sq.m	1.6	4.3	0	0.0	1.6	4.3
	Base Course	500	cu.m	180.0	90.0	20.0	10.0	160	80.0
	Sub-Base Course	700	"	155.0	108.5	15.0	10.5	140	98.0
	Sub-Total				367.1		148.2		218.9
	Total	14.20	km		6,724.2		2,380.6		4,343.6
3.	Contingency				672.4		238.1		434.4
	Grand Total				7,396.6		2,618.7		4,778.0

TABLE M-6. BREAKDOWN OF WATERSHED MANAGEMENT (CASE B - 1)

No.	Description	Qty's	Unit	Total Rate (Rs)	Total Amount ('000 Rs)	F.C Rate (Rs)	F.C Amount ('000 Rs)	L.C Rate (Rs)	L.C Amount ('000 Rs)
1.	Bund								
1.1	Bund								
	Type A	860	place	16,166.0	13,902.8	6,923.0	5,953.8	9,243.0	7,949.0
	Type B	98	"	14,936.0	1,463.8	5872.0	575.5	9,064.0	888.3
	Type C	1,200	"	12,628.0	15,153.6	4222.0	5,066.4	8,406.0	10,087.2
	Sub-Total				30,520.2		11,595.7		18,924.5
2.	Vetiver Grass								
2.1	Seedbed	7.8	ha	7,876.0	61.4	0	0	7,876.0	61.4
2.2	Planting								
	Zone II	1325.0	km	11,418.0	15,128.9	187.0	247.8	11,231.0	14,881.1
	Zone III	630.0	"	11,550.0	7,276.5	297.0	187.1	11,253.0	7,089.4
	Sub-Total				22,466.8		434.9		22,031.9
3.	Gully Pluging	1,980	place	3,969.0	7,858.6	6.0	11.9	3,963.0	7,846.7
4.	Pond	6	"	838,809.0	5,032.9	209,150.0	1,254.9	629,659.0	3,778.0
5.	Water Point	15	"	70,727.0	1,060.9	54,348.0	815.2	16,379.0	245.7
6.	Grass Seeding	12,100	ha	162.0	1,960.2	44.0	532.4	118.0	1,427.8
	Total				68,899.6		14,645.0		54,254.6

TABLE M-7. BREAKDOWN OF WATERSHED MANAGEMENT (CASE B - 2)

No.	Description	Qty's	Unit	Total Rate (Rs)	Total Amount ('000 Rs)	F.C Rate (Rs)	F.C Amount ('000 Rs)	L.C Rate (Rs)	L.C Amount ('000 Rs)
1.	Bund								
1.1	Bund								
	Type A	860	place	16,166.0	13,902.8	6,923.0	5,953.8	9,243.0	7,949.0
	Type B	327	"	14,936.0	4,884.0	5872.0	1,920.1	9,064.0	2,963.9
	Type C	1,200	"	12,628.0	27,781.6	4222.0	9,288.4	8,406.0	18,493.2
	Sub-Total				46,568.4		17,162.3		29,406.1
2.	Vetiver Grass								
2.1	Seedbed	11.0	ha	7,876.0	86.4	0	0	7,876.0	86.4
2.2	Planting								
	Zone II	1325.0	km	11,418.0	15,128.9	187.0	247.8	11,231.0	14,881.1
	Zone III	630.0	"	11,550.0	7,276.5	297.0	187.1	11,253.0	7,089.4
	Zone IV	252.0	"	11,495.0	2,896.7	253.0	63.8	11,242.0	2,832.9
	Zone V	543.0	"	11,418.0	6,200.0	187.0	101.5	11,231.0	6,098.5
	Sub-Total				31,588.5		600.2		30,988.3
3.	Gully Pluging	3,600	place	3,969.0	14,288.4	6.0	21.6	3,963.0	14,266.8
4.	Pond	6	"	838,809.0	5,032.9	209,150.0	1,254.9	629,659.0	3,778.0
5.	Water Point	62	"	70,727.0	4,385.1	54,348.0	3,369.6	16,379.0	1,015.5
6.	Grass Seeding	24,700	ha	162.0	4,001.4	44	1,086.8	118.0	2,914.6
	Total				105,864.7		23,495.4		82,369.3

TABLE M-8. DISBURSEMENT SCHEDULE FOR THE PROJECT COST (CASE A)

(unit: '000 Rs)

