Participatory Watershed Development: Experiences From IWDP

Central Soil and Water Conservation Research and Training Institute, Dehradun

Objectives

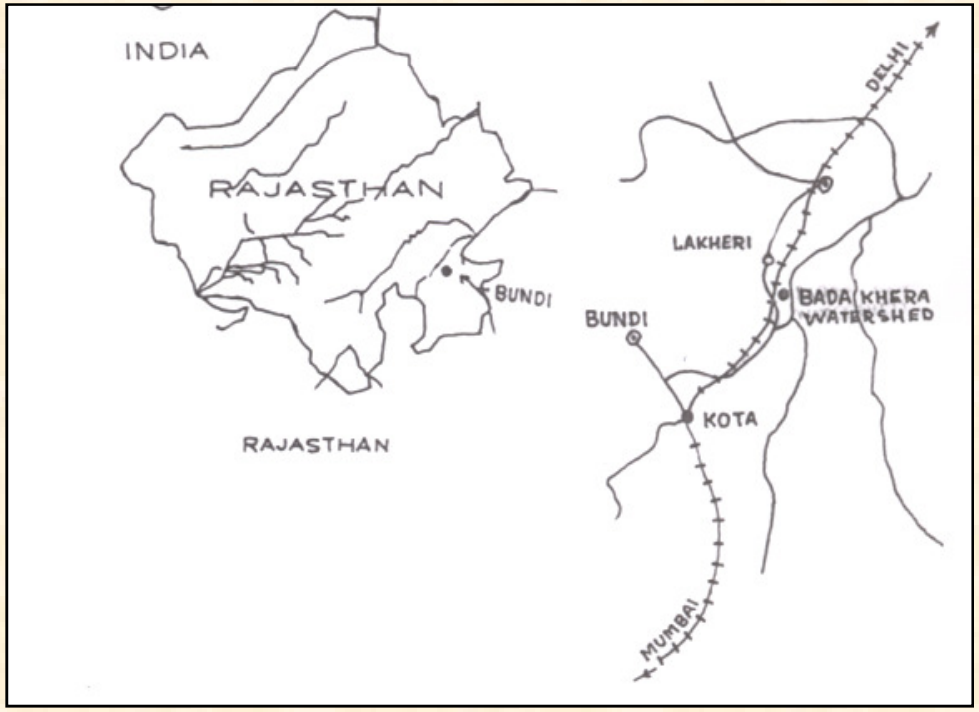
- ✓ The watersheds were developed with the primary objective of promoting economic development of the watershed communities, which are directly or indirectly dependent on watersheds' natural resources, by
  - mitigating ecological degradation
  - employment and income generating activities

- ✓ Secondly, to restore ecological balance in the watersheds by development of natural resources through simple and affordable technological solutions, including local technical knowledge and available materials, implemented by sustained community actions.
  - Participatory approach was the bottom line concept of these watershed development programmes.

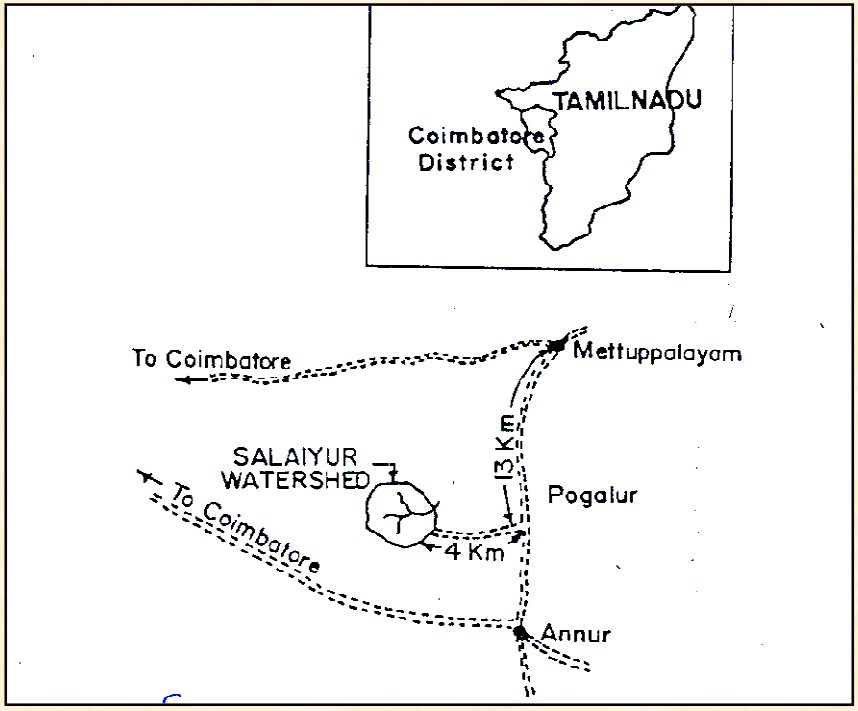
- ✓ Lastly, special emphasis was laid on improvement of economic and social condition of the resource poor and disadvantaged sections of the watershed communities through
  - equitable distribution of benefits of land and water resources
  - greater access to income generating opportunities
  - human resource development

Details of Watersheds Developed by CSWCRTI under IWDP

Water-shed & location	Agro-ecological region No.	Average annual rainall (mm)	Area (ha)	Elevation range (m) a.m.s.l. (slope%)	No. of families (population)	Major occupation (%)		Average land-holding size (ha)	Average annual income (Rs./ family)
						Agricul-ture	Landless Labour		
BadaKhera Bundi (Rajasthan)	5	750	682.5	150-173 (1-30%)	117 (1117)	78	22	3.23	25,811
Salaiyur Coimbatore (Tamil Nadu)	19	602	513	370-472 (3-15%)	314 (1314)	56	38	1.63	19,837



Location map of Bada Khera watershed



Location map of Salaiyur watershed

Area under different land uses in the IWDP watersheds

S. No.	Particulars	Bada Khera	Salaiyur
1.	Cultivated land		
	Rainfed farming	338.7 (49.6)	340.5 (66.4)
	Irrigated farming	40.2 (5.9)	65.6 (12.8)
	Sub total	378.9 (55.5)	406.1 (79.2)
2.	Wasteland	303.6 (44.5)	94.3 (18.4)
3.	Forests, pastures, habitation, road, etc.	Neg.	12.6 (2.5)
	Sub-total	303.6 (44.5)	106.9 (20.8)
	Total	682.5 (100.0)	513.0 (100.0)

Figures in parentheses are the percent of the total watershed area; Neg. - Negligible

Wastelands of Bada Khera watershed

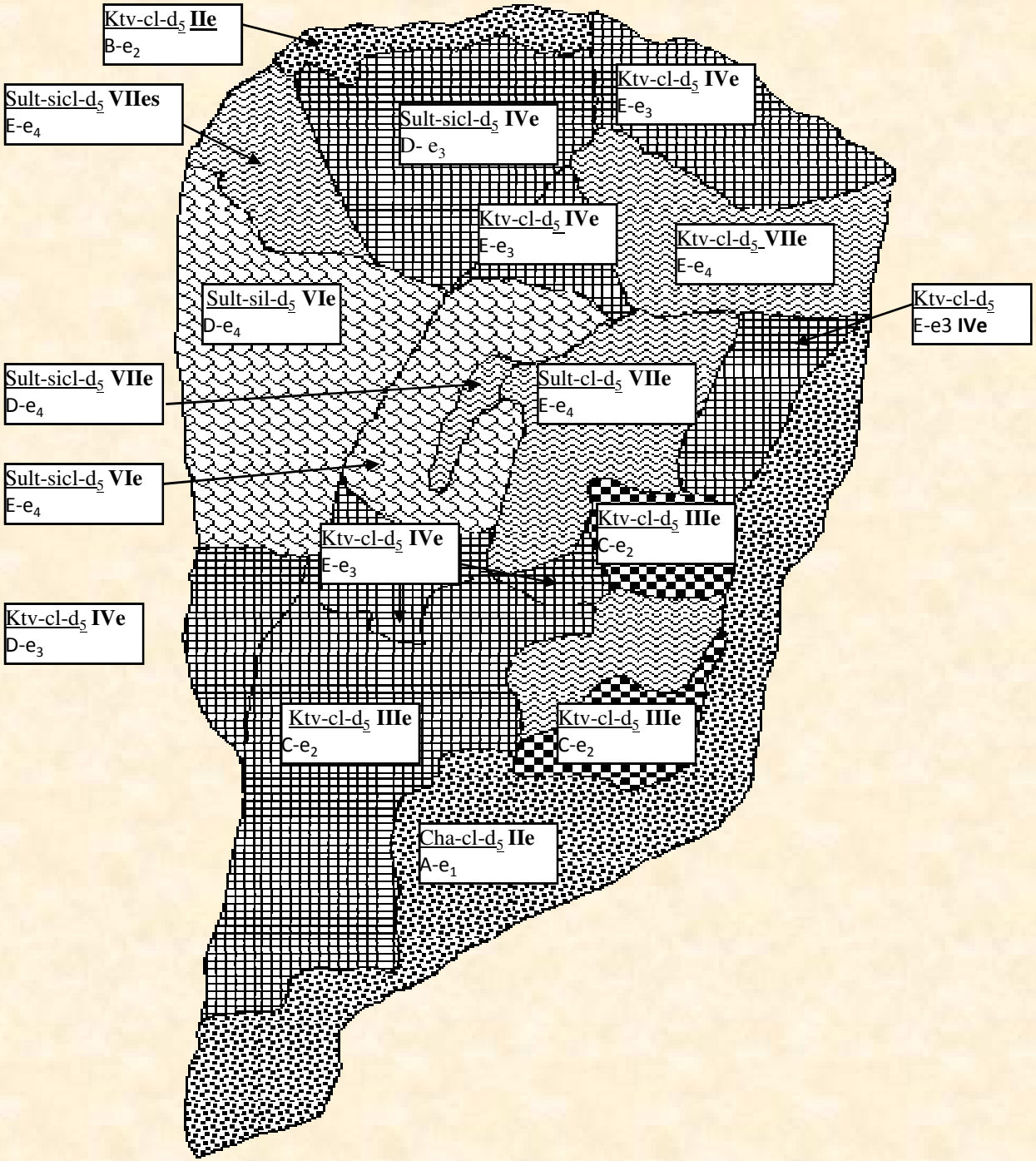
Wastelands of Salaiyur watershed

Bada Khera Watershed

Period of Execution : 1997 – 2003

Cost : Rs 27.44 lakh

Soil and Land Capability Map of Bada Khera Watershed



Soil Legends

Soil Series
Ktv- Kota variant
Cha - Chambal
Sult- Sultanpur

Soil texture
cl - Clay loam
l - Loam
sicl - Silty clay loam

Depth
d_5 -Very deep 90 cm

Slope
A-Nearly level 0-1%
B-Very gentle slope 1-3%
C-Gentle slope 3-5%
D-Moderate slope 5-10%
E-Strong slope 10-15%

