CHAPTER I

INTRODUCTION

The existence or the absence of favourable natural resources can facilitate or retard the process of economic development. Natural resources determine the course of development and constitute the challenge which may not be accepted by the human mind. India's rainfed areas (65 per cent of arable land) is characterised by low productivity, high risk and uncertainty, low level of technological change and vulnerability to degradation of natural resources. The region is abode of sizeable number of unemployed, poverty-ridden and under-nourished population. After Independence, with the advent of the First Five Year Plan in the country the major challenge was to ensure food availability to the teaming million populations. To meet the food demand as well as to contribute effectively to the economic growth of the country the role of agriculture was necessitated, subsequently the watershed as an effective approach to meet the challenge as the majority (about 70 per cent) population are dependent on agriculture. Agriculture in India is still under subsistence and prone to weather and market uncertainties. The available land and water resources in the country are not much effectively utilised due to certain limitations.

Section-I

Land and Water Position in India

Crop Production and Productivity

The overall growth rate of crop production declined from 3.72 per cent per annum in the previous decade to 2.29 per cent in the 1990s and that of crop productivity fell from 2.99 per cent per annum to 1.21 per cent during the same period (Planning Commission, 2002). Average yield levels of rice and wheat have more than halved between 1986 and 2002, indicating a plateauing of productivity in these two major foodgrains. The output of crops grown and consumed by the poorest of the poor (coarse grains, pulses and oilseeds) and grown largely in the drylands, actually declined during this decade and the rate of growth of their yields decelerated considerably (Table 1.1).

Table 1.1 : Rate of Growth (%) of Production and Yield of Foodgrains In India, 1962-2003

Crop	1962/65 to 1970/73	1970/73 to 1980/83	1980/83 to 1990/93	1990/93 to 2000/03
Production				
Rice	1.52	2.23	3.56	1.24
Wheat	10.85	4.51	3.81	2.13
Coarse Cereals	0.61	1.32	0.91	(-) 0.60
Pulses	-0.33	0.38	1.38	(-) 0.93
All Foodgrains	2.28	2.26	2.92	1.08
Oilseeds	1.17	1.82	5.62	(-) 0.62
Yield				
Rice	1.05	1.60	3.01	1.00
Wheat	6.26	2.66	3.19	1.45
Coarse Cereals	0.89	-0.15	1.63	1.18
Pulses	0.69	1.88	2.70	0.14
All Foodgrains	1.82	1.86	3.22	1.55
Oilseeds	0.74	0.93	2.47	0.64

Source : Indian Agricultural Statistics, various issues.

The rate of growth of foodgrain production also fell steeply from 2.92 per cent recorded between 1980/83 and 1990/93 to 1.08 per cent during 1990/93 to 2000/03. For the first time since the mid-sixties, the 1990s witnessed a rate of growth in foodgrain production, which was lower than the rate of growth of population. As a result, both per capita foodgrain production and availability were lower in 2000-03 than their pre-Green Revolution (1960-63) levels. The decline has been the sharpest in the 1990s (Table 1.2). Consumption data based on NSS surveys show that foodgrain consumption and calorie intake has declined substantially during the 1990s in aggregate and for the poorest deciles in terms of expenditure (Ghosh, 2005).

Table 1.2 : Production and Per Capita Availability of Foodgrains in India, 1960-2003

Year	Foodgrain output (million tonnes)	Net per capita output (kg/year)			Net per capita availability (grams/day)		
		Cereals	Pulses	Total	Cereals	Pulses	Total
1960-63	82.0	158	29	187	400	69	469
1970-73	103.5	144	17	162	418	51	469
1980-83	130.8	149	14	163	417	38	455
1990-93	174.8	163	13	176	468	42	510
2000-03	194.3	152	10	162	391	26	417

Source : Indian Agricultural Statistics, various issues.

A major reason for the slowdown in agriculture seems to be the precipitous fall in public investment in agriculture. The decline has been quite sharp in absolute terms and as a proportion to gross capital formation in agriculture and overall public sector gross capital formation (Table 1.3).

Table 1.3 : Gross Fixed Capital Formation In Agriculture 1970-71 to 2000-01, At 1993-94 Prices

Year	GCFA/GCF(%)	PGCFA/GCFA(%)	PGCFA/PGCF(%)
1970-71	14.3	37.5	13.8
1980-81	15.4	51.3	17.7
1990-91	9.9	30.4	7.1
2000-01	7.8	22.7	5.7

Source : EPWRF (2004).

Note : GCF = Gross Capital Formation; GCFA = Gross Capital Formation in Agriculture; PGCF = Public Sector GCF; PGCFA = Public Sector GCFA.

Another reason for decline in cereals pulses and other foodgrains is due to degradation of soil fertility especially the loss of soil organic matter (SOM). There are different estimates of degraded lands requiring watershed treatment in India (Table 1.4). Land degradation both reduces land productivity and reduces water use efficiency. De Vries *et al.* (2008) state that a 13 per cent yield loss, as a result of severe degradation on 40 per cent of agricultural land and moderate degradation on a further 9 per cent of agricultural land, is equivalent to a decline in water use efficiency of at least 13 per cent. A global agricultural model suggests that a slight increase in degradation relative to baseline trends could result in 17–30 per cent higher world prices for key food commodities in 2020, and increased child malnutrition (Agcaoili *et al.*, 1995). The face of degraded land is varied in nature by different estimates. More or less it is evident that considerable fertile area is lost due to different practices followed by the farmers injudiciously.

Table 1.4 : Estimates Of Degraded Land In India
Needing Watershed Treatment (Million Ha)

1976	National Commission on Agriculture	175	Secondary Data
1985	Ministry of Agriculture Government of India	174	Land Degradation Statistics of States
1994	NBSS-LUP Nagpur	188	Mapping on 1:4.4 million scale
1994	Ministry of Agriculture Government of India	107	Land Degradation Statistics of States
2000	NRSA	64	Mapping on 1:50000 scale

Source : Planning Commission (2004).

The Ministry of Agriculture estimated in 1985 that over 100 mha of India's geographical area is affected by soil erosion due to surface water runoff. Annual soil erosion due to water in India is estimated to be 5334 million tonnes (roughly 16.35 tonnes per ha per year) (Dhruvanarayana, 1993). About 10 per cent of this is deposited in large dam reservoirs, representing loss of their storage capacity of about 1-2 per cent every year. The Himalayan foothills, Western Ghats and North- Eastern States account for over 60 per cent of the total soil erosion in the country. According to the Report of the Inter-Ministry Task Force on Integrating Ongoing Schemes, larger reservoirs in India have lost over one-third of their storage capacity due to siltation. This has resulted in a reduction in area irrigated as also lower electricity generation; thereby rendering the large investments in these projects unviable (Planning Commission, 2004). The problem of reservoir siltation, far in excess of rates estimated before construction, is threatening to lower the life of many large dams. The siltation rate in Hirakud dam, for instance, is two and a half times more than the rate assumed and, therefore, the expected life of the dam has been reduced by more than half.

Water Resources Development

Since Independence, two major interventions of water resource development were followed. One intervention was the construction of large irrigation projects and the other was intensive tapping of groundwater through tubewells. Adoption of the water intensive Green Revolution package was made possible by substantial public investment in irrigation. According to one estimate, total outlay in irrigation since Independence till 2000- 01 amounts to ₹ 79,055 crore at current prices (₹ 1,98,952 crore at 1996-97 prices). As a result of an investment of this magnitude, the gross irrigated area went up by over 300 per cent, from 22.56 million ha (mha) in 1950-51 to 75.14 mha in 2000-01. At present, India has the largest irrigated agriculture in the world. However, a remarkable fact is that since the mid-1970s, the rate of expansion of irrigated area has undergone a global decline. According to the Food and Agriculture Organisation (FAO, 2003), the global rate of expansion of irrigated area, which was 2.17 per cent between 1961-63 and 1971-73, steadily came down in the subsequent periods, reaching 1.23 per cent between 1990-93 and 1997-99. Incremental irrigated area reached its maximum (4.01 mha/year) between 1971-73 and 1981-83. It came down to 3.19 mha /year between 1991-93 and 1997-99 (Table 1.5).

The expansion of irrigated area in India also follows a similar pattern. The rate of growth of irrigated area (1.83 per cent) was the lowest in the period 1990-93 to 1999-2000, compared to earlier decades (Table 1.5). The reasons for the decline in the rate of growth of irrigated area can be traced to the number of problems faced by these two major thrust areas of water policy at present.

It is estimated that 4400 (large, medium and small) dams have been constructed in India so far (CWC, 2002). The pace of dam construction reached its peak in the 1970s, subsequent to which it slowed down considerably. We must also note that there is a severe financial constraint that restricts the possibilities of growth in surface irrigation based on big dams. Due to delays in construction and consequent cost overrun, many of the projects taken up spill over from one plan to the next. At the beginning

Table 1.5 : Gross Irrigated Area In The World And India, 1960-2000

Year	Gross Irrigated Area (mha)	Increment (mha/year)	CAGR(%)
WORLD			
1961-63	141.7	-	-
1971-73	175.6	3.40	2.17
1981-83	215.7	4.01	2.08
1991-93	251.7	3.60	1.56
1997-99	270.9	3.19	1.23
INDIA			
1960-63	28.6	-	-
1970-73	38.6	0.99	3.02
1980-83	51.0	1.25	2.84
1990-93	65.0	1.40	2.45
1999-2000	76.5	1.28	1.83

Source : FAO (2003) and Indian Agricultural Statistics, various issues.

Note : CAGR = Compound Annual Growth Rate.

of the Tenth Plan, there were 410 ongoing major and medium irrigation projects in the country, some of them dating back to the Fifth Plan period (Planning Commission, 2002). The Steering Committee on Irrigation for the Tenth Plan estimates that total spill over costs of previous projects to the Tenth Plan will be ₹ 1,77,739 crore. However, the total public sector allocation during the Tenth Plan for all irrigation and flood control was only ₹ 1,03,315 crore. The Steering Committee categorically states that "given the large number of projects taken on hand, the frequent changes in project scope, and the escalation of project costs due to a variety of reasons, there is little likelihood that the outlay in the budgets can ever match the total demand". The Steering Committee, therefore, gives top priority to completion of ongoing projects and says, "New projects may be taken up selectively, keeping in view the necessity for removal of regional imbalances and development of drought prone and tribal areas" (Planning Commission, 2002). Rapidly escalating cost of creating additional irrigation potential is a serious problem faced by major and medium irrigation projects. This has happened because the best sites suitable for dam construction have already been covered and only progressively more expensive and socio-economically and ecologically less favourable sites are left for exploration. The cost of creating additional potential from M&M projects had already reached the fairly mind-boggling figure of ₹ 1,42,662 per ha by the end of the Ninth Plan (Planning Commission, 2002).

Evidence is also accumulating regarding the ill-effects of over-irrigation, which has become a feature of many irrigation commands. The Ministry of Water Resources estimated the area affected in irrigation project commands and came up with figures of 1.6 mha for waterlogging, 3.1 mha for salinity and 1.3 mha for alkalinity (Vaidyanathan, 1994). It should also be remembered that the track record of development projects in handling the problems of proper rehabilitation of displaced persons has been extremely poor (ILO-ARTEP, 1993); 75 per cent of the displaced (an estimated 15 to 25 million people) have not been rehabilitated. These include the poorest of the poor in the country, such as the tribals. The proportion of tribals displaced by M&M projects could be as much as 40 per cent. The problem of displacement imposes another serious constraint on the expansion of surface irrigation.