Description	Project Cost			Project Year									
	Grand Total			1994		1995		1996		1997		1998	
	Total	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Dispersion Structure													
1.1 Dispersion Structure I	15,159	4,454	10,705							2,672	6,423	1,782	4,282
1.2 Dispersion Structure II	27,521	6,968	20,553							4,181	12,332	2,787	8,221
1.3 Separating Dike	9,456	2,268	7,188							1,134	3,594	1,134	3,594
2. Distribution Structure													
2.1 Chhabri Branch	4,188	3,154	1,034							3,154	1,034		
2.2 Suchani Branch	4,756	3,581	1,175							3,581	1,175		
2.3 Phullar Branch	3,700	2,798	902							2,798	902		
3. Road	7,397	2,619	4,778							1,571	2,867	1,048	1,911
4. Engineering Fee	7,223	4,709	2,514	1,177	503	1,177	503	785	503	785	503	785	502
Sub-Total (1-4)	79,400	30,551	48,849	1,177	503	1,177	503	785	503	19,876	28,830	7,536	18,510
5. Price Escalation	27,200	3,083	24,122	47	83	71	131	64	173	1,998	13,171	903	10,564
Total	106,600	33,634	72,971	1,224	586	1,248	634	849	676	21,874	42,001	8,439	29,074

TABLE M-9. DISBURSEMENT SCHEDULE FOR THE PROJECT COST (CASE B-1)

(unit: '000 Rs)

Description	Project Cost Grand Total			Project Year 1994		1995		1996		1997		1998		1999		2000		2001	
	Total	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Dispersion Structure																			
1.1 Dispersion Structure I	15,159	4,454	10,705							2,672	6,423	1,782	4,282						
1.2 Dispersion Structure II	27,521	6,968	20,553							4,181	12,332	2,787	8,221						
1.3 Separating Dike	9,456	2,268	7,188							1,134	3,594	1,134	3,594						
2. Distribution Structure																			
2.1 Chhabri Branch	4,188	3,154	1,034							3,154	1,034								
2.2 Suchani Branch	4,756	3,581	1,175							3,581	1,175								
2.3 Phullar Branch	3,700	2,798	902							2,798	902								
3. Road	7,397	2,619	4,778							1,571	2,867	1,048	1,911						
Sub-Total (1-3)	72,177	25,842	46,335							19,091	28,327	6,751	18,008						
4. Watershed Management																			
4.1 Zone II	35,399	7,047	28,352							2,114	8,506	1,409	5,670	1,409	5,670	1,409	5,670	706	2,836
4.2 Zone III	33,500	7,597	25,903									1,084	3,700	2,171	7,401	2,171	7,401	2,171	7,401
Sub-Total	68,899	14,644	54,255							2,114	8,506	2,493	9,370	3,580	13,071	3,580	13,071	2,877	10,237
5. Engineering Fee	9,874	6,402	3,472	1,600	872	1,600	872	1,067	288	1,068	288	1,068	288		288		288		288
Total (1-5)	150,950	46,888	104,062	1,600	872	1,600	872	1,067	288	22,273	37,121	10,312	27,666	3,580	13,359	3,580	13,359	2,877	10,525
6. Price Escalation	71,150	5,576	65,574	64	145	98	227	87	104	2,317	17,428	1,301	16,243	532	9,539	615	11,371	561	10,518
Grand Total	222,100	52,464	169,636	1,664	1,017	1,698	1,099	1,154	392	24,590	54,549	11,613	43,909	4,112	22,898	4,195	24,730	3,438	21,043

TABLE M-10. DISBURSEMENT SCHEDULE FOR THE PROJECT COST (CASE B-2) (1/2)

Description	Project Cost			Project Year											
	Grand Total			1994		1995		1996		1997		1998		1999	
	Total	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Dispersion Structure															
1.1 Dispersion Structure I	15,159	4,454	10,705							2,672	6,423	1,782	4,282		
1.2 Dispersion Structure II	27,521	6,968	20,553							4,181	12,332	2,787	8,221		
1.3 Separating Dike	9,456	2,268	7,188							1,134	3,594	1,134	3,594		
2. Distribution Structure															
2.1 Chhabri Branch	4,188	3,154	1,034							3,154	1,034				
2.2 Suchani Branch	4,756	3,581	1,175							3,581	1,175				
2.3 Phullar Branch	3,700	2,798	902							2,798	902				
3. Road	7,397	2,619	4,778							1,571	2,867	1,048	1,911		
Sub-Total (1-3)	72,177	25,842	46,335							19,091	28,327	6,751	18,008		
4. Watershed Management															
4.1 Zone II	35,399	7,047	28,352							2,114	8,506	2,114	8,506	1,409	5,670
4.2 Zone III	33,500	7,597	25,903											1,084	3,700
4.3 Zone IV	11,422	2,379	9,043												
4.4 Zone V	25,545	6,473	19,072												
Sub-Total	105,866	23,496	82,370							2,114	8,506	2,114	8,506	2,493	9,370
5. Engineering Fee	12,457	8,114	4,343	2,029	335	2,029	335	1,352	335	1,352	334	1,352	334		334
Total (1-5)	190,500	57,452	133,048	2,029	335	2,029	335	1,352	335	22,557	37,167	10,217	26,848	2,493	9,704
6. Price Escalation	122,700	8,271	114,429	82	56	124	87	111	121	2,347	17,444	1,289	15,756	371	6,928
Grand Total	313,200	65,723	247,477	2,111	391	2,153	422	1,463	456	24,904	54,611	11,506	42,604	2,864	16,632