Erosion
e_1- Slightly or no erosion
e_2- Moderate erosion
e_3- Severe erosion
e_4- Very severe erosion

Area and Characteristic feature of each LCC in Bada Khera watershed

S. No.	Particulars	Land Capability Class				
		IIe	IIIe	IVe	VIe	VIIe
1	Area (ha)	138.0	130.5	110.4	174.4	129.2
2	% of total area	20.2	19.1	16.2	25.6	18.9
3	Soil depth (cm)	>90	>90	>90	>90	>90
4	Slope (%)	<2	3-5	5-10	1-10	>10
5	Drainage	----------Well drained----------				Seasonally Wet
6	Bench mark land use	Single cropping	Single cropping	Occasional cropping	Wasteland	
7	Major crops grown	Soybean, maize, mustard, wheat	Sorghum, pigeon pea, *taramira*, mustard, chick pea + linseed		-	-
8	Major problems	Erosion, multi directional slopes, cracked surface and deficit moisture			Ravine lands	
9	Scope	Production improvement and stabilization through efficient in situ water harvesting and improved package of practices.		In-situ water harvesting, agri-horti systems, improved package of practices.	Staggered trenching, alternate land use systems	Afforestation, drainage line treatment to improve ground water availability and protecting adjoining cultivated lands.

Area under different crops with average yield under agriculture land use in watershed during pre-project

Crop	Area under crop		Average yield (kg/ha)
	Area (ha)	% of total	
Rainfed			
Kharif			
Sorghum fodder	1.5	0.39	4200 (Air dry)
Sorghum + pigeon pea	48.3	12.75	782+ 401
Pigeon pea + green gram	1.0	0.26	470 + 400
Pigeon pea + soybean	2.4	0.63	523 + 609
Soybean	64.2	16.95	1148
Green gram	0.2	0.05	343
Maize	0.2	0.05	434
Rabi			
Wheat	38.8	10.24	769
Mustard	41.0	10.82	908
Gram	13.0	3.47	717
Coriander	12.4	3.27	633
Barley	1.7	0.45	595
Linseed + taramira	8.1	2.13	236 + 248
Sub Total	232.8	61.44	
Irrigated			
Kharif			
Soybean	5.5	1.45	1837
Rabi			
Wheat	7.8	2.06	
Sub Total	13.3	3.51	2221
Total cropped area	246.1	64.95	
Cultivable fallow	132.8	35.05	
Total cultivable area	378.9	55.52	
Total	682.5	100.00	

Problems & Needs – Bada Khera Watershed

- The watershed, characterized by highly undulating topography and ravines, had about 44.5% as waste lands (ravines, degraded community pasture lands and drainage ways).
- In remaining 55.5% area under cultivation, the erosion rates were very high, and in absence of conservation measures, sub-soil was exposed at places. The surface layer of soil (vertisols) itself had low organic carbon, available N and P and poor fertility status.
- The arable lands had multi-directional slopes. Shallow preparatory tillage operations, ensured adequate moisture in surface layer for germination and establishment of the crops, however, deeper layers of the profile remained unsaturated due to poor permeability of vertisol and non-adoption of resource conservation measures.
- The addition of FYM in the fields was meager due to open grazing system.
- Out of 338.7 ha under rainfed agriculture, actual cultivated area was only 232.8 ha (68%) in the pre-project year of 1997. The average crop yield were low due to non adoption of improved package of practices, soil moisture stress and poor soil fertility.

Problems & Needs – Bada Khera Watershed

- Only 7.8 ha out of 40.3 ha area recorded as irrigated land had assured irrigation from tube wells. Remaining area never received water during project period as the watershed was located at the tail-end of a canal. Irrigated wheat yield was poor.

- Pasture and community land were also severely degraded. Nomadic tribes and open grazing system almost completely destroyed the natural grass cover of the watershed. About 36% of community grazing land was sparsely vegetated with low quality grass. As a result, the scarcity of fodder was sustained in the area.

- Rainfall (758 mm) is the primary source of water for agriculture in the watershed. However, the 517.2 ha-m rain water received is inadequate. During July and August, 99.5 ha-m water was lost as runoff, which potentially could be retained within the watershed by adopting soil and water conservation measures for use during *rabi* season.

- Landless labourers needed employment / income generation activities.

Multidirectional slopes and poor permeability of soil favor the process of rill formation

These rills grow in to fresh gullies engulfing the cultivated land

Nomadic tribes with large animal population put severe biotic pressure on already degraded ecosystem

Poor community survives on fragile ecosystem

Entry Point Activities (EPA)

1 Construction of community hall in the premises of village temple
2 Construction of a gabion for protecting village road
3 Renovation of a culvert on the village road
4 Renovation of old village pond
5 Leveling and plantation around village temple

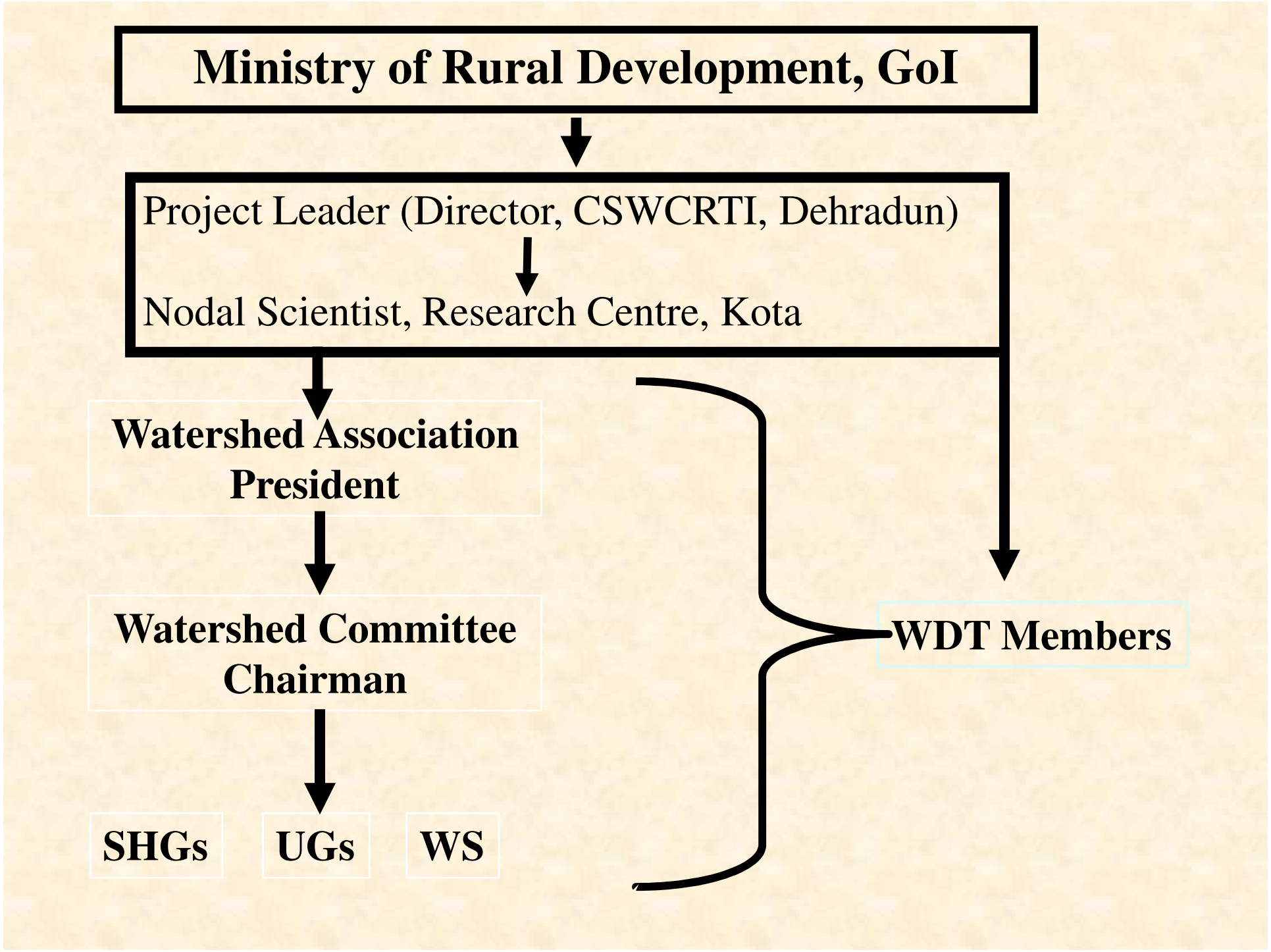
Participatory Rural Appraisal (PRA)

❖ Various maps and charts were prepared by the farmers in playful manner to define the problems, needs and opportunities in the watershed



❖ Preferential ranking of problems

1 Ravine extension into table lands
2 Severe erosion due to undulating topography
3 Lack of irrigation facilities
4 Scarcity of timber and fruits
5 Acute shortage of fodder and fuel wood
6 Unemployment / under employment
7 Subsistence level of cropping
8 Lack of technical know how
9 Low productivity of arable lands
10 Abundance of low yielding milch cattle
11 Poor socio-economic condition


Ministry of Rural Development, GoI
Project Leader (Director, CSWCRTI, Dehradun)
Nodal Scientist, Research Centre, Kota
Watershed Association President
Watershed Committee Chairman
SHGs
UGs
WS
WDT Members

Community Organization

Gender and Caste Wise Break-up of Self Help Groups

Self Help Group	Gender		Total	Caste				Total
	Male	Female		General	OBC	SC	ST	
1. Mason	12	-	12	01	03	08	-	12
2. Barber	06	-	06	-	06	-	-	06
3. Black smith	03	-	03	03	-	-	-	03
4. Carpenter	08	-	08	-	08	-	-	08
5. Washer man	01	-	01	-	01	-	-	01
6. Tailor	11	04	15	06	05	02	02	15
7. Embroider	-	02	02	02	-	-	-	02
8. Vegetable vendor	01	-	01	-	01	-	-	01
9. Milk vendor	01	-	01	-	-	-	01	01
10. Grocer	-	01	01	-	-	-	01	01
Total	**43**	**07**	**50**	**12**	**24**	**10**	**04**	**50**

Details of Users Groups Formed in Bada Khera watershed

	User Group	Caste				Total
		General	OBC	SC	ST	
1	Bunding & leveling	3	1	11	9	24
2	Masonry structures	2	1	3	4	10
3	Gabion & loose boulder structures	3	1	5	7	16
4	Water resource development	2	1	3	4	10
5	Horticulture development	2	-	-	3	5
6	Crop development	1	-	-	5	6
	Total	**13**	**4**	**22**	**32**	**71**

All the members of Users Groups were male and head of the families.