The recent expansion in irrigated area owes much more to groundwater. Nearly 60 per cent of the irrigation in the country is from groundwater. Moreover, of the addition to irrigated area of 25.7 mha between 1970 and 1990, groundwater accounted for over 85 per cent. Table 1.6 shows that the area under canal irrigation has ceased to expand significantly since the mid-1970s while the area irrigated by tanks has actually declined. The annual extraction of groundwater in India is over 150 billion cubic metres (bcm), which is by far the highest in the world (Tushaar Shah et al,

2000) (Studies in India have shown that crop yield per cubic metre on groundwater irrigated farms tends to be 1.2-3 times higher than on surface water irrigated farms (Dhawan 1989,167). The most dramatic change in the groundwater scenario in India is that the share of tubewells in irrigated area rose from a mere 1 per cent in 1960-61 to 37 per cent in 1999-2000. By the year 2000, tubewells had become the largest source of irrigation in India.

Table 1.6 : Share Of Various Sources In Net Irrigated Area (Nia) In India, 1960-2000 (%)

Year	Tubewells	Wells	Tanks	Canals	Others	NIA(mha)
1960-61	1	29	19	42	10	24.7
1970-71	14	24	13	41	8	31.1
1980-81	25	21	8	40	7	38.7
1990-91	30	21	7	35	7	47.8
1999-2000	37	22	5	31	5	56.8
Area Irrigated (mha)						
Year	Tubewells	Wells	Tanks	Canals	Others	NIA
1960-61	0.2	7.1	4.5	10.3	2.4	24.7
1970-71	4.4	7.5	4.0	12.8	2.5	31.1
1980-81	9.5	8.2	3.2	15.3	2.6	38.7
1990-91	14.3	10.0	3.3	16.7	3.3	47.8
1999-2000	21.0	12.5	2.8	17.6	2.8	56.8
Increment (1970-2000)	16.6	5.0	-1.2	4.8	0.4	25.7
Share in Increments (%)	65	20	-5	19	1	100

Source: Indian Agricultural Statistics, various issues.

Groundwater availability is dependent on the water storage and transmission characteristics of underlying geological strata. Tubewell technology was initially introduced in the alluvial tracts of Indo-Gangetic Plains, which had a favourable geology for this technology. Indiscriminate extraction of groundwater here has lowered the water table to such an extent that a serious question is being posed about the sustainability of such high levels of extraction in a low rainfall tract (HLC, 2001). Assessments by the Central Groundwater Board of the level of groundwater development (GWD) (Level of Groundwater Development (GWD) = Extraction / Utilisation * 100) provide a grim picture of an impending crisis in the core Green Revolution areas (Table 1.7).

Table 1.7 : Groundwater Availability, Net Draft and Level Of Development, 2003

States	BCM/yr (1)	BCM/yr (2)	BCM/yr (3)	% (2)/(1)
Haryana	7.3	8.1	0.0	112.2
Punjab	16.8	16.4	0.4	97.7
Rajasthan	10.7	9.3	1.4	86.4
Tamil Nadu	22.4	14.5	7.9	64.4
Gujarat	17.3	9.6	7.7	55.2
Uttar Pradesh	69.0	32.3	36.7	46.9

Source : CWC (2002).

The Table shows that the alluvial tracts of Haryana and Punjab have already reached the limit beyond which further extraction of groundwater becomes unsustainable. Rajasthan, Tamil Nadu and Gujarat are fast approaching it. This is also reflected in the numbers of critical blocks ("dark" and "overexploited" blocks with GWD >90 per cent) in these states (Table 1.8). Nearly 60 per cent of the blocks in Punjab and 40 per cent of blocks in Rajasthan and Haryana are experiencing over-extraction of groundwater.

Table 1.8 : Number Of Dark And Over-exploited Blocks, 2002

States	Districts	Blocks/Mandals/Taluks/Watersheds				
		Total	Over-exploited	Dark	Critical Blocks (3+4)	% (5/1)
Punjab	17	138	72	11	83	60%
Rajasthan	32	236	74	20	94	40%
Haryana	17	108	33	8	41	38%
Tamil Nadu	27	384	64	39	103	27%
Gujarat	19	184	13	15	28	15%

Source : CWC (2002).

Table 1.9 gives India's overall water budget. Out of total precipitation, the available water is 60 per cent. Only 48.8 per cent of the water is earmarked for utilisation. Hardly 50 per cent of the water at present is being utilised.

The foregoing analysis thus far shows that the limits to further expansion of surface and groundwater irrigation through big dams and tubewells are being reached rapidly. This makes the urgency of a different strategy for India's drylands even greater. Such a strategy needs to recognise the location-specific characteristics of different parts of India and also needs to be sensitive to the limits set by the eco-system. One such strategy is revisiting the efficient use of of land and water in a better way. This calls for broad strategy of watershed development. The results of initial efforts by different organisations were mixed one.

Watershed Approach

The initial interventions on soil and water conservation by the Ministry of Agriculture had begun in the early 1960s (Planning Commission, 2004). After Independence India relied on multi-purpose reservoirs for providing

Table 1.9 : India's Water Budget (All volumes in cubic kms)

	Estimates based on Ministry of Water Resources[1]	Estimates based on world-wide Comparison[2]
Annual Rainfall	3,840	3,840
Evapotranspiration	3840 - (1,869 + 432) = 1,539 (40%)	2,500 (65%) World-wide comparison
Surface runoff	1,869 (48.7%)	Not used in estimate
Groundwater Recharge	432 (11.3%)	Not used in estimate
Available water	2,301 (60%)	1,340 (35%)
Utilisable water	1,123 (48.8%) Gupta and Deshpande, Curr. Sci., 2004	654 (48.8% of 1,340)
Current water use	634	634
Remarks	Current use (634) well below 1,123	Current use (634) close to 654

Source : 1 Ministry of Water resources, 2002; Planning Commission, 2007;
2 Narasimhan, 2008.

irrigation and generating hydro-electricity. To stabilise the catchments of reservoirs and to control siltation, a Centrally Sponsored Scheme of "Soil Conservation Work in the Catchments of River Valley Projects (RVP)" was launched in 1962-63. The Ministry of Agriculture started a scheme of Integrated Watershed Management in the Catchments of Flood Prone Rivers (FPR) in 1980- 81. During the 1980s, several successful experiences of fully treated watersheds, such as Sukhomajri in Haryana and Ralegaon Siddhi in Western Maharashtra, came to be reported. The Ministry of Agriculture launched a scheme for propagation of water harvesting/conservation technology in rainfed areas in 19 identified locations in 1982-83. In October 1984, the Ministry of Rural Development (MoRD) adopted this approach in 22 other locations in rainfed areas. In these 41 model watersheds the

Indian Council of Agricultural Research (ICAR) was also involved to provide research and technology support. The purpose of these Operation Research Projects was to develop "model watersheds" in different agro-climatic zones of the country. With experience gained from all these, the concept of integrated watershed development was first institutionalised with the launching of the National Watershed Development Programme for Rainfed Areas (NWDPRA) in 1990, covering 99 districts in 16 states. Meanwhile, conservation work was ongoing in the Drought Prone Areas Programme (DPAP) launched by MoRD in 1972-73. The objective of this programme was to tackle the special problems of areas constantly affected by severe drought conditions. In 1977-78, the MoRD started a special programme for hot desert areas of Rajasthan, Gujarat and Haryana and cold desert areas of Jammu & Kashmir and Himachal Pradesh (which were earlier under DPAP) called Desert Development Programme (DDP).

These programmes were reviewed in 1973 by a Task Force headed by Dr. B.S. Minhas, by another Task Force headed by Dr. M.S. Swaminathan in 1982 as well as by an Inter-Departmental Group in 1984. In 1988 the National Committee on DPAP and DDP was set up under the Chairmanship of the Member, Planning Commission to appraise and review the DPAP and DDP. The committee was initially headed by Dr. Y.K. Alagh and later by Shri L.C. Jain who took over as Member, Planning Commission in charge of the subject. The committee submitted its report in August 1990.

In 1994, a Technical Committee under the Chairmanship of Prof. C.H. Hanumantha Rao was appointed to appraise the impact of the work done under DPAP/DDP; identification of the weaknesses of the programme and to suggest improvements. The Hanumantha Rao Committee felt that "the programmes have been implemented in a fragmented manner by different departments through rigid guidelines without any well-designed plans prepared on watershed basis by involving the inhabitants. Except in a few places, in most of the programme areas the achievements have been dismal. Ecological degradation has been proceeding unabated in these areas with reduced forest cover, reducing water table and a shortage of drinking water, fuel and fodder" (Hanumantha Rao Committee, 1994, Preface). The

Committee, therefore, decided to revamp the strategy of implementation of these programmes, drawing upon the "the outstanding successes" of some ongoing watershed projects. It recommended that sanctioning of works should be on the basis of the action plans prepared on watershed basis instead of fixed amount being allocated per block as was the practice at that time. It called for introduction of participatory modes of implementation, through involvement of beneficiaries of the programme and non-government organisations (NGOs). It recommended that "wherever voluntary organisations are forthcoming, the management of watershed development should be entrusted to them with the ultimate aim of handing over to them one-fourth of total number of watersheds for development". The Committee also called for a substantial augmentation of resources for watershed development by "pooling resources from other programmes being implemented by the Ministry of Rural Development, e.g., Jawahar Rozgar Yojana, Employment Assurance Scheme, etc., and by integrating them with DPAP and DDP". The Committee recommended suitable institutional mechanism for bringing about coordination between different departments at the Central and state levels with a view to ensuring uniformity of approach in implementing similar programmes for the conservation of land and water resources. On the basis of these recommendations, the Hanumantha Rao Committee formulated a set of "Common Guidelines", bringing five different programmes under the MoRD, namely, DPAP, DDP and Integrated Wastelands Development Programme (IWDP), as also the Innovative- Jawahar Rozgar Yojana (I-JRY) and Employment Assurance Scheme (EAS), 50 per cent of the funds of both of which were to be allocated for watershed works. The watershed projects taken up by MoRD from 1994 to 2001 followed these Common Guidelines of 1994. In 2000, the Ministry of Agriculture revised its guidelines for NWDPRA, making them "more participatory, sustainable and equitable". These were called WARASA – JAN SAHABHAGITA Guidelines. The Common Guidelines of 1994 were revised by MoRD in 2001 and then again modified and reissued as "Guidelines for Hariyali" in April 2003. The watershed programme became the centerpiece of rural development in India. The Ministry of Environment and Forests as well as bilateral funding agencies are also involved in implementation of watershed projects in India. The on-going watershed programmes are listed in Table 1.10.

Table 1.10 : Area Treated (Mha) and Investment Undertaken (₹ Crore), Watershed Programmes In India

No.	Programme	Up to end of 8th Plan		During 9th Plan		During 10th Plan till March 2005		Total (Till March 2005)	
		Area	Investment	Area	Investment	Area	Investment	Area	Investment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I	Ministry of Agriculture								
(a)	National Watershed Development Project for Rainfed Areas (NWDPRA)	4.22	967.93	2.77	911.01	0.96	519.82	7.95	2398.76
(b)	River Valley Project (RVP) and Flood Prone Rivers (FPR)	3.89	819.95	1.60	696.26	0.60	377.91	6.09	1894.12
(c)	Watershed Development Project in Shifting Cultivation Areas (WSDSCA)	0.07	93.73	0.15	82.01	0.06	60.61	0.28	236.35
(d)	Alkali Soils	0.48	62.29	0.08	20.25	0.56	82.54		
(e)	Externally Aided Project (EAP)	1.00	646.00	0.50	1425.01	0.86	2685.25	2.36	4756.26
	Sub-total	9.66	2589.90	5.02	3114.29	2.56	3663.84	17.24	9368.03

(Contd.)