TABLE M-10. DISBURSEMENT SCHEDULE FOR THE PROJECT COST (CASE B-2) (2/2)

Description	Project Year													
	2000		2001		2002		2003		2004		2005		2006	
	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Dispersion Structure														
1.1 Dispersion Structure I														
1.2 Dispersion Structure II														
1.3 Separating Dike														
2. Distribution Structure														
2.1 Chhabri Branch														
2.2 Suchani Branch														
2.3 Phullar Branch														
3. Road														
Sub-Total (1-3)														
4. Watershed Management														
4.1 Zone II	705	2,835	705	2,835										
4.2 Zone III	2,171	7,401	2,171	7,401	2,171	7,401								
4.3 Zone IV					793	3,014	1,586	6,029						
4.4 Zone V							926	2,725	1,849	5,449	1,849	5,449	1849	5449
Sub-Total	2,876	10,236	2,876	10,236	2,964	10,415	2,512	8,754	1,849	5,449	1,849	5,449	1,849	5,449
5. Engineering Fee		334		334		334		334		333		333		333
Total (1-5)	2,876	10,570	2,876	10,570	2,964	10,749	2,512	9,088	1,849	5,782	1,849	5,782	1,849	5,782
6. Price Escalation	494	8,995	562	10,560	649	12,459	611	12,103	496	8,778	543	9,943	592	11200
Grand Total	3,370	19,565	3,438	21,130	3,613	23,208	3,123	21,191	2,345	14,560	2,392	15,725	2,441	16,982

ANNEX N. PROJECT EVALUATION

ANNEX N. PROJECT EVALUATION

Page

CHAPTER I. NET RETURN OF AGRICULTURAL BENEFITS (FINANCIAL) .... N - 1

CHAPTER II. NET RETURN OF AGRICULTURAL BENEFITS (ECONOMIC) .... N - 19

CHAPTER III. BASIC ANIMAL PRODUCTION MODEL .... N - 37

CHAPTER IV. CONVERSION FACTORS .... N - 39

3.1 Accounting Rate of Interest .... N - 39

3.2 Standard Conversion Factor .... N - 39

3.3 Sector Conversion Factors .... N - 39

LIST OF TABLES

Page

Table N - 1.	Present and Proposed Crop Yields, Unit Price, Production Cost, Gross Value and Net Return (Market Price)	N - 2
Table N - 2.	Net Return in Case A (Market Price)	N - 5
Table N - 3.	Net Return in Case B - 1 (Market Price)	N - 9
Table N - 4.	Net Return in Case B - 2 (Market Price)	N - 13
Table N - 5.	Present and Proposed Crop Yields, Unit Price, Production Cost, Gross Value and Net Return (Accounting Price)	N - 20
Table N - 6.	Net Return in Case A (Accounting Price)	N - 23
Table N - 7.	Net Return in Case B - 1 (Accounting Price)	N - 27
Table N - 8	Net Return in Case B - 2 (Accounting Price)	N - 31
Table N - 9.	Basic Production Model	N - 38
Table N - 10.	Major Imports & Exports and Custom Duties, Subsidies	N - 45
Table N - 11.	Conversion Factor of Earth Work	N - 45
Table N - 12.	Conversion Factor of Cement & Masonry Work	N - 46
Table N - 13.	Conversion Factor of Direct Construction Cost	N - 46
Table N - 14.	Operation & Maintenance Cost in Accounting Price	N - 46

LIST OF FIGURES

Figure N - 1.	Financial Agricultural Benefit Frequency Curve	N - 17
Figure N - 2.	Economic Agricultural Benefit Frequency Curve	N - 35

CHAPTER I. NET RETURN OF AGRICULTURAL BENEFITS (FINANCIAL)

The agricultural benefits of this Project, net return per hectare of the irrigable area and total net return with and without the project, by main return periods for each project case were calculated.

The results of this calculation are shown in Tables N-1 to N-4. To estimate annual average agricultural benefits, the total net return without and with the project by each case were plotted on the normal probability paper as shown in Figure N-1. And the figures mentioned above are used for estimation of agricultural benefits in the Main Report.