Watershed Committee Constituted in Bada Khera Watershed

S. No.	Position	Name	Caste	Mode of appointment
1	Chairman	Dharam Raj Singh	General	Nominated by WA
2	Secretary	Purushottam Gupta	General	Salaried employee
3	Departmental	Rajive K. Singh	General	Nominated by PIA
4	Member	Parvati Bai	SC	
5	Member	Ram Narain	OBC	
6	Member	Mohan Lal	SC	
7	Member	Nar Singh Lal	SC	
8	Member	Ram Chandra Meena	ST	
9	Member	Hira Lal	SC	
10	Member	Mathura Lal	OBC	

Composition of Watershed Committee

Watershed	Representatives of				Total Members
	Panchayat	Women	Landless/SC/ ST/OBC	General	
Badakhera	0	1 (SC)	6	3	10

Developmental Activities Undertaken in Bada Khera Watershed

Arable Land

- Land leveling (68.1 ha)
- Contour and graded bunds (22.2 ha)
- Crop improvement (17.6 ha)

Leveling and bunding were most preferred by the farmers

Gabions spillways on smaller fields (1- 5 ha) and masonry drop spillways on large size fields (> 5 ha) were provided for safe disposal of excess rain water.

Crop demonstrations (138) were laid for improved package of practices for maize, sorghum + pigeon pea intercropping, soybean etc. (right).

Bumper crop production through increased in-situ water conservation quickly recovered cost of leveling and bunding

Developmental Activities Undertaken in Bada Khera Watershed

Arable / Non-arable Land

- Gully control structures / plugs (131.6 ha)
- Check dams / spillways for gully stabilization (381.9 ha)

The upstream channel of check dams silted up to crest height until the nala bed became cultivable.

Loose boulder check dams were constructed in shallow and small gullies for their reclamation.

Gabion or masonry check dams were constructed in medium to deep gullies to stabilize the drainage line and reclaim the gullied lands.

Developmental Activities Undertaken in Bada Khera Watershed

Arable/Non-arable land

- Water harvesting structures (benefiting 21.65 ha)
- Horticulture development (1.3 ha)

Non-Arable land

- Afforestation (35.5 ha)

The village pond was the only source of water for animals during severe drought condition (above).

One dug type farm pond of 0.6 ha-m capacity (top) and one village pond with 1.6 ha-m capacity (below) were constructed.

Impact of Different Interventions in Bada Khera Watershed

Land Improvement of Different Land Uses

Land Uses	Area (ha)	Bench mark slope class (%)	Land Leveling Index (LLI)	
			Pre-project	Post- project
Cultivable land	268	< 5	0.20-0.33	0.67-0.80
	110	5-10	0.22-0.36	0.50-0.62
Non-cultivable land	200	>10	0.25-0.30	0.43-0.46

- **Average LLI of the watershed before project = 0.28; after project = 0.62**
- **Check dams (36, catchment area 506.6 ha) reclaimed 9.12 ha (severely gullied) and 24.6 ha (moderately degraded) land.**

Water Resource Development

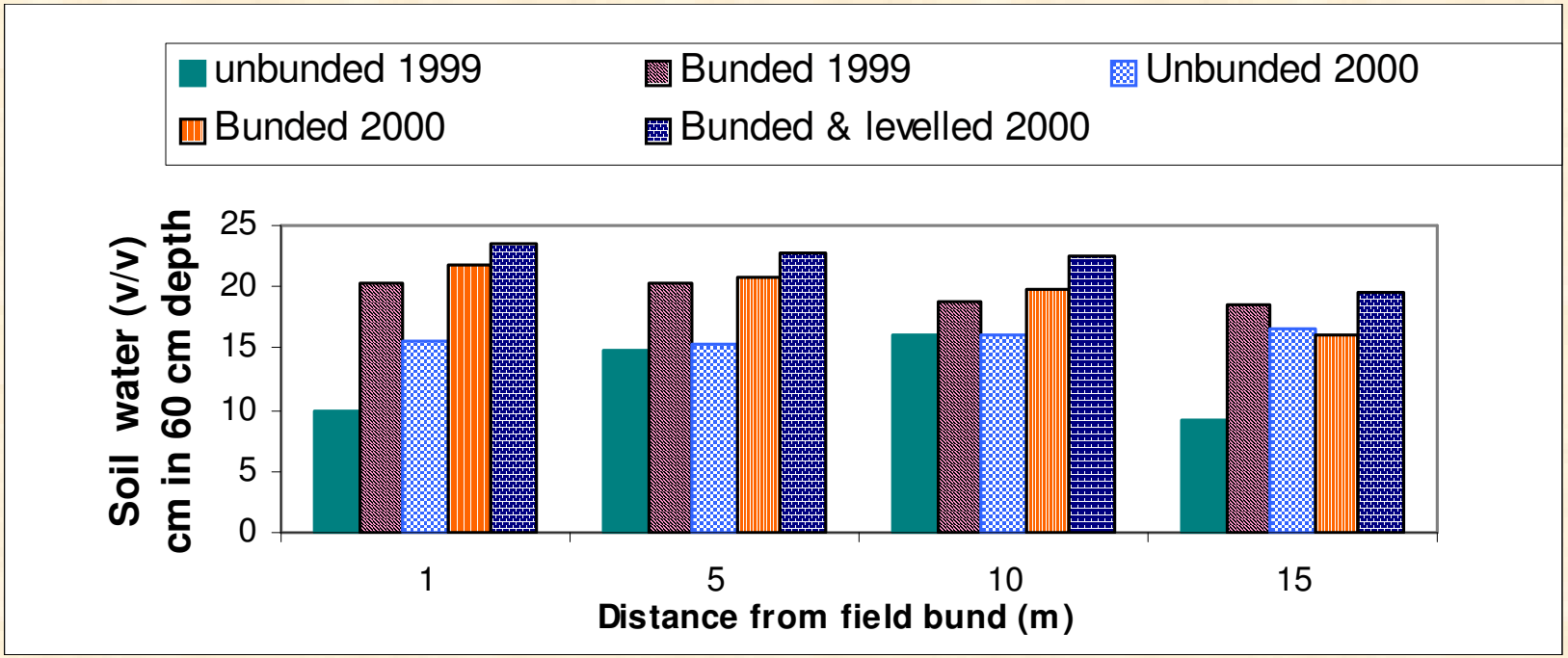
Water storage capacity created (ha-m)	Wells influenced (%)	Increase in well recharge rate (%)	Irrigated area increase (%)
2.56	**20**	**6**	**65**

- During the summer months of year 2001 when entire region faced acute water shortage due to third consecutive drought year, the village pond maintained minimum water level up to 50% of its storage capacity.
- During this period the entire livestock and wild life population in this area solely depended on this pond as other water sources including a perennial Mej river dried up.

Runoff and Soil loss

Watershed	Surface Runoff (%)		Soil Loss (t ha^{-1} yr^{-1})	
	Before Project	After Project	Before Project	After Project
Bada Khera	30.0	10.0	40.0	10.0

Effect of Land Treatments on Soil Moisture



- In 15 m vicinity of the bunds about 56% and 22% higher soil moisture was present in the fields during the year 1999 and 2000 correspondingly compared to unbunded fields.
- Leveling + bunding treatments further improved *in-situ* moisture conservation by 17% over bunding alone treatment.
- Increased water availability during post monsoon period played a critical role in boosting crop yields.

Crop Diversification, Crop Productivity and Cultivated Land Utilization

Watershed	Crop Diversification Index (CDI)		Cultivated Land Utilization Index (CLUI)		Crop Productivity Index (CPI)	
	Before Project	After Project	Before Project	After Project	Before Project	After Project
Badakhera	0.79	0.54	0.26	0.27	0.83	0.99

Various conservation and crop improvement measures undertaken showed positive results:

- **Overall CPI increased by 19% in the watershed.**
  - **Kharif: from pre-project 0.83 to post project 0.85**
  - **Rabi: from pre-project 0.82 to post project 1.11**

- **Overall CLUI increased marginally from 0.26 to 0.27 against the potential of 0.33.**

- **The overall CDI decreased, as in the pre-project period the farming community in the watershed was cultivating a number of crops for biological insurance against low and highly erratic rainfall pattern under rainfed conditions.**
- **Wheat cultivation is now limited to irrigated fields only and in rainfed area mustard and chickpea have completely replaced wheat.**
- **The CDI showed improvement after the project in irrigated areas as farmers preferred to also raise high value cash crops like soybean, mustard, coriander etc. along with traditional irrigated crops.**

- **Overall crop production in terms of sorghum grain equivalent production increased by 44% from 3212 q (during pre-project) to 4615 q (during post-project).**

Socio-Economic Indicators

People's Participation Index (%)

Watershed	Planning	Implementation	Overall
Bada Khera	**64**	**38**	**51**

Farmers' Contribution to Various Developmental Activities

S. No.	Activities	Project Contribution (%)	Villagers' contribution (%)
	Entry Point Activities		
1.	Construction of community hall in the premises of village temple.	100	0
2.	Construction of a gabion for protecting village road.	80	20
3.	Renovation of a culvert on the village road.	60	40
4.	Leveling and plantation around temple.	40	60
5.	Renovation of old village pond.	20	80
	Other Developmental Activities		
6.	Bunding and leveling	90-92	8-10
7.	Check dams and spillways	92-95	5-8
8.	Vegetative measures	40	60
9.	Water harvesting structures	100	0
10.	Improved package for cropping system.	40	60
11.	Agri-horti systems	20	80
12.	Plantation of fuel and fodder species	40	60

Total amount deposited in the Watershed Development Fund = Rs 1,78,207

Impact of SHGs Activities on Income Generation

Name of SHG	No. of members	Av. employment generated (man days/ member)	Additional annual Income / member		Credit performance	
			% increase	Rs / annum	Seed money	Recovery (%)
1. Mason	12	64	40	3200	6456	----
2. Barber	6	42	42	2081	2556	----
3. Blacksmith	3	31	20	1517	2202	----
4. Carpenter	8	39	33	1953	10064	----
5. Washer man	1	23	39	1170	348	----
6. Tailor	15	15	52	773	5340	----
7. Embroider	2	14	52	675	2000	100
8. Vegetable vendor	1	13	130	650	1000	100
9. Milk vendor	1	12	41	575	1000	100
10. Grocer	1	13	57	625	1000	100

Employment Generation

- About 10,167 man-days (15 man-days/ha) of employment created under different activities.
- Maximum employment was recorded in the construction of check dams (72%) .