Table 1.10 : *(Contd.)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
II	Department of Land Resources (MoRD)								
(a)	Drought Prone Areas Programme (DPAP)	6.86	1109.95	4.49	668.26	3.78	845.19	15.13	2623.40
(b)	Desert Development Programme (DDP)	0.85	722.79	2.48	519.80	2.38	615.19	5.71	1857.78
(c)	Integrated Watershed Development Programme (IWDP)	0.28	216.16	3.58	943.88	2.46	1001.77	6.32	2161.81
(d)	EAP	0.14	18.39	0.22	194.28	0.36	212.67		
	Sub-total	7.99	2048.90	10.69	2150.33	8.84	2656.43	27.52	6855.66
III	Ministry of Environment & Forests								
	Integrated Afforestation & Eco-Development Project scheme (IAEPS)	0.30	203.12	0.12	141.54	0.40	469.07	0.82	813.73
	Grand Total	17.95	4841.92	15.83	5406.16	11.80	6789.34	45.58	17037.42

Source : Parthasarathy Committee, 2006.

It is imperative that the present study focuses on the land and water use practices for sustainable smallholders' livelihoods where 72 per cent of landholding constitutes small and marginal farmers (Table 1.11). Their lands mostly fall under rainfed area.

Table 1.11 : Number (Absolute Units) and Area (Absolute Hectares) of Holdings by Size Group (2005-06)

Size-Class (ha)	Number of Holdings	Area
Marginal	150883 (100) (58.97)	46348 (100) (2.74)
Small	33294 (100) (13.01)	46916 (100) (2.77)
All	255849 (100) (100)	1694077 (100) (100.00)

Source : Agriculture Census, 2005-06.

Section II

Review of Literature

The challenges faced by the small and marginal farmers in rainfed areas are manifold. Most of these are confined to the resource conservation, management, investment decisions, risk and vulnerability and access to markets. Although much has been learned from earlier interventions of various natural resource management based experiences (DDP, DPAP, IWDP and NWDPRA) in sustainable resource management, there is still inadequate understanding of the market, policy and institutional failures that shape and structure farmer incentives and investment decisions. Market linkages, access to credit and availability of pro-poor options for beneficial conservation are critical factors in enhancing sustainable livelihood and investments. Addressing the externalities (mostly upper and downstream; investment made and realised benefits accrued-gestation period) and institutional failures (delivery mechanisms-timely and capability) that prevent private and joint investments for management of agricultural landscapes will require new kinds of institutional mechanisms for empowering communities through local collective action that would ensure broad participation and equitable distributions of the gains from joint conservation investment. The following review of some of the interventions made earlier could be highlighted.

Resource development, management and governance are crucial components to raise the productivity, protection and institutional arrangements to guide resources management. The practices of land and water focusing on water harvesting and soil conservation typically state three objectives (Kerr 2007): conserve and strengthen the natural resource base, make agriculture and other natural resource-based activities more productive, and support rural livelihoods to alleviate poverty. These objectives are interlinked to each other. In seasonally dry areas (semi-arid) where land and water use practices focus on (often held in common), water harvesting, the natural resource base in question typically includes soil, water, agricultural land, pastures, and forests. Steps to strengthen one of these natural resources inevitably affect others and the livelihoods that depend on them. The catchment area development approaches (Watershed Projects) (is defined by the hydrological linkages among all these resources: - collective action among all these resource users is needed to manage hydrological processes for maximum productivity of the whole catchment area/watershed system) typically begin by investing in soil conservation in upper catchment area. Upper catchment area treatments (practices) often are hilly, with pasture or forest land use rather than agriculture. In such cases, soil conservation typically involves increasing vegetative cover since bare ground is more prone to erosion. This involves planting new vegetation and making the area off-limits to grazing animals. Water harvesting involves building small dams to capture runoff from upper catchment areas after heavy rains. Reducing erosion reduces silt in runoff water and in water harvesting ponds, thus lengthening their lifespan. Water harvesting in turn benefits farms further down the slope by providing irrigation, either via surface water or by recharging groundwater.

These interventions are designed to eventually raise the productivity of all natural resources in the catchment area. Soil becomes more productive for agriculture, water is captured for irrigation, and pastures and forests yield more biomass. All livelihood activities that depend on these resources may be enhanced, and employment may increase as agriculture becomes more productive and additional labour is needed for harvesting and other operations. One important point is that improvements in different natural resources have different durations. Water harvesting for example can begin almost immediately but forests and pastures take time to yield biomass increase, and they are off limits to grazing and harvesting during plantation.

Socio-economic Challenges

The successful land and water use practices face socio-economic challenges across India in recent past. In more cases, benefits are incremental and gradual. Most of the interventions across India with less visible connection between investments made and benefits realised, organisational challenges become more apparent (Kerr 2002). The major challenge to land and water use practices is that its costs and benefits are distributed unevenly. Uneven impacts result from spatial variation and multiple, conflicting uses of natural resources. The conflict between using upper reaches of catchment area for grazing and protecting them for regeneration to support downstream irrigation is a good example (Kerr 2007). The question arises here about those who gain immediate benefits through the intervention and those whose benefits are gradual and incremental in the long run. Whether poor people who depend on the resource for their livelihood will wait for these gradual and incremental benefits for three to four years? There is need to create mechanisms to encourage natural resource utilisation consistent with the common good.

Technical Challenges

In India, recent hydrological research suggests that land and water related and watershed projects may be exacerbating precisely the water shortages they aim to overcome. At the macro watershed level (covering many villages), Batchelor et al (2003) document cases where water harvesting in upper watersheds reduced water availability downstream. Calder et al (2006) refer to this as 'catchment closure', whereby water harvesting upstream concentrates groundwater locally and then intensive pumping exhausts the shallow aquifer. The land and water use practice/ watershed activities prevent both surface runoff and groundwater from moving naturally downstream. It suggests two perverse project outcomes; first, what is good for one micro watershed can be bad for others downstream, and second, what is good for a watershed in the short term can be bad in the long term. More so, in India, most of the state's electricity to run pump is free in some states and subject to a low, flat fee in others, allowing pump owners to draw unlimited water without affecting their costs. In addition, whoever pumps water first owns it (Singh 1992) and this encourages over-pumping.

Uncertainty and misunderstanding about technical watershed relationships, combined with the uneven distribution of benefits and costs of management, create severe challenges to manage land and water use practices/watersheds. This raises questions about what really can be expected of catchment area/watershed development as a strategy for transforming rural natural resources and livelihoods. Keeping in view the above socio-economic and technical challenges, the present study made an attempt to examine different dimensions of these resources across different states in India. By reducing siltation rates through control of the volume and velocity of surface water runoff, watershed programmes can make a big contribution to enhancing storage capacities of big dam reservoirs. They can similarly be also effective in restoring fallen water tables in areas that have seen massive groundwater over-exploitation.

Evolution of Approaches for Sustainable Land and Water Management

Concern with land and water degradation in smallholder agriculture is not a new issue. It has been around for a long time and farmers are involved in a constant struggle to adopt and adapt mitigation and conservation strategies under changing climatic and socio-economic conditions. The strategies adopted and technological solutions to the problem of land degradation varied over time and space. In many sloping areas with undulating topographies, the traditional emphasis has been on arresting soil erosion and reducing runoff. In semi-arid regions where rainfall is either unreliable or insufficient, the focus has been on technological solutions for capturing and utilising surface and groundwater. As indicated above, stimulating widespread adoption and adaptation of land and water management innovations has seen limited success, especially in marginal and vulnerable environments with limited socio-economic infrastructure. In an effort to redress the problem and improve actual livelihood and environmental outcomes, the approach to soil and water conservation has evolved through several phases. These different approaches may be grouped into three major types (Biot et al. 1995): top-down interventions, populist or farmer-first, and neo-liberal approaches.

Most of the early soil and water conservation approaches focused on top-down interventions mainly using structural methods for arresting the physical process of soil erosion. This approach is also characterised by lack of farmer participation in technology design and use of command-and-control type policies for implementation of externally developed structural measures. In the pre-Independence era, colonial governments, following concerns with the rapid rate of land degradation in marginal areas (i.e., the reserves) instituted policies that aimed at checking the rate of soil and water degradation. These policies included forced adoption of soil erosion control, planting of trees on hillsides, and protection of water/river catchments. However, the policies were largely driven by fear of future consequences of inaction.

Based on the experiences gained from the failed command-and-control policies, a new paradigm—referred to as ''populist''—that upturned the process and made the farmer central to programme design and implementation of soil and water conservation activities has emerged. This view appeared in the late 1980s and was marked by the publication of Farmer First (1989)—a book that embodies many of the ideas behind the ''populist'' approach (Chambers et al. 1989). The difficulties of implementing such farmer-led participatory approaches has prompted some researchers to reject this model in favour of a broader approach, in which farmer innovation is driven by the economic, institutional and policy environment (Biot et al. 1995; Robbins and Williams, 2005).

The neo-liberal approach advocates the need to understand the present structure of incentives that prevents resource users from adopting and adapting existing land and water management technologies. This approach recognises the appropriate roles for farmer innovation but brings to the center stage the critical role of markets, policies and institutions to stimulate and induce farmer innovation, adoption and adaptation of suitable options. The critical importance of making conservation attractive and economically rewarding to farmers through productive technologies and improved access to markets is regarded as the driving force for igniting farmer investments in sustainable land water management options. Growing understanding and recognition of the public goods characteristics of soil and water conservation and the non-technical factors that condition individual technology choice and adaptation has also prompted strategies that address institutional and organisational constraints and internalise local externalities to induce proper action at the community and landscape level (Reddy 2005; Kerr et al. 2007). An example of this is the integrated watershed management programme(IWMP) approach that aims to improve both private and communal livelihood benefits from wide-ranging technological and institutional interventions. The concept of IWMP goes beyond traditional integrated technical interventions for soil and water conservation to include proper institutional arrangements for collective action and market related innovations that support and diversify livelihoods. In the last few years, the approach for soil and water conservation in agriculture has also slowly moved towards the concept of sustainable land (and water) management (SLM) both at the farm and landscape level (Robbins and Williams 2005). There is no single definition for SLM but Hurni (2000) suggests that SLM implies ''a system of technologies and/or planning that aims to integrate ecological and socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra- and inter-generational equity''. The broadening of the concept shows the complexity of the challenges and the need for broadening of desired partnerships and the disciplinary analyses required for stimulating and promoting options for sustainable land and water management. The following section builds on this broader concept of SLM and develops an integrating conceptual framework for analyses of challenges for adoption and adaptation of beneficial conservation methods and practices.