TABLE N-1. PRESENT AND PROPOSED CROP YIELDS, UNIT PRICE, PRODUCTION COST, GROSS VALUE AND NET RETURN (1/3)
(MARKET PRICE)

Crops	Yield	Unit Price	Gross Value	Seeds	Ferti-lizers	Culti-vation	Harvest-ing	Total Cost	Net Return
	Kgs	Rs./Kg	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Present Situation									
Jowar	1,000	4.0	4,000	100	0	180	685	965	3,035
	4,000	0.3	1,200					0	1,200
Bajra	900	4.5	4,050	125	0	180	685	990	3,060
	3,600	0.3	1,080					0	1,080
K.Fodders	9,000	0.3	2,700	75	0	180	555	810	1,890
Wheat	1,200	3.5	4,200	400	0	180	685	1,265	2,935
	1,800	0.3	540					0	540
Gram	890	5.5	4,895	360	0	180	625	1,165	3,730
Oilseed	770	4.5	3,465	75	0	180	625	880	2,585
R,Fodders	7,000	0.3	2,100	75	0	180	375	630	1,470

TABLE N-1. PRESENT AND PROPOSED CROP YIELDS, UNIT PRICE, PRODUCTION COST, GROSS VALUE AND NET RETURN (2/3)
(MARKET PRICE)

Crops	Yield	Unit Price	Gross Value	Seeds	Ferti-lizers	Culti-vation	Harvest-ing	Total Cost	Net Return
	Kgs	Rs./Kg	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Future Situation	(Return Period 2-Year)								
Jowar	1,020	4.0	4,080	102	0	187	699	988	3,092
	4,080	0.3	1,224					0	1,224
Bajra	920	4.5	4,140	128	0	187	699	1,014	3,126
	3,680	0.3	1,104					0	1,104
K.Fodders	9,180	0.3	2,754	77	0	187	566	830	1,924
Wheat	1,220	3.5	4,270	408	0	187	638	1,233	3,037
	1,830	0.3	549					0	549
Gram	910	5.5	5,005	367	0	187	638	1,192	3,813
Oilseed	790	4.5	3,555	77	0	187	625	889	2,666
R,Fodders	7,140	0.3	2,142	77	0	187	383	647	1,495
Future Situation	(Return Period 5-Year)								
Jowar	1,050	4.0	4,200	105	0	199	720	1,024	3,176
	4,200	0.3	1,260					0	1,260
Bajra	950	4.5	4,275	131	0	199	720	1,050	3,225
	3,800	0.3	1,140					0	1,140
K.Fodders	9,460	0.3	2,838	79	0	199	583	861	1,977
Wheat	1,260	3.5	4,410	420	0	199	720	1,339	3,071
	1,890	0.3	567					0	567
Gram	940	5.5	5,170	378	0	199	657	1,234	3,936
Oilseed	810	4.5	3,645	79	0	199	657	935	2,710
R.Fodders	7,360	0.3	2,208	79	0	199	394	672	1,536

TABLE N-1. PRESENT AND PROPOSED CROP YIELDS, UNIT PRICE, PRODUCTION COST, GROSS VALUE AND NET RETURN (3/3)
(MARKET PRICE)

Crops	Yield	Unit Price	Gross Value	Seeds	Ferti-lizers	Culti-vation	Harvest-ing	Total Cost	Net Return
	Kgs	Rs./Kg	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Future Situation	(Return Period 10-Year)								
Jowar	1,110	4.0	4,440	110	0	219	757	1,086	3,354
	4,440	0.3	1,332					0	1,332
Bajra	990	4.5	4,455	138	0	219	757	1,114	3,341
	3,960	0.3	1,188					0	1,188
K.Fodders	9,940	0.3	2,982	83	0	219	613	915	2,067
Wheat	1,330	3.5	4,655	442	0	219	757	1,418	3,237
	1,995	0.3	599					0	599
Gram	980	5.5	5,390	398	0	219	690	1,307	4,083
Oilseed	850	4.5	3,825	83	0	219	690	992	2,833
R.Fodders	7,730	0.3	2,319	83	0	219	414	716	1,603
Future Situation	(Return Period 25-Year)								
Jowar	1,280	4.0	5,120	128	0	295	878	1,301	3,819
	5,120	0.3	1,536					0	1,536
Bajra	1,150	4.5	5,175	160	0	295	878	1,333	3,842
	4,600	0.3	1,380					0	1,380
K.Fodders	11,540	0.3	3,462	96	0	295	712	1,103	2,359
Wheat	1,540	3.5	5,390	513	0	295	878	1,686	3,704
	2,310	0.3	693					0	693
Gram	1,140	5.5	6,270	462	0	295	802	1,559	4,711
Oilseed	990	4.5	4,455	96	0	295	802	1,193	3,262
R.Fodders	8,980	0.3	2,694	96	0	295	481	872	1,822