Impact of Project on Income

Category of stakeholders	Total annual income (Rs/family)		Change (%)
	Pre-project	Post- project	
Landless	13000	16947	30
Marginal	20376	26025	28
Small	24436	33534	37
Medium	32646	50637	55
Large	59007	95319	62
Overall	25811	37089	44

Economic Viability (Benefit-Cost Ratio)

Watershed	Arable land	Non-arable land	Overall
Bada Khera	1.80 (20,10)	1.44 (20,10)	1.54 (20,10)

Figures in parentheses are project life and discount rate, respectively

Salaiyur Watershed

Period of Execution : 1997 – 2003

Cost : Rs 20.24 lakh

Land Capability Map of Salaiyur Watershed

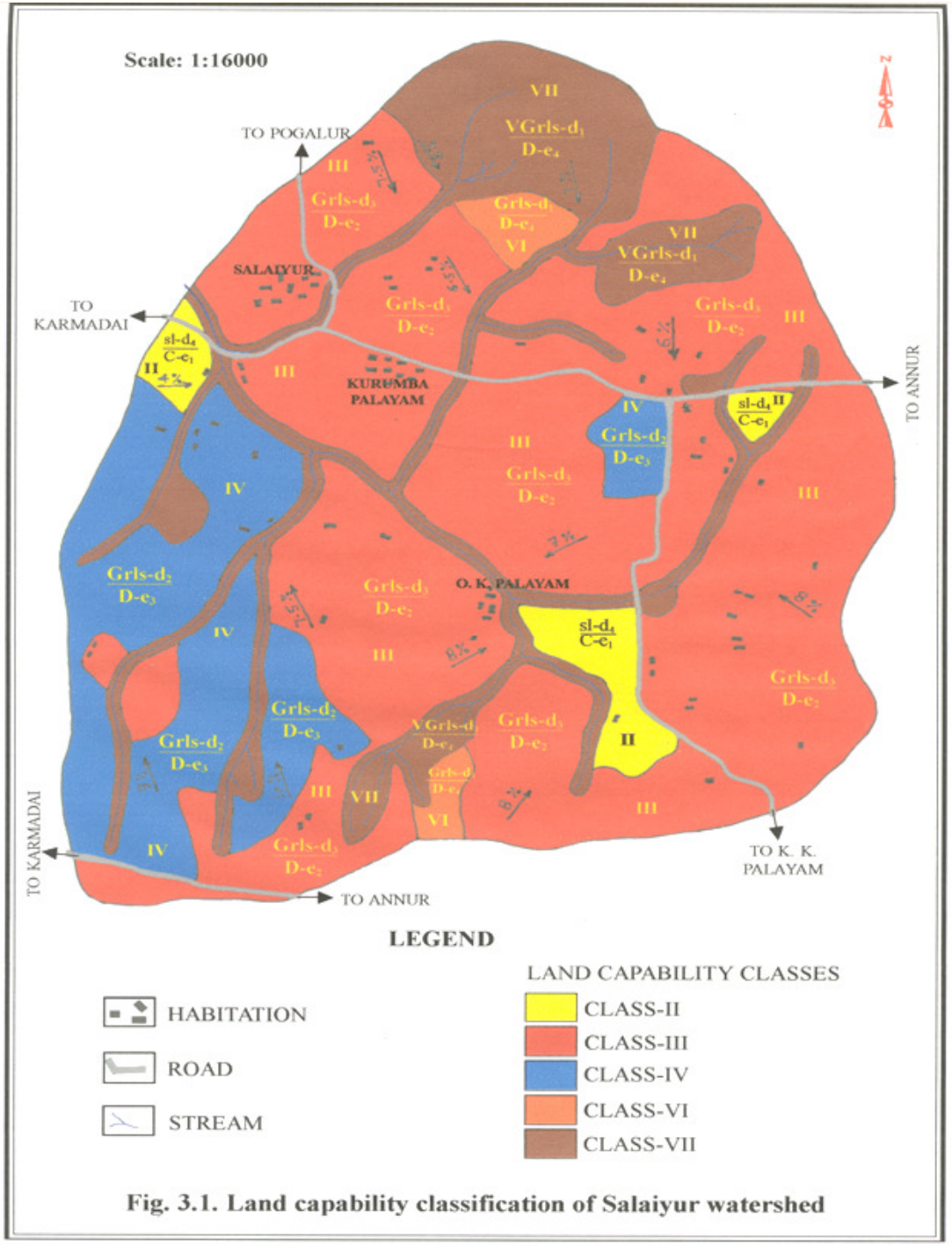


Fig. 3.1. Land capability classification of Salaiyur watershed

Area and Characteristic Feature of each LCC in Salaiyur Watershed

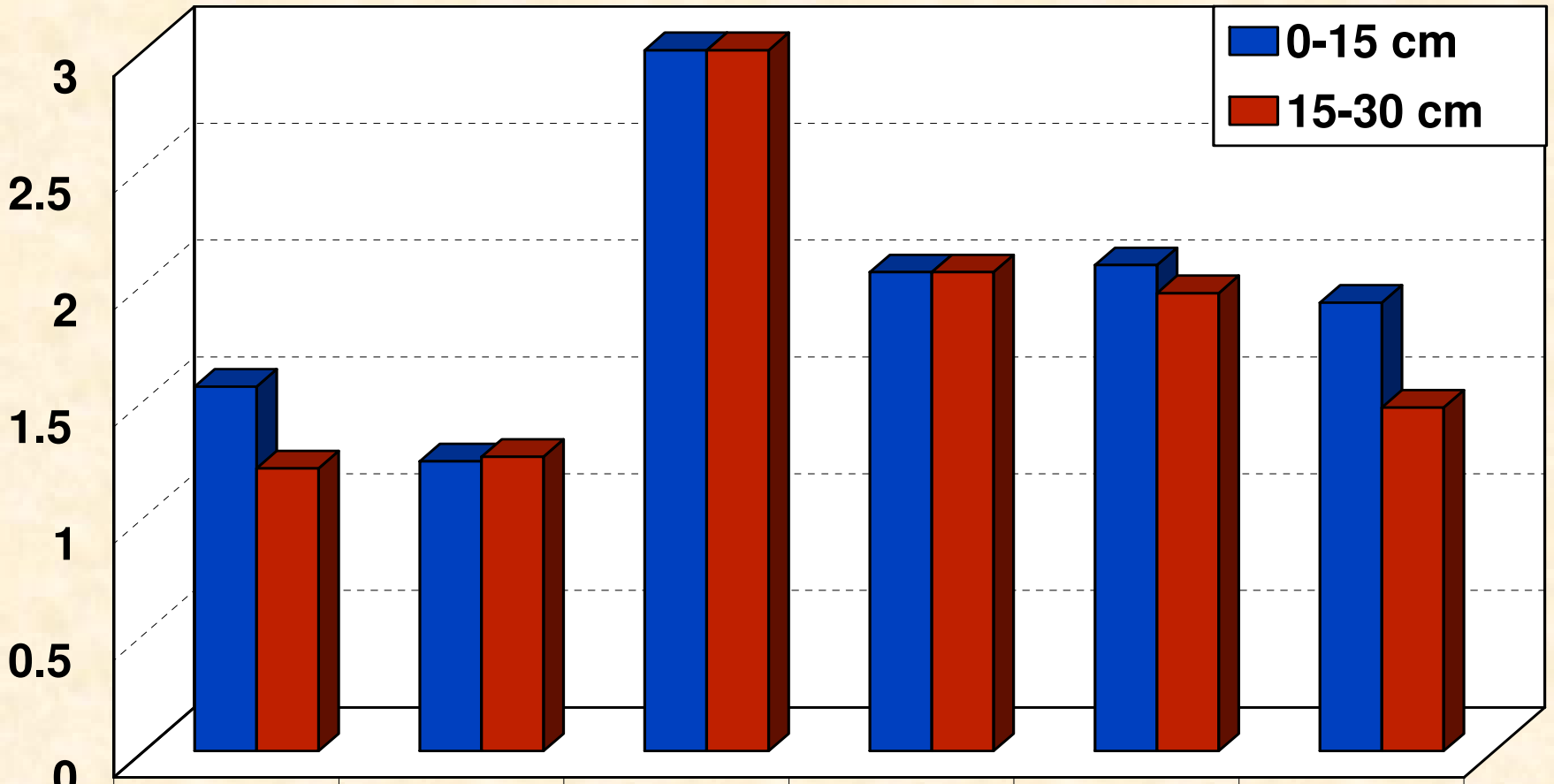
S. No.	Particulars	Land Capability Class				
		IIe	IIIe	IVe	VIe	VIIe
1	Area (ha)	31.2	325.7	69.6	13.1	73.4
2	% of total area	6.1	63.4	13.6	2.6	14.3
3	Soil depth	Moderately deep to very deep	Shallow to medium	Shallow	Very shallow	Very shallow
4	Slope (%)	3-5	5-10	5-10	5-10	5-10
5	Drainage	Good	Poor to moderate	Good surface drainage, poor in sub-surface due to hard pan at places		
6	Bench mark land use & crops	Irrigated through open dug wells & air compressor pumps fitted to bore wells. Crops: sugarcane, banana, coconut, cassava & vegetables	Irrigated and dry land agriculture Irrigated crops: sugarcane, banana, coconut, cassava & vegetables Dry land agricultural crops: Fodder sorghum, pulses & oil seeds, cotton, ragi and maize.	Dry land agricultural crops: Fodder sorghum, pulses & oil seeds.		Common lands, streams and water bodies
7	Major problems	Moderate erosion. Poor water holding capacity	Moderate erosion. Poor water holding capacity. Poor soil fertility and low crop yields	Severe erosion. Poor water holding capacity. Poor soil fertility and low crop yields		Severe erosion, over grazing, poor vegetation cover with few uneconomical bushes
8	Scope	Improving Water Use Efficiency through water management, growing short duration crops with less water requirement.	Improve Water Use Efficiency through water management, growing short duration crops with less water requirement. Improving soil fertility & following in-situ moisture conservation practices.	Improving soil fertility & in-situ moisture conservation practices. Alternate land use systems		Afforestation, stream bank protection.