Adoption and Adaptation of NRM Interventions

Smallholder farmers in many developing regions are dual economic agents engaging simultaneously in the production and consumption of the same commodities and investments in improving productivity and sustainability of natural resources. Hence, smallholder farmers are often referred to as farm-households. This means that smallholder decisions for land and water management in agriculture are likely to be influenced by several inter-related factors both on the production and consumption side. The farm household, pursuing certain feasible livelihood strategies, is the ultimate decision maker on how and when to utilise natural resources in agricultural production or to undertake certain productivity-enhancing investments to attain preferred objectives. Understanding the investment decisions of the resource users and the most important factors that drive such decisions will allow designing effective strategies for up-scaling promising options for sustainable land and water management. In the context of multiple outcomes and pathways that are possible, this would also provide insights on how policymakers, analysts and development practitioners motivate and tailor farmer resource use, production and investment strategies towards win-win pathways that reduce poverty and enhance future production possibilities. This requires a more holistic conceptual framework that captures the intertemporal investment decision problems across alternative livelihood options (crops, livestock, and non-farm diversification) and on-farm natural resource investment possibilities that resource users face at each period and the consequences of these livelihood strategies on the quality of the resource base. The pattern of change in the quality of the natural resource base, household assets and livelihoods would then determine the evolution of the 'development pathway' and incentives for future natural resource investments in subsequent periods (Shiferaw and Bantilan 2004).

The conceptual framework clearly recognises and places household investment decisions in the context of the evolving global, national and local policies and institutional changes that shape production and investment opportunities available to smallholder farmers. This is consistent with the broader evolving inter-disciplinary and dynamic perspective required for technology design and development efforts targeting poverty reduction and sustainable natural resource management in agriculture. In making their production and investment decisions in each period, smallholder farmers attempt to maximise their livelihood benefits over a period of time based on existing resource assets and expected shocks that jointly determine the vulnerability context. These decisions are also conditioned and mediated by the prevailing socio-economic and policy environment, including sub-national and sub-sectoral policy changes and responses to shifts in global and macro policies, transmitted to the local level through policy reforms, institutional changes and infrastructural investments that in turn determine relative input-output prices and access to new technologies and markets at the local level (Shiferaw and Bantilan 2004). The extent to which global and national policies are transmitted to the local level depends on trade policies and the extent to which input and output markets are integrated. In some situations (e.g., watershed management), collective action by the community may further enhance and supplement individual production and investment possibilities. The diversity of household assets and the prevailing biophysical and socio-economic environment therefore, jointly determine the livelihood options and investment strategies available to farmers. Access to markets (including output, credit, input markets), appropriate technologies, and the input and output prices define the production feasibility set and determine the livelihood and investment strategies. While the endowment of family resources and assets determines the initial production and investment capabilities, the socio-economic and policy environment shapes the resource use patterns and the ability to relax initial constraints through trade and market participation.

The framework clarifies that when more profitable resource conserving or improving technologies are available and capital and institutional constraints are not limiting, farm households may undertake productivity enhancing resource investments. Enabling policies (e.g., secure rights to land and water), access to markets and institutional arrangements (e.g., credit services and extension systems) create incentives to invest in options that expand future production and consumption possibilities. Such resource improving and productivity enhancing investments provide opportunities for intensification of agriculture and diversification of livelihood strategies that will help combat resource degradation. This will in turn determine the livelihood and natural resource outcomes in the next period. In a dynamic sense, improved level of well-being and natural resource conditions will in turn enhance the stock of livelihood assets available for production, consumption and investment decisions in the subsequent periods. This shows how the interplay of good technology and conducive socio-economic conditions enable some households to pursue a more sustainable intensification strategy that will also help them escape poverty. Nevertheless, these conditions are often lacking for many smallholder farmers in less favourable regions with poor market access and suffering from high levels of resource degradation. In the absence of enabling policy and institutional environments that encourage technological innovation, smallholder farmers lack the economic rationale to adopt and adapt interventions for sustainable land and water management. In such situations, increasing subsistence demand and land degradation further undermine the ability to manage the resource base. The interface of lack of viable technological options and adverse biophysical, policy and institutional environments, may force smallholder farmers in marginal areas to practise more exploitative and unsustainable livelihood strategies. There may also be several such trajectories leading to less sustainable intensification pathways, indicating extractive resource use patterns (Shiferaw and Bantilan 2004). In this case, the synergistic effects of poverty and resource degradation lead to worsening conditions of the poor, potentially leading to a downward spiral (Scherr 2000). Breaking this spiral is a complex challenge requiring innovative strategies that stimulate technical innovation and enabling policy and institutional arrangements, including targeted subsidies for investments that generate positive public benefits e.g., poverty reduction and sustainability.

Determinants of Farmer Conservation Investments

Farmers adopt and adapt new practices and technologies only when the switch from the old to new methods offers additional gains either in terms of higher net returns, lower risks or both. This means that smallholder farmers are likely to adopt natural resource management (NRM) interventions only when the additional benefits from such investments outweigh the added costs (Lee 2005). Investment in soil and water conservation is often just one of the many investment options available to farmers. Farmers can therefore, defer undertaking such conversation investments until the gains from such investments are perceived to be at least equal to the next best investment opportunities available to them (Kerr and Sanghi 1992). In other words, farmers in developing regions implicitly compare the expected costs and benefits and then invest in options that offer highest net returns (either in terms of income or reduced risk). In some cases, the highest (but short term) net returns might be realised from foregoing soil and water conservation. Where private costs of adopting and adapting conservation interventions outweigh the benefits, voluntary adoption will be greatly hampered unless society is willing to internalise some of the costs and offer subsidies to farmers. In many cases, farmers reject some interventions for lack of additional benefits (incentive problem). In other cases, farmers also find themselves highly constrained to adopt and adapt otherwise profitable (or economically attractive) interventions due to poverty, imperfect information, market, policy, institutional and other limiting factors. These constraints further limit the economic gains from investments in some NRM interventions and make it unattractive for farmers to adopt and adapt them on their farms. These factors can be broadly categorised into incentive and market factors, poverty and capacity factors, policy and institutional factors, participation and information factors, and environmental factors. These will be discussed in turn below.

Markets and Incentives

The fundamental economic incentives (related to relative profitability and risk reduction gains) for farmers to adopt NRM interventions are often affected by prevailing relative input and output prices, interest rate, and access to labour and output markets.

Relative Output and Input Prices

Studies that examine the effect of commodity prices on land and water management find mixed effects of price changes on conservation investments. An increase in the price of agricultural commodities may often mask the effect of land degradation and make agricultural production using erosive practices attractive to farmers. In other cases, an increase in commodity prices may make certain NRM interventions profitable or attractive to farmers. Accordingly, some studies find a positive relation between increase in commodity price and adoption of conservation technologies (e.g., Shiferaw and Holden 2000; Lee 2005). However, when conservation does not provide such complementary economic benefits, an increase in the price of an erosive crop would encourage smallholders to expand or intensify the production of such crops without investment in conservation (Shiferaw and Holden 2000). The same effects can be observed when governments provide price support and other subsidies for certain crops that would distort the incentives faced by resource users. The case in point is the commodity price support to irrigated crops (e.g., rice and wheat) that discourages farmers in semi-arid areas to cultivate sorghum and other water-efficient dryland crops. This indicates that good intentioned policies introduced for attaining food security could lead to extensive land degradation and depletion of groundwater resources by encouraging dryland farmers to abandon traditional crops in favour of more erosive or water-intensive irrigated crops. The overall effect of commodity price changes therefore, depends on the likely impact of the associated agricultural practice for the particular product and how this affects the relative prices and profitability of conservation investments. Looking at the input prices, a major determinant of adoption of conservation practices is the price that farmers have to pay to have the technology in place, i.e., the cost of adopting a conservation technology. These costs often raise the cost of production and reduce the profitability of the technology or even make it unaffordable to farmers to invest in such interventions. In some cases the cost of conservation may not show directly in terms of actual cash outlays, but in terms of indirect short-term effects on production or risk management. But, if farmers are able to recognise such indirect costs, they will be factored into their consideration of investment strategies.

Market Access and Off-farm Employment Opportunities

Market access for agricultural products often facilitates commercialisation of production and adoption of commercial inputs like fertiliser, pesticides and the like. When farmers clearly perceive the future costs of current land degradation and when policy and institutional mechanisms support changes in behaviour, improved market access can be the driving force for sustainable intensification of agriculture. But this is not always the case— there are situations where market access for certain products may end up encouraging less sustainable practices. Hence, the overall effect of improved market access on investments in land and water management is not always positive. However, market access is constrained in many rural areas by the poor transport and communication infrastructure leading to high transaction costs in accessing markets. The associated high transaction costs and limited market opportunities in turn affect adoption of sustainable land and water management options (Pender and Kerr 1998). Such market failure caused by high transaction costs is especially endemic in marginal areas where basic market infrastructure and supporting institutions are lacking or underdeveloped (Poulton et al. 2006). Pender and Kerr (1998) for example examine the role of output market failure on adoption of soil and water conservation in the semi-arid areas of India. Their findings suggest that market failure both in input and output markets affects the profitability of investments in such technologies and hence constrain adoption. Since market failure often affects households differently depending on their resource endowments, their study explained why technology choice and conservation investments may actually vary from farmer to farmer. The effect of market access or performance on farmer conservation choice and investments may also vary depending on the dimensions of the affected market. When labour markets are missing or imperfect, the empirical evidence shows that households endowed with more family labour will have an advantage to adopt labour intensive methods. When credit markets are imperfect, wealthier households with higher liquidity will have an advantage to invest in practices that require cash outlays upfront (Pender and Kerr 1998).

An interesting relationship is the effect of off-farm and non-farm employment on adoption and adaptation of sustainable and land water management interventions. Given the higher returns to labour off-farm households with unconstrained access to non-farm employment are likely to conserve less land than their counterparts. Similarly, Shiferaw and Holden (1998) find a negative relationship between off-farm income orientation and maintenance of implemented conservation structures. Kerr and Sanghi

(1992) find reduced soil and water conservation investments around large Indian cities with active off-farm labour markets than more remote areas. Two reasons are offered in the literature for the negative outcomes. First, under some situations, household workers face higher opportunity costs and prefer to allocate family labour into off-farm activities where it fetches higher returns than on-farm soil and water conservation. Second, off-farm employment often directly overlaps with slack season conservation activities and reduces the labour available for adoption and maintenance of conservation practices. Other authors however argue that there exists a positive relationship between off-farm employment and adoption of conservation technologies (Tiffen et al. 1994; Scherr 2000). These studies review empirical examples across sub-Saharan Africa that show how income from off-farm employment under certain enabling conditions can be used to fund essential soil and water conservation investments and contribute to reducing the problem of land degradation. Off-farm employment and migration opportunities may also ease the pressure on land and reduce the intensity of resource use in densely populated areas.

The emerging picture from the above discussion is that market access, especially off-farm employment, should not be necessarily bad for land and water conservation. It would seem that the direction of the effect will depend on the opportunity cost of labour, the policy and institutional environment, and how important agricultural income is for people's livelihoods. Where returns to family labour in agriculture are high due to better market opportunities and supportive policies that encourage farmer conservation, market access is likely to induce adoption of strategies for sustainable intensification.

Poverty, Asset Endowments and Scarcity

There has been a growing concern on the potential linkages between poverty and land degradation, some positing a nexus that locks poor people under a low level equilibrium that perpetuates poverty and environmental degradation. Several studies across the developing world have shown that under conditions of imperfect credit and insurance markets, asset endowments (including human capital) and wealth will have a significant influence on the ability of smallholder farmers and resource users to adopt and adapt certain conservation practices (Reardon and Vosti 1995; Holden et al. 1998; Scherr 2000; Swinton and Quiroz 2003).