TABLE N-2. NET RETURN IN CASE A (RETURN PERIOD 2-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,122	85.0	4,235	13,220
	Bajra	459	12.5	4,140	1,901
	K.Fodders	92	2.5	1,890	174
	Subtotal	3,672	100.0		15,294
	(Rabi)				
	Wheat	140	67.9	3,475	485
	Gram	48	23.4	3,730	179
	Oilseed	18	8.6	2,585	46
	R.Fodders	0	0.1	1,470	0
	Subtotal	206	100.0		710
	Total (T)	3,878			16,004
	CCA (C)	13,348	T/C=	0.29	
With Project (b)	(Kharif)				
	Jowar	4,257	85.0	4,316	18,375
	Bajra	626	12.5	4,230	2,648
	K.Fodders	125	2.5	1,924	241
	Subtotal	5,009	100.0		21,265
	(Rabi)				
	Wheat	570	67.9	3,586	2,043
	Gram	196	23.4	3,813	749
	Oilseed	72	8.6	2,666	192
	R.Fodders	1	0.1	1,495	1
	Subtotal	839	100.0		2,986
	Total (T)	5,848			24,250
	CCA (C)	13,348	T/C=	0.44	
(b)-(a)	(Kharif)				
	Jowar	1,136			5,155
	Bajra	167			748
	K.Fodders	33			67
	Subtotal	1,336			5,971
	(Rabi)				
	Wheat	430			1,558
	Gram	148			569
	Oilseed	54			147
	R.Fodders	1			1
	Subtotal	634			2,275
	Total	1,970			8,246

Note) CCA; Cultivable Command Area.

TABLE N-2. NET RETURN IN CASE A (RETURN PERIOD 5-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,642	85.0	4,235	15,426
	Bajra	536	12.5	4,140	2,218
	K.Fodders	107	2.5	1,890	202
	Subtotal	4,285	100.0		17,846
	(Rabi)				
	Wheat	163	67.9	3,475	566
	Gram	56	23.4	3,730	209
	Oilseed	21	8.6	2,585	53
	R.Fodders	0	0.1	1,470	0
	Subtotal	240	100.0		829
	Total (T)	4,525			18,674
	CCA (C)	13,348	T/C=	0.34	
With Project (b)	(Kharif)				
	Jowar	6,136	85.0	4,436	27,218
	Bajra	902	12.5	4,365	3,939
	K.Fodders	180	2.5	1,977	357
	Subtotal	7,219	100.0		31,514
	(Rabi)				
	Wheat	821	67.9	3,638	2,985
	Gram	283	23.4	3,936	1,113
	Oilseed	104	8.6	2,710	282
	R.Fodders	1	0.1	1,536	2
	Subtotal	1,208	100.0		4,382
	Total (T)	8,427			35,895
	CCA (C)	13,348	T/C=	0.63	
(b)-(a)	(Kharif)				
	Jowar	2,493			11,793
	Bajra	367			1,721
	K.Fodders	73			154
	Subtotal	2,933			13,668
	(Rabi)				
	Wheat	658			2,419
	Gram	227			904
	Oilseed	83			228
	R.Fodders	1			2
	Subtotal	969			3,553
	Total	3,902			17,221

TABLE N-2. NET RETURN IN CASE A (RETURN PERIOD 10-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,918	85.0	4,235	16,595
	Bajra	576	12.5	4,140	2,386
	K.Fodders	115	2.5	1,890	218
	Subtotal	4,610	100.0		19,198
	(Rabi)				
	Wheat	175	67.9	3,475	609
	Gram	60	23.4	3,730	225
	Oilseed	22	8.6	2,585	57
	R.Fodders	0	0.1	1,470	0
	Subtotal	258	100.0		892
	Total (T)	4,868			20,090
	CCA (C)	13,348	T/C=	0.36	
With Project (b)	(Kharif)				
	Jowar	7,531	85.0	4,686	35,290
	Bajra	1,107	12.5	4,529	5,016
	K.Fodders	221	2.5	2,067	458
	Subtotal	8,860	100.0		40,763
	(Rabi)				
	Wheat	1,007	67.9	3,836	3,863
	Gram	347	23.4	4,083	1,417
	Oilseed	128	8.6	2,833	361
	R.Fodders	1	0.1	1,603	2
	Subtotal	1,483	100.0		5,644
	Total (T)	10,343			46,407
	CCA (C)	13,348	T/C=	0.77	
(b)-(a)	(Kharif)				
	Jowar	3,612			18,695
	Bajra	531			2,630
	K.Fodders	106			240
	Subtotal	4,250			21,565
	(Rabi)				
	Wheat	832			3,254
	Gram	287			1,192
	Oilseed	105			304
	R.Fodders	1			2
	Subtotal	1,225			4,752
	Total	5,475			26,317