Area under different crops with average yield under agriculture land use in the watershed during pre-project

Crops	Area (ha)	Per cent of total	Average yield (kg/ha)
Dry land			
Fodder sorghum	250.5	48.80	18,500
Ragi	1.9	-	850
Maize	1.0	-	1,080
Horse gram	35.1	6.84	320
Cowpea	8.0	1.56	530
Red gram	4.5	-	760
Green gram	4.2	-	540
Sesamum	15.2	2.96	290
Groundnut	16.6	3.24	670
Cotton	3.5	-	630
Sub total (A)	340.50	66.37	
Irrigated			
Sugarcane	33.0	6.43	75,000
Banana	12.0	2.34	25,000
Vegetables	12.3	2.40	-
Cassava	5.0	-	-
Turmeric	0.5	-	-
Paddy	1.8	-	-
Flower	1.0	-	-
Sub total (B)	65.6	12.79	
Total agriculture (A+B)	406.1	79.16	
Current fallow (C)	29.6	5.77	
Total area (A+B+C)	513.0	100.00	

Problems & Needs of Salaiyur Watershed

- Lack of water resources, both for domestic and agricultural needs was the major problem due to less rains. More attention needed to be given for supplementing ground water recharge.
- Most of the red soils in the watershed are gravelly, light and are prone to erosion. Since soil depth is shallow, land leveling was not advisable.
- Soils of the watershed have low water holding capacity and low nutrient status.
- There is no forest as such in the watershed. There are open pastures or vegetation on rocky and degraded wastelands.
- Landless labourers form a significant part of population and need employment or other income generation activities.



	OC	N	EC	pH	P	K
0-15 cm	1.56	1.24	3	2.05	2.08	1.92
15-30 cm	1.21	1.26	3	2.05	1.96	1.47

NI ratings: Low (1.5); Medium (1.5-2.5); High (>2.5)

Fertility Indices of Salaiyur Watershed

Rainfall Analysis of Annur Block (1957 to 1988)

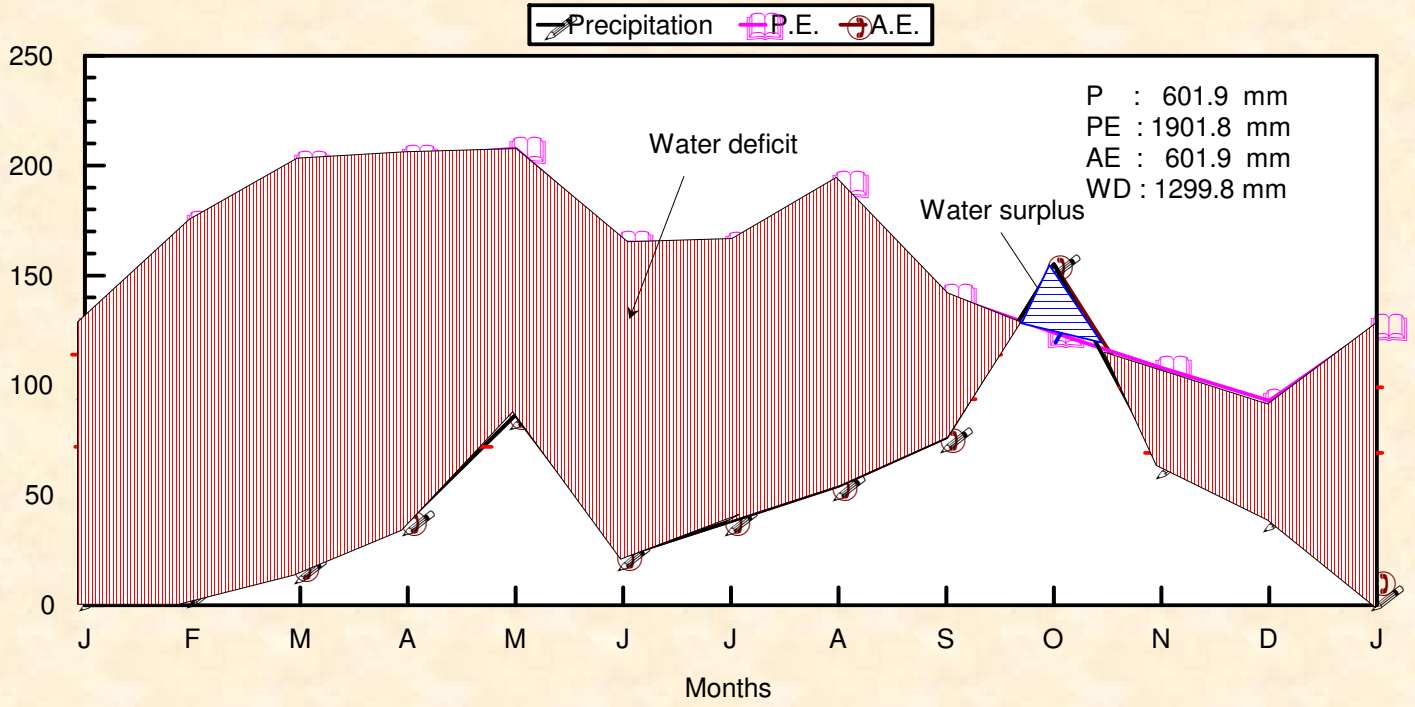
Season	Mean rainfall (mm)	S.D. (mm)	C.V.
Winter	9.73	17.58	180.55
Summer	141.53	64.75	43.75
S.W. monsoon	191.44	91.10	47.58
N.E. monsoon	259.28	156.39	60.31
Annual	601.98	243.73	40.40

Water Resources

- Deviations of annual rainfall data of 32 years (1957-1989) from the normal rainfall indicate that out of 32 years, 16 years had normal or higher rainfall while rest of the years had drought of varying intensity. This suggests that once in every two years, a drought of mild to severe intensity may be expected.
- During the above period of record, mild drought was experienced 22% of the period followed by severe drought (15%) and moderate drought (13%).

Water Balance Diagram for Salaiyur Watershed

P - Precipitation
PE- Potential Evaopatranspiration
AE- Actual Evapotranspiration
WD- Water Deficit



Depth wise distribution of open wells

Depth (m)	Frequency (Nos.)
Upto 20	35
20 to 30	73
>30	6
Total	114

Average size of the well 5m X 5m

Deep bore wells 68 No.
(100-180 m depth)

Surface water impoundments

Percolation tanks 2 No.

Check dams 3 No.

Problems Related to NRM in Salaiyur Watershed

Degraded land

Unlined water storage pond

Damaged check dam

Silted up farm pond

Entry Point Activities (EPA)

- Two ceiling fans & steel benches to Primary School
- Burial ground land developed

Community hall constructed

10 iron ploughs

One hand pump

Participatory Rural Appraisal (PRA)

- Social / resource mapping
- Seasonality analysis
- Transect walk
- Matrix ranking
- Problem tree analysis
- Historical time line

Self Help Groups (SHGs) Formed in Salaiyur Watershed

Name of SHG	No. of groups	Total members	Initial grant (Rs.)
SHGs Formed from Seed Money			
1.Coir rope making	1	5	4800
2.Petty shop	2	2	2000
3.Coconut frond weaving	2	12	4000
4.Tailoring	2	12	5718
5.Fibre extraction from agave	1	10	23900
6.Power sprayer	1	1	3923
Sub total	9	42	44341
SHGs Formed from Revolving Fund			
1.Sheep rearing	1	1	1000
2.Vegetable selling	1	1	1000
3.Coconut selling	1	1	1000
4.Cattle feed selling	1	1	2000
5.Plastic wire bag knitting	3	3	816
6.Tailoring	1	6	2890
7.Thrift society	1	10	1000
8.Hand sprayer	1	1	880
9.Thrift society	2	20	10000
10.Thrift society	2	23	11500
11.Coconut frond weaving	2	12	3500
12.Vegetable selling	1	1	1000
13.Iron box	1	1	1000
14.Overlock machine	1	1	2500
Sub total	19	82	40086
Total	28	124	84427

User Groups Formed for Different Works/Activities

Activity	Year of start	No. of UGs	Male	Female	Total members
Construction of check dams and percolation ponds	1998	1	10	1	11
Desilting and deepening of percolation ponds	1998	1	8	-	8
Agroforestry	1998	1	8	2	10
Total		**3**	**26**	**3**	**29**

These groups were involved in following activities:

- Calling of quotations and rates
- Supervision of works/quality
- Measurements for payment
- Passing for payment (jointly WC and WDT)
- Payment (jointly WC and WDT)
- Distribution of planting material

Watershed Committee Members

Watershed	Representatives of				Total Members
	Panchayat	Women	Landless/SC /ST/OBC	Others	
Salaiyur	2 (2 OBC men)	3 (OBC)	7	1	13