Farmer Capacity to Invest in Conservation

The credit, insurance and labour markets in rural areas of many developing countries tend to be either missing or highly imperfect. This means that households who lack in cash capital, labour, essential skills or in their ability to manage risks will face constraints, especially when these resources are needed for adoption and adaptation of sustainability investments. This indicates that smallholder farmers better endowed with such family resources will have greater capacity to undertake certain conservation investments that require more of these resources. For example, education and human capital endowments affect adoption and adaptation of such practices through several directions (e.g., Swinton and Quiroz 2003). First, it enhances the likelihood of farmers perceiving land degradation as a problem. Second, it increases the likelihood of farmers to receive and process information about a technology that can solve the problem by increasing their managerial ability. On the other hand, higher levels of education under certain conditions may raise the opportunity cost of family labour in agriculture and direct its allocation into other activities that offer higher returns (e.g., migration and non-agricultural wage employment). Another important factor for farmer investment is operating capital or access to credit. This is particularly important for certain capital-intensive investments that require heavy investments upfront (e.g., irrigation, terracing, tree planting, and fertiliser use). While credit is generally found to have a significant effect in stimulating farmer investments for land and water management, it may at times conflict with the adoption of indigenous soil and water conservation practices.

Land and Water Scarcity

The effect of population pressure on incentives for sustainable resource management has been contested for a long time. Diverging theories exist on how population growth and the relative scarcity of agricultural land may affect incentives for land and water management (Boserup 1965; Cleaver and Schreiber 1994). These theories will not be reviewed here but empirical evidence provides support to both Malthusian and Boserupian type responses. However, the empirical regularities seem to suggest that, other things being equal, scarcity of land and water would stimulate farmer innovation and investment patterns in conservation practices or methods that augment and enhance the productivity of these resources (Templeton and Scherr 1999; Scherr 2000; Mazzucato et al. 2001; Shiferaw and Bantilan 2004). As we show below, lack of proper policy and institutional arrangements and informational asymmetries may however prevent farmers from pursuing strategies that save or conserve scarce resource as is often observed in over-exploitation and depletion of common pool resources (groundwater, grazing lands, lake fish, etc). Similarly, poverty and lack of credit arrangements also prevent farmers from adopting fertiliser and improved seeds, the necessary land-augmenting investments needed as farm size and/or soil fertility decline due to population growth and land degradation.

Risk

Another important factor conditioning adoption and adaptation of conservation technologies is risk. Smallholder farmers are generally risk averse and face constant difficulties in buffering various risks triggered by from health, climatic and socio-economic shocks. Hence, land and water. management technologies that increase variability or uncertainty of the income stream tend to be shunned by farmers. Such risks can arise from greater odds of crop failure or could be caused by insecure property rights. Whereas soil and water conservation generally tend to reduce production risks, there may be circumstances in which some proposed interventions may actually increase risks (Critchley et al. 1992; Shiferaw and Holden 1998; Mazzucato et al. 2001). In addition to the above risks associated with conservation itself, exogenous risks can also dampen farmers' motivation to adopt conservation technologies. Unless conservation counteracts the problem, the increased risks of crop failure due to weather variability and pest and disease outbreaks can also discourage farmer investments. But, substantial empirical evidence shows that when farmers perceive the risk-reducing benefits of conservation investments, they will be willing to increase expenditures as part of their strategy to cope with and adapt to drought and climatic shocks (e.g., water harvesting and irrigation in many semi-arid areas of India and Africa). This shows the need for farmers to recognise the risk-reducing benefits of land and water management interventions which could serve as an additional incentive to stimulate greater adoption of such practices.

Gestation Period

Most resource management investments require heavy initial investments (either in cash or in-kind) but deliver benefits many years in the future. At the same time, land and watershed degradation often impose long-term economic and environmental effects. For example, the short on-site productivity effects of soil erosion are often small but impose greater long-term consequences unless action is taken immediately. However, most resource-poor farmers have short planning horizons and face difficulties in adopting a long view (Holden et al. 1998). This is particularly the case when the cost of borrowing is high (e.g., high rates of interest) and capital markets in rural areas are largely imperfect. This raises the subjective rate of discount for poor farmers contemplating certain investments, and discourages adoption of technologies that may not offer immediate benefits, but improve livelihoods only in the long haul.

Government Policies

One of the important policy issues is the interest of some governments to provide certain agricultural input and investment subsidies to improve productivity and reduce reliance on rainfed agriculture. The effect of agricultural policies on conservation investments can best be examined by looking at public support for irrigation water and infrastructure. In India, as in many Asian countries, water for smallholder irrigation is free while the electricity used for pumping groundwater is highly subsidised (Reddy 2005). These subsidies provide distorted signals to farmers and landholders and displace efforts to invest in soil erosion control and conservation of available water (Shiferaw and Bantilan 2004; Reddy 2005). In addition, irrigation subsidies cause farmers to shift cropping patterns to water-intensive crops which should not be promoted in semi-arid areas. Subsidies can also temporarily raise the returns to conservation practices and create an impression that farmers are investing in the new management practices only for them to resort to old practices once the subsidies are withdrawn. The upshot is that while subsidies could be justified under some conditions where market or institutional failures prevent socially desirable conservation, there is a need for careful appraisal of the equity and sustainability implications of policies that affect smallholder resource use and management decisions.

Other Institutional Factors

The institutional factors conditioning the adoption of conservation technologies mainly relate to the prevailing system of property rights, that is the right of access and security of rights to land, water and other natural resources. Understandably, farmers lack economic incentives to invest their time or money if they cannot capture the full benefits of their investments. This condition may prevail when farmers have insecure rights to land (e.g., non-transferable usufruct rights) or when the natural resource is governed by open access property regime. In addition, farmers are not likely to invest on sustainable resource management of rented private property if the length of use right does not allow them to recoup their investments (Ahuja 1998; Barrett et al. 2002; Shiferaw and Bantilan 2004). Incomplete property rights and the associated public goods externalities (high costs of exclusion and non-rivalry) can also discourage private conservation investments. This is typical in investments characterised by externalities such as flood control in community watersheds. In some cases the externality may flow in both directions (reciprocal externality) or in one direction. In such cases, the inter-dependence of resource users and resources (as in watershed programmes) will require collective action and cooperation to achieve socially desirable levels of conservation investments. Promotion of certain interventions that affect several users within a given landscape and provide public goods benefits may therefore, require new kinds of policies and institutional arrangements to induce and sustain collective action. Evidence also shows that collective action (which embodies social capital) can play a significant role in the adoption and adaptation of technologies for conservation and management of contested resources.

Lack of Information and Farmer Participation

Farmer participation in the design of conservation technologies and availability of information about the potential benefits and risks associated with new methods has an important role to play in influencing farmers' attitudes and perceptions. Many past interventions that followed the top-down non-participatory approach have failed (Reij 1991; Tiffen et al. 1994; Robbins and Williams 2005). A number of factors have contributed to the success of participatory conservation technologies designed using bottom-up approaches. First, such technologies take into account the unique socio-economic characteristics of target farmers, allowing them to adapt to their specific circumstances. Second, farmers are able to test, try or experiment with and adopt various practices at their own pace and preferred sequence. This process of farmer innovation and adaptive experimentation leads to a high degree of compatibility with local situations and farming systems (Robbins and Williams 2005). Third, participatory approaches allow farmers to gradually adapt the technology to changing market and agro-climatic conditions (Bunch 1989). The information and perception issues are also important as some types of land degradation may not be directly visible to farmers, especially when external variability in growing conditions makes it difficult for farmers to attribute such changes to declining resource quality. Farmers will adopt technologies only if they perceive soil and water degradation as a major problem that affects their livelihood (Fujisaka 1994; Baidu-Forson 1999; Cramb et al. 1999). Along with participatory technology design, education and awareness about new options and the process of resource degradation or depletion (e.g., levels of soil fertility or groundwater depletion) are critical in stimulating awareness and action by individual resource users and communities.

Biophysical Environment

Finally the profitability of natural resource investments will ultimately depend on the agro-ecological and bio-physical conditions. Factors like the natural fertility of soils, topography, climate and the length of the growing period influence the success of research investments and the type of technologies needed to sustain livelihoods and conserve the resource base. For example, meta-analysis of watershed development impacts in India identified rainfall and water availability as major determinants of the success of community watershed programmes. Cost-benefit ratios were found to be largely positive in medium rainfall (701– 900 mm) and low-income regions (Joshi et al. 2005). This indicates that in drought-prone semi-arid areas with infertile soils and erratic rainfall patterns, risk considerations imply emphasis on water management to reduce vulnerabilities to drought and to increase crop yields. In such areas suffering from moisture stress and seasonal drought, water conservation provides an important entry point, hence the need to focus on enhancing in-situ conservation and productivity of water. Technologies for water harvesting and supplementary irrigation provide higher incentives for farmers to adopt other complementary inputs. This is mainly because the quick gains in terms of reduced risk of drought and increased productivity of other purchased inputs (e.g., fertiliser) enhance the expected returns from such investments. Similarly, in higher rainfall areas, soil and water conservation may emphasise mitigating soil erosion through cost-effective methods, which reduce overland flow and improve safe drainage of excess water. Even in such areas, the excess water may derive some benefits for supplementary irrigation during the post-rainy season or for domestic and livestock use. The heterogeneity of the biophysical system in both dry and wet areas therefore, suggests the need for careful consideration of local conditions in designing conservation options. The challenge is on how to balance applied research needed to adapt to micro niches with the need for strategic knowledge on crosscutting issues that will have wider relevance and application.

Recent Efforts by the Government of India through Watershed Programmes

In India, from 1994-95 onwards, participatory watershed development approaches have been seen as the solution for the problem of rural resource degradation and poverty. Studies conducted on a large number of projects (Farrington, J., C., Turton. and A. J. James 1999; Jodha, N. S. 1986; Kerr, J.

and K. Chung 2001; Knox, A. and R., Meinzen-Dick 2001; Hemantha Kumar U. et al 2007; SSP Sharma et al 2008) : claim substantial improvements, mostly based on the positive bio-physical indicators as well as the new institutions built during the project. However, there is still no convincing evidence if there has been equity in the distribution of benefits and if they have been successful strong cases in alleviating poverty of the most vulnerable sections and more so with an emphasis on better land and water use practices. Though the overall impact of the several projects under watershed approach in India, on livelihood of the people of the project area has been remarkable, there have been significant differences in the benefits accrued between farmers and landless labourers. While the farmers benefited from the improved natural resource base directly by increasing productivity and adopting economically favourable cropping patterns, the landless could not derive their full share of benefits from the project due to lack of access to land. Equity in resource possession/ enhancement is also not visible. Other institutional building efforts did less to strengthen their voice and bargaining power to articulate their interests. Group dynamics (both heterogeneous/homogeneous in nature) while dealing with the watershed related activities are not documented much.

Gaps in Literature

It is clear from the above reviewed that concerted efforts have been made in the past to make various natural resource management based programmes (include watershed programmes) an important source of growth in the rainfed areas. Yet there are a number of gaps in the existing framework that do not allow reaping the potential benefits of investment incurred on various programmes. Few important gaps have been documented from the earlier studies, which need to be addressed properly. The following issues need attention to revisit the policy environment.

* From small and marginal farmers' point of view special attention is needed for developing suitable methods to assess the impact of watershed development programmes on poverty alleviation, employment generation, livelihood patterns and conservation of soil and water resources in the rainfed areas.