TABLE N-2. NET RETURN IN CASE A (RETURN PERIOD 25-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	4,216	85.0	4,235	17,853
	Bajra	620	12.5	4,140	2,567
	K.Fodders	124	2.5	1,890	234
	Subtotal	4,959	100.0		20,654
	(Rabi)				
	Wheat	188	67.9	3,475	655
	Gram	65	23.4	3,730	242
	Oilseed	24	8.6	2,585	62
	R.Fodders	0	0.1	1,470	0
	Subtotal	278	100.0		959
	Total (T)	5,237			21,612
	CCA (C)	13,348	T/C=	0.39	
With Project (b)	(Kharif)				
	Jowar	8,906	85.0	5,355	47,691
	Bajra	1,310	12.5	5,222	6,839
	K.Fodders	262	2.5	2,359	618
	Subtotal	10,477	100.0		55,148
	(Rabi)				
	Wheat	1,263	67.9	4,397	5,555
	Gram	435	23.4	4,711	2,051
	Oilseed	160	8.6	3,262	522
	R.Fodders	2	0.1	1,822	4
	Subtotal	1,861	100.0		8,132
	Total (T)	12,338			63,280
	CCA (C)	13,348	T/C=	0.92	
(b)-(a)	(Kharif)				
	Jowar	4,690			29,838
	Bajra	690			4,273
	K.Fodders	138			384
	Subtotal	5,518			34,495
	(Rabi)				
	Wheat	1,075			4,900
	Gram	370			1,809
	Oilseed	136			460
	R.Fodders	2			4
	Subtotal	1,583			4,172
	Total	7,101			41,667

TABLE N-3. NET RETURN IN CASE B-1 (RETURN PERIOD 2-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,122	85.0	4,235	13,220
	Bajra	459	12.5	4,140	1,901
	K.Fodders	92	2.5	1,890	174
	Subtotal	3,672	100.0		15,294
	(Rabi)				
	Wheat	140	67.9	3,475	485
	Gram	48	23.4	3,730	179
	Oilseed	18	8.6	2,585	46
	R.Fodders	0	0.1	1,470	0
	Subtotal	206	100.0		710
	Total (T)	3,878			16,004
	CCA (C)	13,348	T/C=	0.29	
With Project (b)	(Kharif)				
	Jowar	3,867	85.0	4,316	16,688
	Bajra	569	12.5	4,230	2,405
	K.Fodders	114	2.5	1,924	219
	Subtotal	4,549	100.0		19,312
	(Rabi)				
	Wheat	549	67.9	3,586	1,970
	Gram	189	23.4	3,813	722
	Oilseed	70	8.6	2,666	185
	R.Fodders	1	0.1	1,495	1
	Subtotal	809	100.0		2,878
	Total (T)	5,358			22,191
	CCA (C)	13,348	T/C=	0.40	
(b)-(a)	(Kharif)				
	Jowar	745			3,468
	Bajra	110			505
	K.Fodders	22			45
	Subtotal	876			4,018
	(Rabi)				
	Wheat	410			1,485
	Gram	141			542
	Oilseed	52			140
	R.Fodders	1			1
	Subtotal	604			2,168
	Total	1,480			6,187

Note) CCA; Cultivable Command Area.

TABLE N-3. NET RETURN IN CASE B-1 (RETURN PERIOD 5-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without	(Kharif)				
Project	Jowar	3,642	85.0	4,235	15,426
(a)	Bajra	536	12.5	4,140	2,218
	K.Fodders	107	2.5	1,890	202
	Subtotal	4,285	100.0		17,846
	(Rabi)				
	Wheat	163	67.9	3,475	566
	Gram	56	23.4	3,730	209
	Oilseed	21	8.6	2,585	53
	R.Fodders	0	0.1	1,470	0
	Subtotal	240	100.0		829
	Total (T)	4,525			18,674
	CCA (C)	13,348	T/C=	0.34	
With	(Kharif)				
Project	Jowar	5,664	85.0	4,436	25,123
(b)	Bajra	833	12.5	4,365	3,635
	K.Fodders	167	2.5	1,977	329
	Subtotal	6,663	100.0		29,088
	(Rabi)				
	Wheat	805	67.9	3,638	2,927
	Gram	277	23.4	3,936	1,091
	Oilseed	102	8.6	2,710	276
	R.Fodders	1	0.1	1,536	2
	Subtotal	1,185	100.0		4,297
	Total (T)	7,848			33,385
	CCA (C)	13,348	T/C=	0.59	
(b)-(a)	(Kharif)				
	Jowar	2,021			9,698
	Bajra	297			1,418
	K.Fodders	59			127
	Subtotal	2,378			11,243
	(Rabi)				
	Wheat	642			2,361
	Gram	221			882
	Oilseed	81			223
	R.Fodders	1			1
	Subtotal	945			3,468
	Total	3,323			14,711