Community Capacity Building in Salaiyur watershed

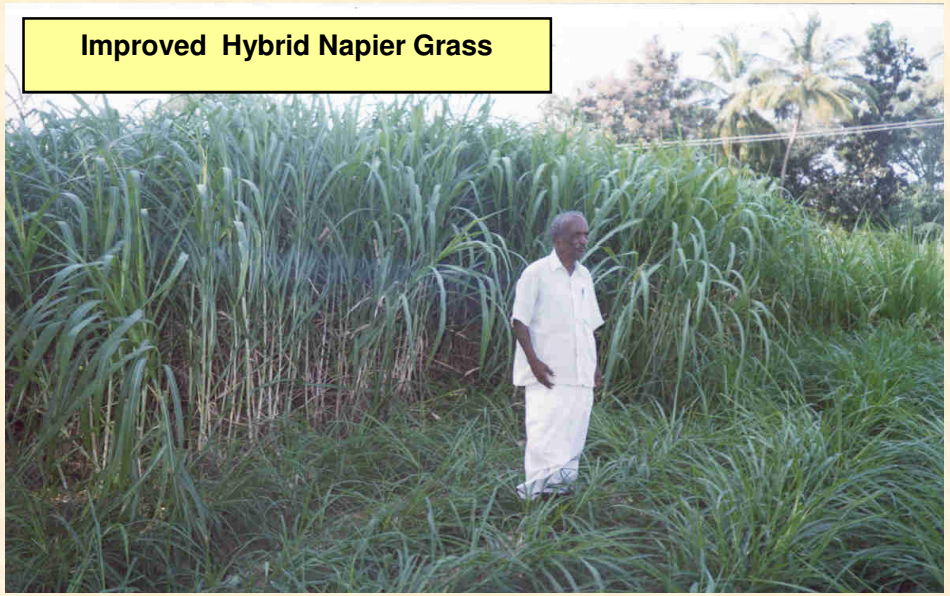
Name of training	No. of participants		Total	Follow up (%)
	Male	Female		
Training for nursery raising techniques for UGs.	7	0	7	12
Awareness camp for women on health and hygiene and income generation	0	41	41	10
Farmers training for plantation techniques	53	0	53	70
Training for Watershed Committee members to maintain accounts and receipts etc.	4	2	6	95
Training for UGs to involve in supervision of watershed works	33	0	33	75
Training for SHGs on concept of thrift society, realization of loans from society and bank and to carry out income generating activities etc.	8	49	57	85
Veterinary camp to create awareness about livestock care	62	25	87	45
Total	167	117	284	

Developmental Activities Undertaken in Salaiyur Watershed

Arable Land

- Field bunding (5000 r m, 30 ha)
- Fodder production improvement
- Crop improvement
- Drip irrigation (6.36 ha)

***Ragi* + pulses intercropping system in demonstration plot.**



Fodder production

Drip irrigation

Coconut

Name of crops	Number of fields	Total area (ha)
Coconut	3	1.28
Banana	3	0.88
Sugarcane	2	0.80
Mango	3	1.00
Tamarind	1	0.40
Mulberry	5	2.00
Total	17	6.36

Developmental Activities Undertaken in Salaiyur Watershed

Non-arable Land

- Vegetative barriers (3213 r m)
- Sericulture

Developmental Activities Undertaken in Salaiyur Watershed

Arable / Non-arable Land

- Rejuvenation / construction of percolation ponds (14)
- Check dams (6)
- HDPE lining of 3 ponds
- Horticulture/ agri-horti plantation (31.88 ha)
- Agroforestry & afforestation (8.5 ha)

Rejuvenated percolation pond

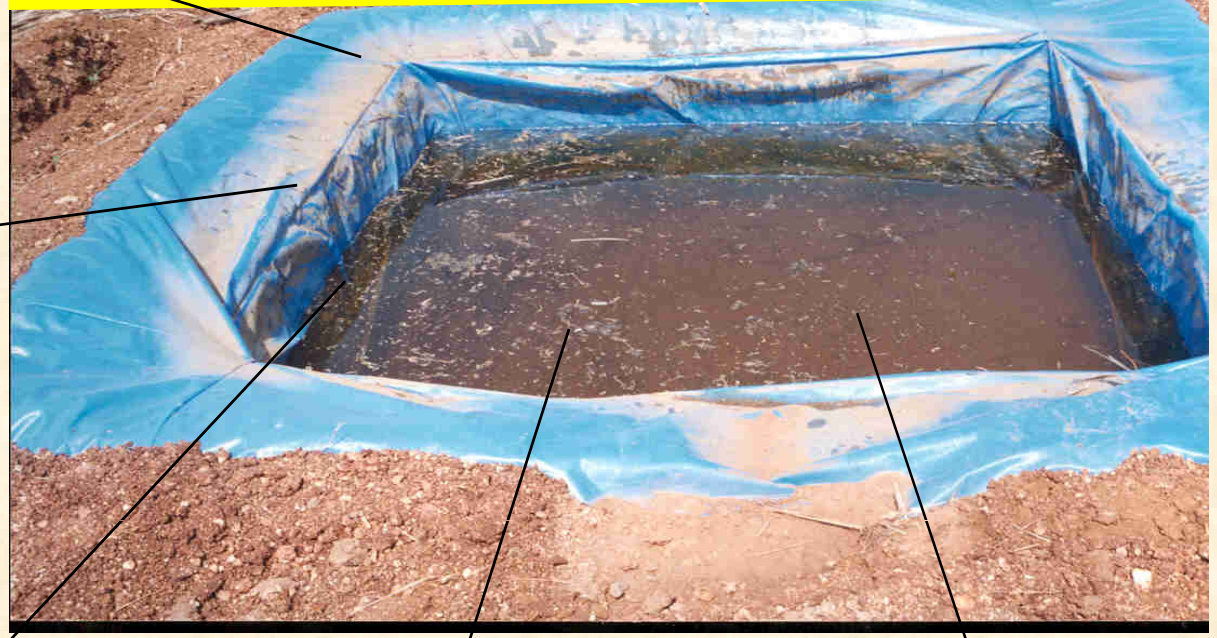
New percolation pond

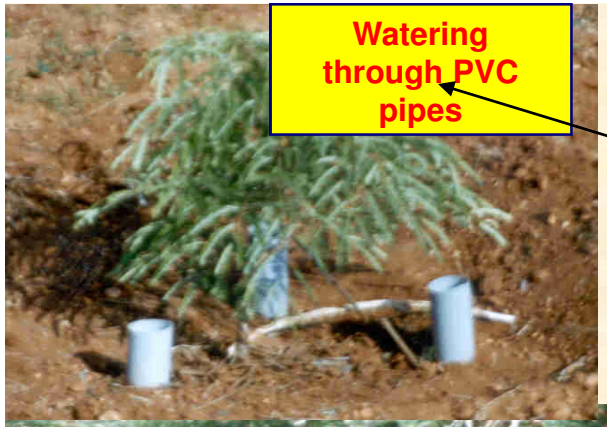
Water Harvesting Structures in Salaiyur Watershed

S. No.	Name of Pond	Total (cum)
1	Ramasamy Pond	1325
2	State Govt Pond	2330
3	Thalai kuttai	3744
4	Thoppu kuttai	2660
5	Check dam –I	216
6	Check dam –II	306
7	Check dam –III	822
8	State Govt Pond near temple and main road	1950
9	Manian Pond	480
10	Sivakumar Pond	440
11	Thirumoorthy Pond	450
12	Chinnan Pond	680
13	Arumugam Pond	4100
14	Mango Subramani Pond	650
15	Oor Gownder Pond	520
16	Palanisamy Pond	1377
17	Gurusamy Pond	130
18	Subbanna Gr. Pond	340
19	Burial Ground Pond	580
20	Pond Near Chairman's house	3500
	Total (cum)	**26600**

Pond Lining

Water storage pit lining





Watering through PVC pipes

Pitcher Irrigation

Watering through waste oil cane

Watering through Bamboo poles

Watering through waste water bottles

Horticulture Planting Material Distributed

Farmer transporting seedling after paying contribution

Seedlings		Total
Tamarind		3125
Sapota		360
Guava		135
Coconut		950
Mango		3300
Pomegranate		35
Amla		100
Total		8005

Agro-forestry and Afforestation

- Under afforestation works, species like *Ailanthus excelsa, Albizia lebbeck* and *Acacia leucophloea* were planted in common land as a mixed plantation.
- In private agricultural lands these species were also planted under agroforestry system.
- Apart from these species, teak (3900 numbers) was also planted on field bunds in private lands where irrigation facilities exist.
- On community land, an area of 8.5 ha was afforested with the above forest species.

Ailanthus excelsa on field boundary of a plot cultivated with vegetable cowpea & fodder sorghum in agroforestry system

Impact of Different Interventions in Salaiyur Watershed

Water Resource Development

Water storage capacity created (ha-m)	Wells influenced (%)	Increase in well recharge rate (%)	Irrigated area increase (%)
2.66	46	10-15	84

- In addition to the fixed storage capacity of 2.66 ha-m, this storage capacity was repeatedly available for different fillings once the already stored water was percolated. A maximum amount of 3.86 ha-m runoff water was harvested and stored during the year 2001, due to more runoff producing rainfall events, resulting in three times filling of ponds.
- Water table rose in the range of 0.5 to 1.0m in the influence zone of percolation ponds (300-500m). A total of 53 wells (i.e. 46%) found to be partly or fully influenced.
- Duration of water availability in wells increased from 3-6 months before watershed interventions to 9-12 months (38 to 45%) after watershed interventions.
- Before watershed programme, the wells used to go dry after pumping for 0.5 to 1.5 hours and get recuperated in 38-48 hours. While after implementation, pumping can be done for 1 to 2.5 hours before well goes dry and it takes 24-36 hours to recuperate.

Runoff and Soil loss

Watershed	Surface Runoff (%)		Soil Loss (t ha^{-1} yr^{-1})	
	Before Project	After Project	Before Project	After Project
Salaiyur	4.5 – 7.2	1.3	1.7 – 8.9	0.5 – 1.6

Effect of Measures for Containing Seepage and Efficient Irrigation

(i) **HDPE lining of small ponds:** Lining of small ponds (21m X 12m) with 500 gauge HDPE sheet was found to effect water saving of 33% over no lining.

(ii) **Drip irrigation:** Earlier one farmer in the watershed used to cultivate only 0.2 ha of banana by surface method of irrigation but with drip 0.4 ha of banana could now be cultivated. Water saving of 29% was observed due to drip apart from other benefits such as obtaining additional yield, early and uniform crop maturity.

Sugarcane yield increased by 5.38% under drip irrigation when compared with surface irrigation. Water saving of 28.9% was observed due to drip apart from other benefits such as labour saving (103 mandays/ha) and increased water use efficiency.

Benefits from Field Bunding

- Farmers taken up green gram after bunding due to good pre-monsoon rain received during the year. The additional grain yield of 70 to 120 kg/ha was obtained due to better in situ moisture conservation.
- An additional returns of Rs.1400-2400/ha was obtained due to field bunding.