* Formulation of investment strategies for watershed development and there is a need to prioritise regions, delineation of water scarce and poverty ridden areas.

* Evolve policy options that ensure equitable sharing of watershed management benefits across sections of watershed community and for allocating water and sharing costs and benefits among upstream and downstream communities to mitigate the problem of externalities.

* Develop policies for introducing high-value commodities and marketing strategy in the watershed areas to enhance productivity of water and other resources- strengthen diversification opportunities.

* Development of transparent institutional framework to overcome the conflicting objectives, free riders' problem and sharing of costs and benefits.

* Institutionalisation of partnership between the government, private sector, non-governmental agencies, research institutions and clearly defining their roles and responsibilities to achieve convergence and efficiency.

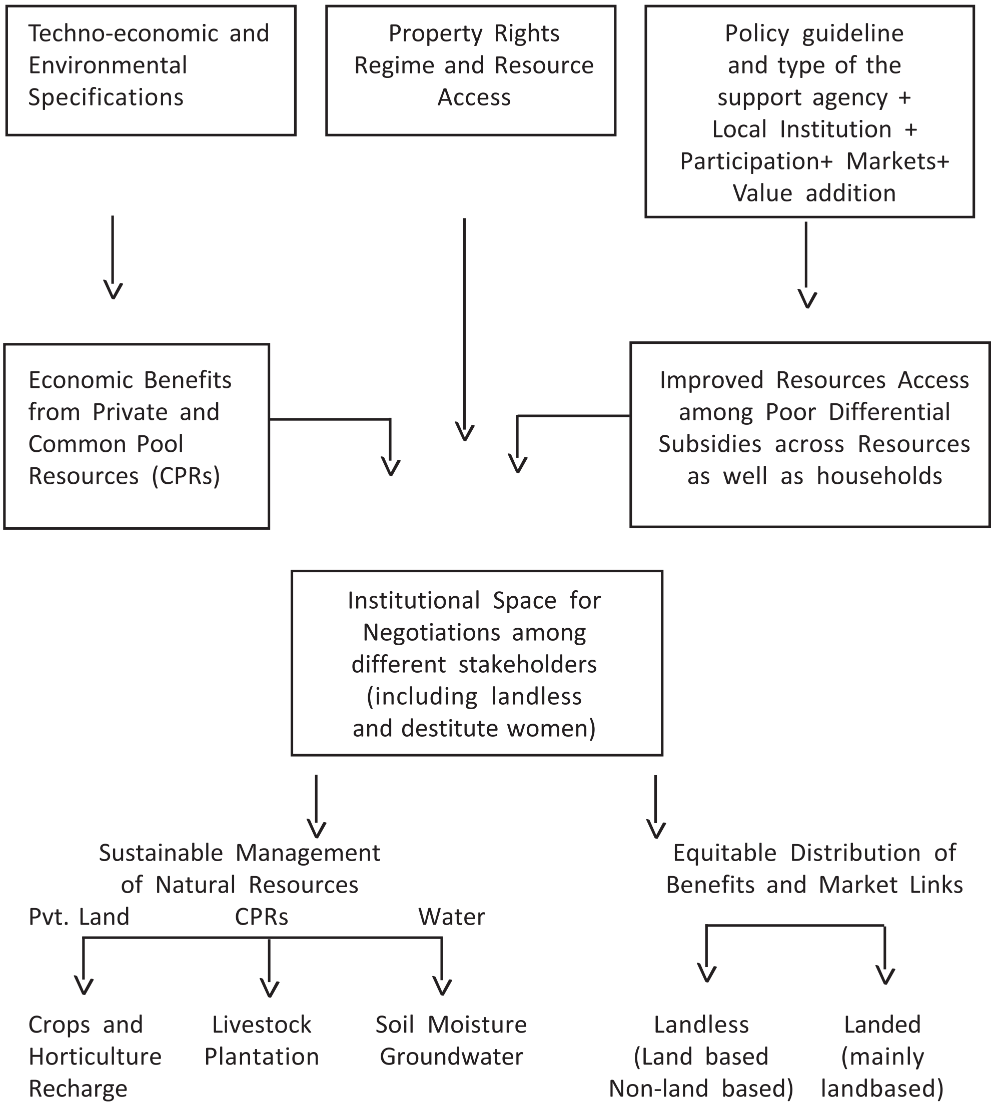
* Promotion of innovative institutions (contract farming or cooperatives) to strengthen production and marketing

* Dissemination of information by making use of ICT on latest technologies, markets, prices, etc.

* A continuous flow of improved demand-driven technologies is needed for developing targeted and location-specific technologies to meet the needs of small farmers based on their resource endowments.

To overcome certain imbalances while dealing with these resources, one has to refer its dynamics and act accordingly (see Figure I).

Figure I : Natural Resources and its Dynamics



Source : K.J Joy et al (2006), "Reorienting the Watershed Development Programme in India", Forum for Watershed Research and policy Dialogue, Occasional Paper, SOPPECOM, GIDR and CISED.

Providing livelihood assurance for the poor (small and marginal, landless and destitute women), at the same time ensuring environmentally sustainable resource augmentation and use, is dependent on how all these stakeholders negotiated and equal distribution of benefits received among themselves keeping in view availability of funds, processes and institutional arrangements have to be worked out by identifying the expected outcome in the light of above logical framework. All these work through integration of all possible fronts (including convergence across sectors) as well as institutional arrangements and group dynamics (homogenous/ heterogeneous).

Objectives

The objectives of the study are

1. To examine the land and water use practices of small and marginal farmers, and

2. To study the livelihood security of small and marginal holders under the changing scenario of land and water use practices.

Area and Period of the Study

For comparative picture, four States were selected, namely Gujarat, Tamil Nadu, Jharkhand and West Bengal. The study was carried out in the year 2009.

Hypothesis

The hypothesis of the study is the determining factor of land and water use practices properly considered for assignment purposes of entitlements, and livelihood security of small and marginal farmers stands unaltered despite the changing scenario of land and water use practices.

Methodology

To study the effectiveness of land and water use practices, the study has been carried out in four States viz., Gujarat, Tamil Nadu, Jharkhand

and West Bengal. Based on the secondary data, one rainfed district was selected in each State. The selection of the district and sample villages was further based on rainfall patterns, runoff/soil erosion, exploitation of groundwater, low crop yields and drinking water scarcity. The data were collected at two levels, primary and secondary. The primary data were collected at village as well as household level through structured questionnaire and focus group discussions (FGD). From the selected district, based on above criteria, the study identified two rainfed blocks. Based on same criteria from each block two villages were selected. The sample technique was purposive and the sample size was 12 (include small, marginal farmers and women) households in each village (Table 1.12). The indicators developed and studied were working condition of the inventions done, nature of technology and management arrangements, farmers' perceptions and alternative about soil and water conservation methods, implementation of the works, decision-making process, farmers' involvement/farmers' opinion, impact and livelihood security. For secondary data collection the study mostly relied upon the village level records (Patwari/village secretary).

Table 1.12 : Sample Design

Name of the State	Name of the District	Block	Sample Gram Panchayats/ Villages	No. of sample respondents
Gujarat	Sabarkantha	Malpur	1. Dodiya (Jogi vanta kumpa)	12
			2. Persoda	12
		Vijaynagar	3. Itavadi	12
			4. Masota	12
Tamil Nadu	Ramanadhapuram	Kadaladi	1. S. Vagaikulam	12
			2. Uchilankulam	12
		R.S.Mangalam	3. A.R. Mangalam	12
			4. Guduluru	12
Jharkhand	Deoghar	Sarawan	1. Jaikhara	12
			2. Banwariya	12
		Palojori	3. Parnagari (Basputia)	12
			4. Basata	12
West Bengal	Burdwan	Ausgram		
			1. Ukta (Sifafati)	12
			2. Asgram (Banangram)	12
		Kanksa	3. Kanksa (Amani Danga)	12
			4. Trilokchandra (Setar bandh)	12

Section III

Role of Smallholding Agriculture : Challenges and Opportunities

The agricultural economy contribution to gross domestic product (GDP) is one-sixth, and provides employment to 56 per cent of the workforce, however, the real development in terms of growth shared by all sections of the population has not taken place. The problems of poverty, unemployment, inequalities inaccess to health and education and poor performance of agriculture sector are still prevalent in the country. In recent past (after post-reform period) the growth in agriculture sector showed lower than 2 per cent per annum in the decade of mid-1990s to mid-2000s. There are also concerns on food security and livelihoods. Small holdings agriculture which is the focus of this study is important for raising agricultural growth, food security and livelihoods in India. It may be noted that Indian agriculture is the home of small and marginal farmers (72 per cent).

Therefore, the future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers. The first and foremost problem faced by the small and marginal farmers is that the average size declined from 2.3 ha in 1970-71 to 1.37 ha in 2000-01. Small and marginal farmers account for more than 72 per cent of total farm households and their share in operated area is around 44 per cent. Thus, there are significant land inequalities in India. Small holdings also face new challenges on integration of value chains, liberalisation and globalisation effects, market volatility and other risks and vulnerability, adaptation of climate change etc. (Thapa and Gaiha (2011). Recent developments have aggravated the situation further such as commercialisation of increasing proportions of input and output, institutional changes helped large farm holders. Broadly, agricultural development policies over time can be divided into four sets of policy packages: (a) institutional reforms; (b) public investment policies; (c) incentive policies; and (d) reforms and globalisation policies. The relative importance of the first three sets has varied over time (Mahendra Dev, 2012).

* The first three Five Year Plans (1950–65), *institutional reforms and public investment packages* dominated. The Central and State

governments enacted a number of laws regarding land reforms. These laws mainly relate to three aspects: abolition of zamindari system, land ceiling and redistribution of land, and tenancy reforms. The government was successful in abolishing the zamindari or intermediary system after paying compensation to the zamindars. The land ceiling laws were not effective although there was redistribution of some land to the beneficiaries. The tenancy reforms were more successful in two States, West Bengal in the east and Kerala in the south, than in others. West Bengal succeeded in giving ownership rights to tenants, particularly sharecroppers (bargardars) (some kind of entitlement). Some efforts were made to consolidate fragmented holdings in India since Independence. In some parts of north and north-west India these efforts were relatively successful.

* There was significant *public investment* in agriculture during 1950–65. To achieve the objective of self-sufficiency in foodgrains, there was massive investment particularly in constructing irrigation reservoirs and distribution systems. Another important policy during this period was the expansion of institutional credit which helped reduce informal sources that had been exploitative in respect of interest rates and terms and conditions.

* During the 1967–90 period, *incentive policies* for adoption of new technology and public investment policies dominated government strategy in agriculture. After the humiliating experience with import of foodgrains in the mid-1960s (especially under PL 480), there was a vigorous drive for achieving self-sufficiency in foodgrains by stepping up public investment in irrigation and introduction of new technology through incentives. Yields increased significantly for wheat initially and later for rice. This breakthrough is popularly known as the 'green revolution'. The productivity improvement associated with the green revolution is best described as forest- or land-saving agriculture. It may be noted that without the green revolution it would not have been possible to lift the production potential of Indian agriculture.