TABLE N-3. NET RETURN IN CASE B-1 (RETURN PERIOD 10-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,918	85.0	4,235	16,595
	Bajra	576	12.5	4,140	2,386
	K.Fodders	115	2.5	1,890	218
	Subtotal	4,610	100.0		19,198
	(Rabi)				
	Wheat	175	67.9	3,475	609
	Gram	60	23.4	3,730	225
	Oilseed	22	8.6	2,585	57
	R.Fodders	0	0.1	1,470	0
	Subtotal	258	100.0		892
	Total (T)	4,868			20,090
	CCA (C)	13,348	T/C=	0.36	
With Project (b)	(Kharif)				
	Jowar	7,023	85.0	4,686	32,910
	Bajra	1,033	12.5	4,529	4,678
	K.Fodders	207	2.5	2,067	427
	Subtotal	8,262	100.0		38,015
	(Rabi)				
	Wheat	998	67.9	3,836	3,828
	Gram	344	23.4	4,083	1,404
	Oilseed	126	8.6	2,833	358
	R.Fodders	1	0.1	1,603	2
	Subtotal	1,470	100.0		5,592
	Total (T)	9,732			43,607
	CCA (C)	13,348	T/C=	0.73	
(b)-(a)	(Kharif)				
	Jowar	3,105			16,315
	Bajra	457			2,292
	K.Fodders	91			209
	Subtotal	3,652			18,816
	(Rabi)				
	Wheat	823			3,219
	Gram	283			1,179
	Oilseed	104			301
	R.Fodders	1			2
	Subtotal	1,212			4,700
	Total	4,864			23,517

TABLE N-3. NET RETURN IN CASE B-1 (RETURN PERIOD 25-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	Cropping Pattern (%)	Net Return (Rs/ha)	Net Return '000 Rs.
Without Project (a)	(Kharif)				
	Jowar	4,216	85.0	4,235	17,853
	Bajra	620	12.5	4,140	2,567
	K.Fodders	124	2.5	1,890	234
	Subtotal	4,959	100.0		20,654
	(Rabi)				
	Wheat	188	67.9	3,475	655
	Gram	65	23.4	3,730	242
	Oilseed	24	8.6	2,585	62
	R.Fodders	0	0.1	1,470	0
	Subtotal	278	100.0		959
	Total (T)	5,237			21,612
	CCA (C)	13,348	T/C=	0.39	
With Project (b)	(Kharif)				
	Jowar	8,476	85.0	5,355	45,392
	Bajra	1,247	12.5	5,222	6,509
	K.Fodders	249	2.5	2,359	588
	Subtotal	9,972	100.0		52,489
	(Rabi)				
	Wheat	1,267	67.9	4,397	5,570
	Gram	437	23.4	4,711	2,057
	Oilseed	160	8.6	3,262	523
	R.Fodders	2	0.1	1,822	4
	Subtotal	1,866	100.0		8,154
	Total (T)	11,838			60,643
	CCA (C)	13,348	T/C=	0.89	
(b)-(a)	(Kharif)				
	Jowar	4,261			27,539
	Bajra	627			3,943
	K.Fodders	125			354
	Subtotal	5,013			31,836
	(Rabi)				
	Wheat	1,078			4,915
	Gram	372			1,814
	Oilseed	137			462
	R.Fodders	2			4
	Subtotal	1,588			7,195
	Total	6,601			39,031

TABLE N-4. NET RETURN IN CASE B-2 (RETURN PERIOD 2-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,122	85.0	4,235	13,220
	Bajra	459	12.5	4,140	1,901
	K.Fodders	92	2.5	1,890	174
	Subtotal	3,672	100.0		15,294
	(Rabi)				
	Wheat	140	67.9	3,475	485
	Gram	48	23.4	3,730	179
	Oilseed	18	8.6	2,585	46
	R.Fodders	0	0.1	1,470	0
	Subtotal	206	100.0		710
	Total (T)	3,878			16,004
	CCA (C)	13,348	T/C=	0.29	
With Project (b)	(Kharif)				
	Jowar	3,652	85.0	4,316	15,761
	Bajra	537	12.5	4,230	2,272
	K.Fodders	107	2.5	1,924	207
	Subtotal	4,296	100.0		18,240
	(Rabi)				
	Wheat	581	67.9	3,586	2,084
	Gram	200	23.4	3,813	764
	Oilseed	74	8.6	2,666	196
	R.Fodders	1	0.1	1,495	1
	Subtotal	856	100.0		3,045
	Total (T)	5,152			21,285
	CCA (C)	13,348	T/C=	0.39	
(b)-(a)	(Kharif)				
	Jowar	530			2,541
	Bajra	78			371
	K.Fodders	16			33
	Subtotal	624			2,946
	(Rabi)				
	Wheat	441			1,599
	Gram	152			584
	Oilseed	56			151
	R.Fodders	1			1
	Subtotal	650			2,335
	Total	1,274			5,281

Note) CCA; Cultivable Command Area.