Productivity Indicators

S. No.	Indicator	Pre-project	Post project
1	**Crop Diversification Index**		
	a. Rainfed	0.47	0.71
	b. Irrigated	0.59	0.76
2	**Cultivated Land Utilization Index**		
	a. Rainfed	0.33	0.46
	b. Irrigated	0.84	0.88
3	**Crop Productivity Index**	0.55	0.61
4	**Crop Fertilization Index**	0.69	0.75
5	**Induced Watershed Eco-Index**	-	0.14

- Crop Diversification Index increased due to watershed programme from 0.469 to 0.707 (51%) under rainfed condition and from 0.59 to 0.762 (28%) under irrigated condition.
- CLUI increased by 0.13 in dry land and by 0.04 in irrigated condition as a result of large scale introduction of horticultural plantation in dry land and increased area under irrigation.
- The overall crop productivity index increased by 12 per cent due to introduction of improved agro-technologies.
- The fertilizer application index registered an increase of 8 per cent indicating improvement in rate of fertilizer application in the watershed area.
- The impact of the project on environment/ecology was gauged through the eco-index which worked out to be 0.14, indicating that 14 per cent additional area has been brought under greenery in the project area.

Socio-Economic Indicators

People's Participation Index (%)

Watershed	Planning	Implementation	Maintenance	Overall
Salaiyur	**75**	**63**	**54**	**62**

Farmers' Contribution to Various Developmental Activities

Works and activities	Contribution (%)	
	Cash	Kind
Plantation works	15	40
HDPE lining of water storage pond	10	-
Agave plantation in private land	25	-
Desilting works in private land	10	-
Land leveling	10	-
Drip irrigation	19	-
Percolation pond in private land	10-15	-

Total amount deposited in the Watershed Development Fund = Rs 44,256

Performance of Self Help Groups

Self Help Group Activities	No. of SHGs	Total Members			Performance of SHGs
		Male	Female	Total	
Coir twisting machine	1	2	3	5	Discontinued
Petty shop	2	2	0	2	Fair
Coconut frond weaving	4	6	18	24	Very good
Tailoring	3	0	18	18	Good
Fibre slicer machine	1	10	0	10	Discontinued
Power sprayer	1	1	0	1	Good
Sheep rearing	1	1	0	1	Fair
Selling coconut	1	1	0	1	Discontinued
Selling cattle feeds	1	1	0	1	Discontinued
Knitting plastic bags	3	0	3	3	Very good
Thrift society	5	0	53	53	Very good
Over lock machine	1	1	0	1	Very good
Selling vegetables	2	0	2	2	Fair
Iron box	1	1	0	1	Good
Hand sprayer	1	1	0	1	Very good
Total	28	27	97	124	

Impact of SHGs Activities on Income Generation

Name of SHGs	No. of SHGs	Av. annual employment generated (mandays / member)	Av. additional annual income (Rs./member/ year)	Credit performance	
				Seed money (Rs.)	Recovery %
1. Petty shop	2	60	1200	2000	70
2. Coconut frond weaving	4	15	1500	7500	83
3. Tailoring	3	15	500	8578	82
4 . Power sprayer	1	22	10440	3923	93
5. Sheep rearing	1	2	1500	1000	65
6 . Selling vegetable	2	12	1500	2000	90
7 . Knitting plastic bags	3	2	160	816	100
8. Thrift society	5	7	276	22500	80
9. Over lock machine	1	90	6000	2500	100
10 . Iron box	1	50	2400	1000	20
11 . Hand sprayer	1	30	2450	880	100

Employment Generation

- About 10,105 man-days of employment generated under different activities.
- Maximum employment was recorded in the construction of conservation SWC works (46%) and dryland horticulture & agroforestry (48%).

Impact of Project on Income

Category of stakeholders	Total annual income (Rs/family)		Change (%)
	Pre-project	Post-project	
Landless	14350	22888	59
Marginal	16560	23433	42
Small	19455	28588	47
Medium	25950	31036	20
Large	40650	69925	72
Overall	19836	28759	45

Economic Viability (Benefit-Cost Ratio)

Watershed	Arable land	Non-arable land	Overall
Salaiyur	1.13 (20,10)	9.78 (20,10)	1.14 (20,10)

Figures in parentheses are project life and discount rate, respectively

HIGHLIGHTS

- Bada Khera and Salaiyur watersheds with a total area of 682.5 and 513 ha, respectively are located in semiarid region, which receives less than 800 mm of annual rainfall.
- The watersheds have 55 to 79% area under cultivation out of which about 340 ha (50-66%) is under rainfed agriculture. Majority of farmers fall in the category of small and marginal farmers.
- Predominant crops cultivated in the watersheds have low productivity due to poor soil fertility and moisture stress.
- Open, deep bore or tube wells are the only source of irrigation and depth to ground water table varies from 50-180 m in the watersheds as a result of deficient recharge and increased dependence on groundwater for agriculture.
- Both watersheds have some wasteland area ranging from 18-44%.
- Under EPA, community halls were constructed in both the watersheds, in addition to other activities.
- As a part of the community organization activities, local level people's institution Watershed Committee (WC) were formed at watershed level .

Contd……

- A large number of SHGs were formed ranging from 10 to 28 with members from the resource poor community in the watersheds for livelihood support activities. Only four SHGs discontinued but the others provided additional income of their members.
- Capacity building through exposure visits, skill development trainings and awareness camps have been conducted for the stake holders in the watersheds.
- In Bada Khera, owing to deep soil, leveling with bunding was taken up. In Salaiyur only field bunding was taken up due to shallow depth of the soil. Crop improvement was taken up in both watersheds. In Salaiyur, drip irrigation and fodder production were also taken up.
- To harvest the surplus rain water lost as surface runoff, water harvesting structures , mainly ponds were created by construction or rejuvenation in both watersheds. These structures reduced runoff from the watersheds, recharged the groundwater in their influence zones and increased the irrigated area.
- Check dams were constructed in both the watersheds to check gully formation. These structures also helped in reducing runoff and soil loss from the watersheds in addition to groundwater recharge.

Contd……

- **In Salaiyur, to facilitate surface water storage in soils having poor water holding capacity, HDPE lining of ponds was done. This helped in saving water by 33%, which was otherwise lost through seepage.**
- **Crop improvement to benefit from the soil and water conservation interventions and increase crop productivity/production was under taken in both the watersheds. This increased crop productivity in both the watersheds.**
- **Community organization component through formation and development of WAs, WC, UGs and SHGs has been a major strength of the projects by way of establishing people's institutions and developing them as cohesive unit to take up development works in the watershed.**
- **The projects had tremendous impact on the income of the stakeholders which increased by about 44% in both watersheds.**
- **More than 10,000 man-days of employment was created in the watersheds due to the project. Regular employment was created due to income generating activities for the landless and new crop production technologies introduced for farmers in the watersheds.**
- **Both the watershed development projects were observed to be economically viable due to > 1 benefit cost ratio.**

Details of Other Watersheds Developed by CSWCRTI under IWDP

Water-shed	Agro-ecological zone	Area (ha)	Elevation range (m) a.m.s.l.	Major occupation (%)		Average land-holding size (ha)	Average annual income (Rs./ family)
				Agricul-ture	Landless		
Aganpur-Bhagwasi, Patiala (Punjab)	9	550	80-286	37	33	1.72	30,526
Antisar, Kehda (Gujarat)	5	812	25-35	88	12	3.12	16,247
Bajni, Datia (M.P)	4	532	263-284	52	48	1.10	18,597
Kokriguda, Koraput (Orissa)	12	317.5	880-1329	93	7	2.15	12,155

Other Projects of Ministry of Rural Development Being Executed By CSWCRTI

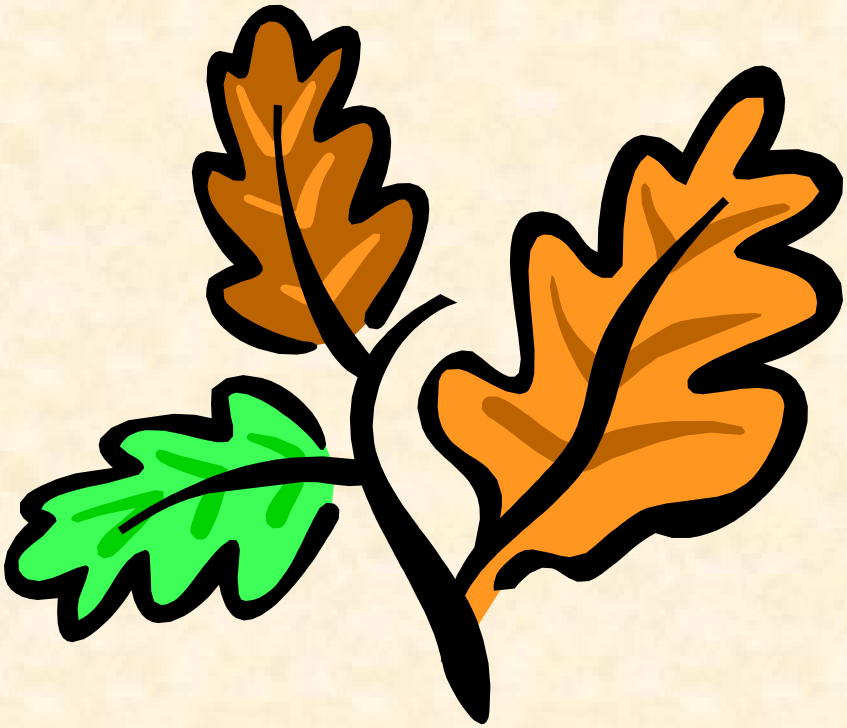
S. No.	MoRD Project	Duration
1.	Participatory dissemination and assessment of land and water management technologies for livelihood security in rainfed areas of north-western Himalayas	2007 to 2010
2.	Resource conservation and management in Netrahalli watershed, Chitradurga distt., Karnataka	2008 to 2011

Watersheds Selected for Development under NWDPRA, Ministry of Agriculture (GoI)

Watershed (State)	Agro-ecological zone	Average slope (%)	Annual rainfall (mm)	Watershed area (ha)	Agriculture area (%)	Population (No.)
Ashti (Uttarakhand)	14	67	1600	473	33	901
Kajiana (Punjab)	9	7	1220	509	29	867
Ayalur (Tamil Nadu)	8	1-7	600	782	90	2710
Lachhaputra Ghati (Orissa)	12	35	1500	601	29	992
Jalalpur (Uttar Pradesh)	4	3	725	698	72	1845
Vejalpur-Rampura (Gujarat)	13	1-5	795	775	76	449
Dhoti (Rajasthan)	5	5	874	677	84	1500
Jigna (Madhya Pradesh)	4	6	840	620	59	3031
Ramasagara (Karnataka)	3	2-25	417	480	74	1019

Farmers Participatory Action Research Programme (FPARP)
Ministry of Water Resources (GoI)

- FPARP funded by Ministry of Water Resources, Govt. of India was implemented at 100 locations (96 villages, 18 districts, 11 states 7 agro-ecological regions) with the objective to increase yield and income per drop of water.
- Under the programme a total of 50 technologies were demonstrated in farmer's fields.
- Depending upon the technology demonstrated, crop production increased in the range of 10 to 116% and water use efficiency (WUE) by 13 to 110%.
- Economic gains per hectare ranged between Rs 2200 to Rs. 195770 (for high value off season vegetable crops) and benefit cost ratio ranged between 1.1 - 7.1 (highest ratio with groundwater recharge technology).