* Incentive policies focused on both inputs and output. Subsidies for inputs like irrigation, credit, fertilisers, and power increased significantly in the 1970s and 1980s. The objective of the subsidies is to provide inputs at low prices to protect farmer interests and encourage diffusion of new technology. Similarly, on the output side, there has been a comprehensive long-term procurement-cum-distribution policy in the post-green revolution period. The government announces the support prices at sowing time and agrees to buy all the grains offered for sale at this price. To support these operations, institutions like the Food Corporation of India (FCI) and the Agricultural Prices Commission (APC) were established in the mid-1960s.

* In the post-reform period, economic reforms in India since 1991 have improved the incentive framework and agriculture has benefited from reduction in protection to industry. The terms of trade for agriculture have improved and private investment has increased. Export of commodities, particularly cereals, has risen and there has been some progress on market reforms in terms of removing domestic and external controls. However, there were also concerns about agriculture and food security in the 1990s. There has been emphasis on price factors at the cost of non-price factors like research and extension, irrigation, and credit. Economic reforms have largely neglected the agricultural sector and only in the last few years have domestic and external trade reforms in the sector started (Mahendra Dev. S, 2012).

Role of Small Holding Agriculture

The small holding character of Indian agriculture is much more prominent today than even before.

* According to the Agricultural Census Division of Department of Agriculture and Cooperation, the average size of holdings in India declined from 2.3 ha. in 1970-71 to 1.33 ha. in 2000-01. It may be noted that 63 per cent of landholdings belong to marginal farmers

with less than 1 ha. The average size of marginal holdings is only 0.24 at all India level. The average size of small holdings is 1.42 ha. The average size of marginal holdings varies from 0.14 ha. in Kerala to 0.63 ha. in Punjab.

* Access to irrigation has increased for all categories of farmers. It is the highest for marginal farmers followed by small farmers. The percentage of area under irrigation for small farmers increased from 40 in 1980-81 to 51 in 2000-01. On the other hand, for large farmers it rose from 16 to 31 per cent during the same period. It may, however, be noted that large farmers capitalise on cheaper sources like canals while small farmers have to rent water. About 40 per cent of the irrigated area for large farmers was from canals while it was less than 25 per cent in the case of small and marginal farmers (NCEUS, 2008).

* The fertiliser per hectare is inversely related to farm size for both irrigated and unirrigated areas. It increased from marginal farmers in irrigated areas from 100 kgs in 1980-81 to 252 kgs in 2001-02. In fact, the per hectare consumption for all farm sizes was similar on irrigated areas in 1981-82 but it rose faster for marginal farmers and small farmers in 2001-02. This is true in the case of unirrigated areas also. Similarly, the percentage of area under high-yielding varieties (HYV) is also inversely related to farm size (Chand et al, 2011). In the irrigated areas, the coverage of area under HYV was 89, 86 and 78 per cent, respectively in marginal, small and large farmers in 2001-02. In the case of unirrigated areas, the coverage was above 50 per cent for marginal, small and semi-medium but it was only 30 per cent for large farmers in 2001-02.

* Multiple cropping indexes are higher for marginal and small farmers than that for medium and large farmers. For marginal farmers, cropping intensity increased from 134 in 1981-82 to 139 in 2001-02. In the case of large farmer, it rose from 116 to 121 during the same period. The differences across farm sizes persisted over time. When it comes to the cropping pattern: (a) small and marginal farmers

allocate larger proportion of their cultivated land to high value crops like fruits, and vegetables ; (b) small and marginal farmers seem to have comparative advantage in growing vegetables than fruits because of quick returns in the former; (c) small and marginal farmers allocate larger proportion of rice and wheat than other farmers; (d) small and marginal farmers allocate lower proportion of land to pulses and oilseeds (Birthal et al (2011).

* The contribution to output is higher for marginal and small farmers as compared to their share in area. The share of these farmers was 46.1 per cent in land possessed but they contribute 51.2 per cent to the total output of the country at all India level in 2002-03 (using NSS unit level data 59th Round on Situation Assessment Survey of Farmers 2003). There are significant regional variations in their contribution to output. The share of output is less than the operated area in ten states. In rest of the states, the reverse was true. The contribution of small and marginal farmers to output ranges from 19 per cent in Punjab to 86 per cent in West Bengal. It is less than 50 per cent in 9 out of 20 states. In the eastern states, the share of both area and output are high for these farmers. On the other hand, in some of the states in central, western and north-western regions, medium and large farmers still dominate in both area and output.

* In terms of production, small and marginal farmers also make larger contribution to the production of high value crops. They contribute around 70 per cent to the total production of vegetables, 55 per cent to fruits against their share of 44 per cent in land area (Birthal, 2011). Their share in cereal production is 52 and 69 per cent in milk production. Thus, small farmers contribute to both diversification and food security. Only in the cases of pulses and oilseeds, their share is lower than other farmers (the reason is obvious that the small farmers have no access to credit and other inputs).

* There has been debate in India on the relationship between farm size and productivity. The results of NSS 2003 farmers' survey empirically established that small farms continue to produce more

in value terms per hectare than the medium and large farms. The value of output per hectare was ₹ 14754 for marginal farmers, ₹ 13001 for small farmers, ₹ 10655 for medium farmers and ₹ 8783 for large farmers. It shows that from efficiency point of view, small holdings are equal or better than large holdings. For marginal farmers, it varies from ₹ 29448 in Punjab to ₹ 7177 in Rajasthan. This is also true for large medium and large farmers – it ranges from ₹ 28983 in Punjab to ₹ 4213 in Rajasthan. In many states, small holdings have higher value of output per hectare than large farms. However, in the case of States like, Kerala, Madhya Pradesh, Uttar Pradesh, Himachal Pradesh and Tamil Nadu, the large farms have higher productivity (in value terms) than marginal farmers. In the case of Punjab, the differences in productivity are not large across farm sizes.

Smallholders' Livelihoods

The sustainability of small and marginal farmers is crucial for livelihoods in rural areas and for the entire country. It is true that small holdings have higher productivity than medium and large farms. But, the net farm income per hectare in large holdings is higher than small holdings (using NSS unit level data 59th Round on Situation Assessment Survey of Farmers 2003). However, the monthly income and consumption figures across different size class of landholdings show that marginal and small farmers have dis-savings compared to medium and large farmers. The average monthly income of farmer households comprises income from wages, net receipts from cultivation, net receipts from farming of animals and income from non-farm business. The average monthly consumption of farmer households comprises total food and non-food expenditure.

According to NSS 2003 data, the monthly consumption of marginal farmers was ₹ 2482 and monthly income was ₹ 1659. It shows that they have dis-savings of ₹ 823. The dis-savings for small farmers were ₹ 655. On the other hand, for large farmers, monthly income and consumption, respectively were ₹ 9667 and ₹ 6418 with savings of ₹ 3249. As NCEUS (2008) says, "consumption expenditure of marginal and small farmers exceeds their estimated income by a substantial margin and presumably the deficits have to be plugged by borrowing or other means". NCEUS (2008) also indicates that the poverty for small holding farmers is much higher than other farmers. The need for increase in productivity and incomes of small holdings and promotion of non-farm activities for these farmers is obvious.

Issues and Challenges for Small Holders

There are many issues and challenges for small holding agriculture in India. NSS farmers' survey of 2003 brought out many issues relating to small and marginal farmers. Based on this Survey, NCEUS (2008) says, "some of the general issues that confront marginal-small farmers as agriculturalists are :

i) imperfect markets for inputs/product leading to smaller value realisations;

ii) absence of access to credit markets or imperfect credit markets leading to sub-optimal investment decisions or input applications;

iii) poor human resource base; smaller access to suitable extension services restricting suitable decisions regarding cultivation practices and technological know-how;

iv) poorer access to 'public goods' such as public irrigation, command area development, electricity grids; greater negative externalities from poor quality land and water management, etc".

Role of Women

The importance of women in agriculture has been increasing. The share of rural females in agriculture was around 83 per cent in 2004-05 as compared to 67 per cent among rural men, showing the importance of women in agriculture in rural areas. Percentage of women among marginal farmers (38.7 per cent) is higher than that for large farmers (34.5 per cent) in 2004-05. These proportions have increased over time. Agriculture is becoming increasingly feminised as men are migrating to rural non-farm sector. They work in "land preparation, seed selection and seed production, sowing, in applying manure, fertiliser and pesticides, weeding, transplanting, threshing, winnowing and harvesting etc as well as in animal husbandry and dairying, fish processing, collection of non-timber forest produces (NTFPs), backyard poultry, and collection of fuelwood, fodder and other products for family needs" (GoI, 2007). Despite their importance, women are continually denied their property rights and access to other productive resources. Protecting women's rights in land, enhancing infrastructure support to women farmers, and giving legal support on existing laws, will facilitate recognition for women as farmers and enable them to access credit, inputs, and marketing outlets.

Social Groups

The proportion of socially disadvantaged groups such as Scheduled Castes (SCs) and Scheduled Tribes (STs) is higher among marginal and small farmers than that of medium and large farmers. Around 22 per cent of semi-marginal and marginal farmers are from SCs compared to 7.8 per cent in medium and large farmers. SCs have more than half of their holdings of less than half a hectare. Similarly, 15.6 per cent of small farmers belong to STs compared to 14.9 per cent among medium and large farmers. The distribution of land ownership among STs is better than SCs. However, the quality of STs land is probably of the lowest quality. Social identity of farmers is also seen to mediate access to economic resources and outcomes. Even after accounting for quantity and quality of land owned by socially deprived classes, their access to information, marketing, credit and publicly provided inputs and extension services is lower. This shows that they possibly suffer from discrimination in the delivery of public services as well as market (NCEUS, 2008).

Land Issues

Land and Tenancy Security

National Commission on Enterprises for Unorganised Sector argued that there is a strong evidence that relatively successful implementation of even a modest package of land reforms dramatically improves the prospect of the poor. Regarding small and marginal farmers, they own and cultivate some land but it is a limiting factor for getting resources. Therefore, tenancy security is important for small holding farmers.

Land relations are extremely complicated and this complexity has contributed significantly to the problems faced by actual cultivators. Unregistered cultivators, tenants, and tribal cultivators all face difficulties in accessing institutional credit and other facilities available to farmers with land titles. One priority is to record and register actual cultivators including tenants and women cultivators, and provide passbooks to them, to ensure that they gain access to institutional credit and other inputs. As part of the reforms, lease market should be freed and some sort of security for tenants has to be guaranteed. This will ensure availability of land for cultivation to marginal and small farmers. The land rights of tribals in the agency areas must be protected. There is considerable scope for further land redistribution, particularly when waste and cultivable lands are taken into account. Complementary inputs for cultivation (initial land development, input minikits, credit, etc.) should be provided to all assignees, and the future assignments of land should be in the name of women.

On land market, the Report of the Steering Committee recommended the following : "Small farmers should be assisted to buy land through the provision of institutional credit, on a long term basis, at a low rate of interest and by reducing stamp duty. At the same time, they should be enabled to enlarge their operational holdings by liberalising the land lease market. The two major elements of such a reform are: security of tenure for tenants during the period of contract; and the right of the land owner to resume land after the period of contract is over" (Planning Commission, 2007a). Basically, we have to ensure land leasing, create conditions including credit, whereby the poor can access land from those who wish to leave agriculture.