TABLE N-4. NET RETURN IN CASE B-2 (RETURN PERIOD 5-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,642	85.0	4,235	15,426
	Bajra	536	12.5	4,140	2,218
	K.Fodders	107	2.5	1,890	202
	Subtotal	4,285	100.0		17,846
	(Rabi)				
	Wheat	163	67.9	3,475	566
	Gram	56	23.4	3,730	209
	Oilseed	21	8.6	2,585	53
	R.Fodders	0	0.1	1,470	0
	Subtotal	240	100.0		829
	Total (T)	4,525			18,674
	CCA (C)	13,348	T/C=	0.34	
With Project (b)	(Kharif)				
	Jowar	5,388	85.0	4,436	23,900
	Bajra	792	12.5	4,365	3,458
	K.Fodders	158	2.5	1,977	313
	Subtotal	6,338	100.0		27,672
	(Rabi)				
	Wheat	857	67.9	3,638	3,119
	Gram	295	23.4	3,936	1,163
	Oilseed	109	8.6	2,710	294
	R.Fodders	1	0.1	1,536	2
	Subtotal	1,263	100.0		4,578
	Total (T)	7,601			32,249
	CCA (C)	13,348	T/C=	0.57	
(b)-(a)	(Kharif)				
	Jowar	1,745			8,474
	Bajra	257			1,241
	K.Fodders	51			111
	Subtotal	2,053			9,826
	(Rabi)				
	Wheat	694			2,553
	Gram	239			953
	Oilseed	88			241
	R.Fodders	1			2
	Subtotal	1,023			3,749
	Total	3,076			13,575

TABLE N-4. NET RETURN IN CASE B-2 (RETURN PERIOD 10-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	3,918	85.0	4,235	16,595
	Bajra	576	12.5	4,140	2,386
	K.Fodders	115	2.5	1,890	218
	Subtotal	4,610	100.0		19,198
	(Rabi)				
	Wheat	175	67.9	3,475	609
	Gram	60	23.4	3,730	225
	Oilseed	22	8.6	2,585	57
	R.Fodders	0	0.1	1,470	0
	Subtotal	258	100.0		891
	Total (T)	4,868			20,090
	CCA (C)	13,348	T/C=	0.36	
With Project (b)	(Kharif)				
	Jowar	6,712	85.0	4,686	31,451
	Bajra	987	12.5	4,529	4,470
	K.Fodders	197	2.5	2,067	408
	Subtotal	7,896	100.0		36,329
	(Rabi)				
	Wheat	1,069	67.9	3,836	4,099
	Gram	368	23.4	4,083	1,504
	Oilseed	135	8.6	2,833	383
	R.Fodders	2	0.1	1,603	3
	Subtotal	1,574	100.0		5,989
	Total (T)	9,470			42,318
	CCA (C)	13,348	T/C=	0.71	
(b)-(a)	(Kharif)				
	Jowar	2,793			14,856
	Bajra	411			2,084
	K.Fodders	82			190
	Subtotal	3,286			17,130
	(Rabi)				
	Wheat	894			3,491
	Gram	308			1,279
	Oilseed	113			326
	R.Fodders	1			2
	Subtotal	1,316			5,098
	Total	4,602			22,228

TABLE N-4. NET RETURN IN CASE B-2 (RETURN PERIOD 25-YEAR) (MARKET PRICE)

	Crop	Cropping Pattern (hectares)	(%)	Net Return (Rs/ha)	'000 Rs.
Without Project (a)	(Kharif)				
	Jowar	4,216	85.0	4,235	17,853
	Bajra	620	12.5	4,140	2,567
	K.Fodders	124	2.5	1,890	234
	Subtotal	4,959	100.0		20,654
	(Rabi)				
	Wheat	188	67.9	3,475	655
	Gram	65	23.4	3,730	242
	Oilseed	24	8.6	2,585	62
	R.Fodders	0	0.1	1,470	0
	Subtotal	278	100.0		959
	Total (T)	5,237			21,612
	CCA (C)	13,348	T/C=	0.39	
With Project (b)	(Kharif)				
	Jowar	8,242	85.0	5,355	44,134
	Bajra	1,212	12.5	5,222	6,329
	K.Fodders	242	2.5	2,359	572
	Subtotal	9,696	100.0		51,035
	(Rabi)				
	Wheat	1,365	67.9	4,397	6,001
	Gram	470	23.4	4,711	2,216
	Oilseed	173	8.6	3,262	564
	R.Fodders	2	0.1	1,822	4
	Subtotal	2,010	100.0		8,784
	Total (T)	11,706			59,819
	CCA (C)	13,348	T/C=	0.88	
(b)-(a)	(Kharif)				
	Jowar	4,026			26,281
	Bajra	592			3,763
	K.Fodders	118			337
	Subtotal	4,737			30,381
	(Rabi)				
	Wheat	1,176			5,346
	Gram	405			1,973
	Oilseed	149			502
	R.Fodders	2			3
	Subtotal	1,732			7,825
	Total	6,469			38,207