THANK YOU

Bio-physical Indicators

Land Levelling Index

- Land levelling programme was one of the important activities during the initial phase of the watershed programme.
- Ratio of recommended land slope to the existing land slope, as defined below:

$$\text{Land Levelling Index (LLI)} = \frac{\text{Recommended Slope (\%)}}{\text{Existing or Treated Slope (\%)}}$$

where, existing slope refers to the individual land slope before the inception of the project and treated slope is the moderated slope due to land levelling activities.

- Higher value of LLI is a measure of better moderation in land slope.
- LLI can attain a maximum value of 1.0, which means a land of desired slope or perfect level.

Crop Diversification Index

- **Crop improvement was a common feature of all the six watershed development projects.**
- **Crop Diversification Index values (CDI), as defined below, were worked out for pre-project and post-project scenarios to assess the impact of watershed management programme on crop diversification:**

$$\text{Crop Diversification Index (CDI)} = \Sigma P_i \log (1/P_i)$$

where,

P_i = Proportion of i^{th} crop in comparison with total cropped area

- **The CDI can attain a maximum value of 1.0 and higher value of CDI is a measure of higher crop diversification.**

Cultivated Land Utilization Index

- **Cultivated Land Utilization Index (CLUI) indicates the impact of watershed interventions on change in cultivable land area and duration of crop cultivation in pre-project and post-project scenarios. It is calculated as**

$$\text{Cultivated Land Utilization Index (CLUI)} = \frac{\sum_{i=1}^{n} a_i d_i}{A \times 365}$$

where,

i =1,2,3……..n
n = total number of crops
a_i = area occupied by i^{th} crop
d_i = days that the i^{th} crop occupied the a_i area
A = total cultivated land area available during the 365 days period

- **The CLUI can attain a maximum value of 1.0 and higher value of CLUI is an indication of availability of more cultivable land area and/or duration of crop cultivation.**

Crop Productivity Index

- **It is used for assessing the overall improvement in crop productivity at the watershed level.**
- **Crop Productivity Index (CPI) indicates the extent of crop productivity level in comparison to the normal yield of crops.**
- **It is calculated by dividing the crops yield obtained in the watershed by the yield obtained under recommended package of practices.**

$$\text{Crop Productivity Index (CPI)} = \frac{1}{n} \sum_{i=1}^{n} (y_i / Y_i)$$

where,

i = 1,2,3……..n
n = total number of crops
y_i = average yield of i^{th} crop cultivated in the watershed
Y_i = standard package of practice yield of i^{th} crop

- **The CPI can attain a maximum value of 1.0 or higher. Higher value of CPI is indicative of crops' yields closer to the maximum attainable yield under standard package of practices.**

Induced Watershed Eco Index

- **Induced Watershed Eco-Index (IWEI) is an index which shows the additional area brought under vegetation including crops, pasture and grassland, horticultural and forestry plantations in a watershed.**

- **IWEI is calculated as the additional area made green through watershed treatment as proportion of whole watershed area.**

$$\text{Induced Watershed Eco-Index (IWEI)} = \frac{\text{Additional area vegetated through project}}{\text{Total area of the watershed}}$$

- **The IWEI can attain a maximum value of 1.0 which indicates that whole of the watershed area has been brought under some form of vegetation.**

Participation and Socio-economic Indicators

People's Participation Index

- Community participation is considered to be the acid test for the success of any natural resource management project and an important index for its sustainability.
- Overall Peoples' Participation Index was computed
  - by randomly selecting a representative sample of respondents.
  - The responses of the respondents were recorded by personal interview in a pre-structured schedule containing statements on peoples' participation in various interventions of watershed programme. Scores were assigned as 1 for 'Yes" and 0 for 'No" response to each statement.
- Higher value of PPI is a measure of better participation in the watershed development activities. PPI can attain a maximum value of 100.0, which means participation by the whole watershed community in all the activities.

Benefit Cost Ratio

- Economic analysis of the projects was carried out for arable lands, non-arable lands and the watershed as a whole using the discounted measure of project worth namely Benefit Cost Ratio (BCR).

- It is defined as the ratio of present value of gross benefits to the present value of total costs.

$$\text{Benefit Cost Ratio (BCR)} = \sum_{t=1}^{n} \frac{B_t / (1+i)^t}{C_t / (1+i)^t}$$

where,

B_t = Benefits (Rs.) at time t

C_t = Costs (Rs.) at time t

i = Discount rate (%)

t = Life of project

- BCR can attain any value equal to or more than zero. Projects with BCR > 1.0 are economically viable and higher the value the more economically sound the project.

$$NI = \frac{N_l + 2N_m + 3N_h}{N_l + N_m + N_h}$$

NI = Nutrient Index

N_l, N_m, N_h = No of soil samples falling in the category of low, medium and high nutrient status

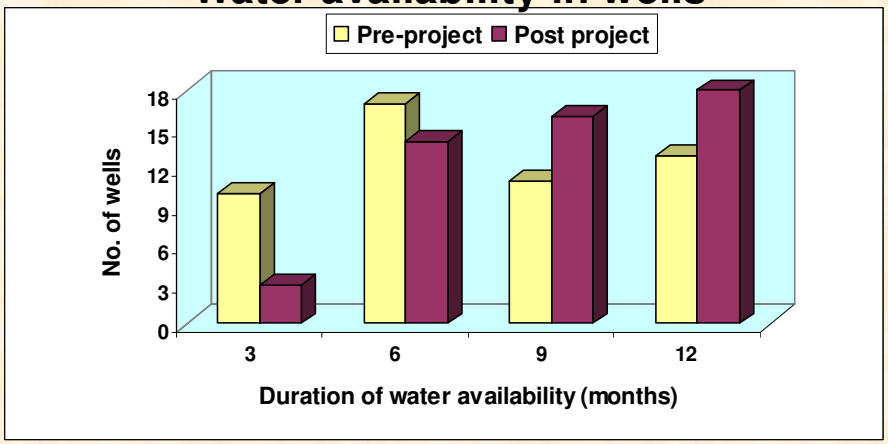
Rating limit of Soil test values

Nutrient	Low	Medium	High
OC (%)	<0.5	0.50-0.75	>0.75
Avai. N ($Kg\ ha^{-1}$)	<280	280-560	>560
Avai. P ($Kg\ ha^{-1}$)	<10	10-24.6	>24.6
Avai. K ($Kg\ ha^{-1}$)	<120	120-280	>280

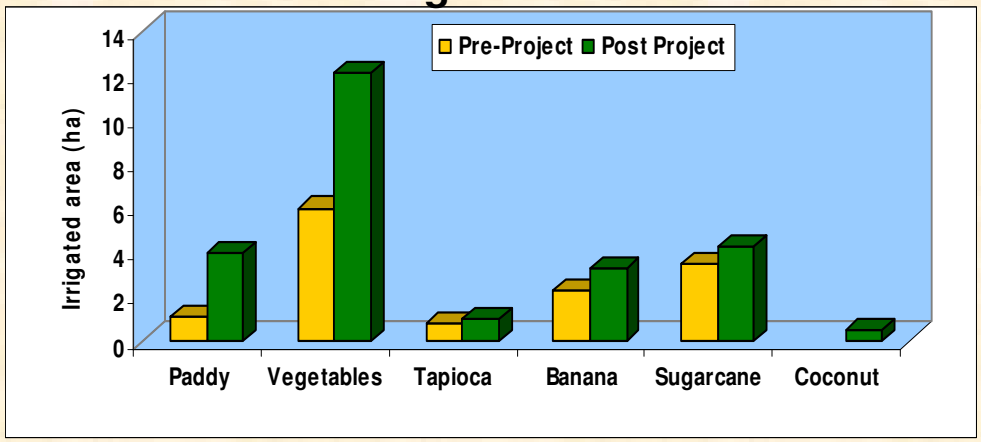
Ground water

Indicator	Pre-project	Post project
Pumping hours till well goes dry	0.5 - 1.5	1.0 - 2.5
Time for recuperation (hours)	38 - 48	24 - 36

Water availability in wells



Irrigated area



- The watershed interventions led to increased ground water table, increased perenniality of water in the wells and increased recuperation rate /water yield that ultimately resulted in increased area under irrigation and crop diversification.
- Duration of water availability in wells has gone up from 3-6 months before watershed interventions to 9-12 months after watershed interventions.
- Water table increase in the wells present in the influence zone of percolation ponds was in the range of 0.5 to 1.0 m.
- Water yield /recuperation rate before and after for different wells indicated that recharge rate has now increased in the range of 10 to 15 per cent and this may be attributed to enhanced groundwater augmentation as a result of WSM.

Crop Diversification, Crop Productivity and Cultivated Land Utilization

Watershed	Crop Diversification Index (CDI)		Cultivated Land Utilization Index (CLUI)		Crop Productivity Index (CPI)	
	Before Project	After Project	Before Project	After Project	Before Project	After Project
Salaiyur	0.53	0.74	0.59	0.67	0.55	0.61

- Overall CPI increased by 11% in the watershed.
- The yield of rainfed crops increased by 11 to 14% and of irrigated by 9 to 16%
- Overall CLUI increased by 14%.
  - Rainfed (40%)
  - Irrigated (5%)
- The overall CDI increased by 39%.
  - Rainfed (51%)
  - Irrigated (29%)