Low Level of Formal Education and Skills

Education and skills are important for improving farming practices, investment and productivity. The literacy and mean years of education are lower for small holding farmers compared to medium and large farmers. For example, literacy among males and females for marginal farmers, respectively were 62.5 and 31.2 per cent while the corresponding numbers for medium and large farmers were 72.9 and 39 per cent. Similarly, mean years of education for males among marginal farmers were 3.9 as compared to 5.3 for medium and large farmers. It is important for small holding farmers to have a reasonable level of awareness regarding information on agriculture. The low level of farmers' education limits public dissemination of knowledge. The NSS farmers' survey clearly shows that awareness about bio-fertilisers, minimum support prices and WTO is associated with education levels which are lower for marginal and small farmers.

Credit and Indebtedness

Small holdings need credit for both consumption and investment purposes. Increasing indebtedness is one of the reasons for indebtedness among these farmers in recent years. Table 16 shows that overall indebtedness is not higher for small and marginal farmers compared to large farmers. However, the indebtedness for the small and marginal farmers from formal institutional sources is lower than large farmers and the reverse is true in the case of informal sources. The dependence on moneylenders is the highest for sub-marginal and marginal farmers. The share of formal source increases with the size of land. At all India level, the share of formal source varies from 22.6 to 58 per cent for small and marginal farmers while it varies from 65 to 68 per cent for medium to large farmers. Dependence of small and marginal farmers on informal sources is high even in States like Andhra Pradesh, Punjab and Tamil Nadu. For example, small and marginal farmers of Andhra Pradesh have to depend on 73 to 83 per cent of their loans on informal sources. This indicates very low financial inclusion for Andhra Pradesh. The NSS data also show that across social groups, indebtedness through formal sources is lower for STs as compared to others.

Risk and Vulnerability

There is enough evidence to suggest that poor and poorest of the poor households are vulnerable to a range of risks affecting individuals, households or whole communities which can have a devastating effect on their livelihoods and well-being. They have higher exposure to a variety of risks at individual or household level. Some of them are (a) health shocks: illness, injury, accidents, disability; (b) labour market risk: many work in informal sector and have high risk of unemployment and underemployment; (c) harvest risks, life cycle risks, social risk and special risks for vulnerable groups. In addition, they have community risks such as droughts, floods, cyclones, structural adjustment policies etc. Small and marginal farmers are vulnerable to all these risks. Most of the coping mechanisms followed by households are: borrowing, sale of assets, spending from savings, assistance from relatives and government expanded labour supply, child labour, bonded labour, reduced consumption, migration etc.

Comprehensive social protection programmes are required to address the negative effects due to risks and vulnerabilities. India has many social protection programmes. The present major schemes for the poor in India fall into four broad categories: (i) food transfer like public distribution system (PDS) and supplementary nutrition (ii) self -employment (iii) wage employment and (iv) social security programmes for unorganised workers. The effectiveness of these programmes has to be improved so that small and marginal farmers can also benefit from these programmes. Crop insurance programmes and future markets have to be strengthened to reduce risks in price and yields.

Opportunities for Small Holding Agriculture

There are many technological and institutional innovations which can enable marginal and small farmers to raise agricultural productivity and increase incomes through diversification and high value agriculture. It is known that India spends only 0.5 per cent of GDP on agricultural research as compared to more than 1 per cent by other developing countries. There is considerable potential for raising the effectiveness of these outlays by reordering the priorities in agricultural research and redefining the relative roles of public and private sectors in research and extension (Mahendra Dev, 2012). There is a need to shift away from individual crop-oriented research focused essentially on irrigated areas towards research on crops and cropping systems in the drylands, hills, tribal and other marginal areas. Dryland technology has to be improved. In view of high variability in agro-climatic conditions in such unfavourable areas, research has to become increasingly location-specific with greater participation or interaction with farmers. Horticulture crops that are land-saving and water-saving should be encouraged in dryland areas. Progress in post-harvest technology is essential to promote value addition through the growth of agro-processing industry.

Technological Innovations

It may be noted that agricultural technologies are 'scale neutral' but not 'resource neutral' (Singh et al, 2002). Small holder-oriented research and extension should give importance to cost reduction without reduction in yields. Therefore, new technological innovations are needed. "These include low external input and sustainable agriculture approaches based on ecological principles but without the use of artificial chemical fertilisers, pesticides or genetically modified organisms; and biotechnology" (Thapa and Gaiha, 2011). The need for adopting the methods of an evergreen revolution has become very urgent now. As Swaminathan (2010) mentions, among other things, there are two major pathways to fostering an evergreen revolution.

* The first is organic farming. Productive organic farming needs considerable research support, particularly in the areas of soil fertility replenishment and plant protection.

* The other pathway to an evergreen revolution is green agriculture. In this context, ecologically sound practices like conservation farming, integrated pest management, integrated nutrient supply and natural resources conservation are promoted. Green agriculture techniques

could also include the cultivation of crop varieties bred through use of recombinant DNA technology if they are good in resisting to biotic and abiotic stresses or have other attributes like improving nutritive quality (Swaminathan, 2010).

* Another technology is that *Zero Tillage*- Cultivation practices such as zero-tillage (which involves injecting seeds directly into the soil instead of sowing on ploughed fields) combined with residue management and proper fertiliser use can help to preserve soil moisture, maximise water infiltration, increase carbon storage, minimise nutrient runoff, and raise yields (WDR, 2010).

* Rural women play a significant role in animal husbandry and are directly involved in major operations like feeding, breeding, management and health care. As the ownership of livestock is more evenly distributed with landless labourers, and marginal farmers, the progress in this sector will result in a more balanced development of the rural economy, particularly in the reduction of poverty and malnutrition. As Singh et al (2002) mention, priorities for livestock technology development are animal health, nutrition, and reproduction.

* Management strategies to improve the nitrogen use efficiency of crops which reduce fertiliser requirements focus on fertiliser best management practices. A note written for IFPRI by Flynn (2009) says that the best practices should look at application type, application rates, application timing and application placement. For example, balancing application rates of nitrogen with other required nutrients including phosphorus, potassium and sulphur is a major way of improving nitrogen use efficiency. Similarly, appropriate nitrogen application rates are important in order to have effectiveness on yields.

* Another way is switching to organic production which can reduce fertiliser use-Better use of existing organic sources of nutrients, including animal manure, crop residues, and nitrogen-fixing crops

such as legumes. Such organic nitrogen sources may also contribute to raising sequestration of carbon in soils (Flynn, 2009). However, yields have to be maintained with organic farming as compared to cultivation with chemical fertilisers.

* Recently India had two revolutions in technology. One is BT cotton and the other is hybrid maize. Studies on Bt cotton showed that small farmers benefited from the introduction of this technology. A study in four districts of Andhra Pradesh (Warangal, Nalgonda, Guntur, Kurnool) examined, among other things, whether the benefits of Bt Cotton technology are shared by all groups of farmers across social categories and size groups (Rao and Dev, 2010). The green revolution technologies have been utilised by upper strata of farmers and later gradually spread to other strata. But in the case of biotechnological application, the small farmers and SC and ST farmers also made use of the technology well since the beginning. The small farmers growing Bt cotton have significantly improved their position compared to the non-Bt growing small farmers. The net income improved by 69 per cent and farm business income improved by 108 per cent. This clearly shows that the small farmers are better-off with Bt cotton than without Bt cotton. Same is the case with Scheduled Castes (SCs). Bt cotton led to improving the net income by 59 per cent. The farm business income is higher by three times than non-Bt farmers from SCs. Therefore, it is very clear that the farmers from SCs, who are also generally small farmers, got benefited from adopting this technology.

Institutional Innovations

Small holding agriculture faces many challenges. But, a number of innovative institutional models are emerging and there are many opportunities for small and marginal farmers in India. Institutions relating to (a) land and water management, (b) group or cooperative approach for inputs and marketing and, (c) value chains and supermarkets can enhance productivity, sustainability and incomes of small holding agriculture.

Institutions for Sustainable Land and Water Management

Major areas of reforms needed in irrigation are: stepping up and prioritising public investment, raising profitability of groundwater exploitation and augmenting groundwater resources, rational pricing of irrigation water and electricity, involvement of user farmers in the management of irrigation systems and, making groundwater markets equitable (Rao, 2005). In a recent study, Shah et al (2009) indicate that the impact of the drought of 2009 is expected be less severe than the drought of 2002 due to groundwater recharge in the last few years. Groundwater can be exploited in a big way in eastern region. Watershed development (IWMP Guidelines, 2008) and, water conservation by the community are needed under water management. Assets created under MGNREGS can help in improving land and water management.

Institutions for Marketing of Small Holdings

For small and marginal farmers, marketing of their products is main problem apart from credit and extension. In recent years, there has been some form of *contract arrangements* in several agricultural crops such as tomatoes, potatoes, chillies, gherkin, baby corn, rose, onions, cotton, wheat, basmati rice, groundnut, flowers, and medicinal plants. There is a silent revolution in institutions regarding non-cereal foods. New production –market linkages in the food supply chain are: spot or open market transactions, agricultural cooperatives and contract farming (Joshi and Gulati, 2003). One of the most successful *producer organisations* is the Indian dairy cooperative which in 2005 had a network of more than 100,000 village level dairy cooperatives with 12.3 million members (Birthal et al 2008). Contract farming has a potential to help the small and marginal farmers overcome constraints in accessing inputs, credit, extension and marketing. In recent years, there has been some form of contract arrangements in several agricultural crops such as tomatoes, potatoes, chilies, gherkin, baby corn, rose, onions, cotton, wheat, basmati rice, groundnut, flowers, and medicinal plants and is spreading throughout India in States like Andhra Pradesh (Dev and Rao, 2005), Tamil Nadu, Karnataka, Punjab and Maharashtra.

Policies to Support to Smallholders

In the case of small holding agriculture, Government has to play an important role in improving productivity and incomes of small farmers. The Eleventh Five Year Plan says that "the agricultural strategy must focus on 85 per cent of farmers who are small and marginal, increasingly female, and who find it difficult to access inputs, credit and extension or to market their output". The National Commission for Enterprises in the Unorganised Sector (NCEUS) has recommended a special programme for marginal and small farmers. The report of NCEUS analyses the status and constraints faced by marginal and small farmers and focuses on the need for a special programme which aimed at capacity building of these farmers, both the farm and non-farm activities. NCEUS recommended four measures. These are: (a) Special programmes for maginal and small farmers; (b) Emphasis on accelerated land and water management; (c) Credit for marginal and small farmers; (d) Farmers' debt relief commission.

The Commission strongly advocates that a strategy for marginal and small farmers must focus on group approaches in order to benefit from the economies of scale. A focused approach can be used to incentivise the formation of farmers' groups and apex organisations and government and other can facilitate in finding solutions to problems of irrigation, inputs, procurement, markets and risk.

The Commission has considered four important models for group approach in the country. These are : Cooperatives, Producer's Companies, Farmers' groups such as those in Andhra Pradesh and SEWA (Self-Employed Women's Association) Farmers' model.

* Cooperatives and farmers' groups on the lines of Self-Help Groups (SHGs) seem to hold greater promise for expansion. It may be noted that formation of marginal and small farmers' groups on the lines of SHGs has developed under agency structure such as 'Velugu' or Indira Kranti Pradham (IKP) or CMSA mentioned above in Andhra Pradesh, 'Kudumbashree' in Kerala and SEWA in Gujarat.

* Such initiatives are being developed in Tamil Nadu, West Bengal, Odisha and Madhya Pradesh as well. As the Commission mentions, the "main lesson of these experiences is the capacity building and group formation among the poor, marginal and small farmers cannot be simply seen as an extension of routine departmental activity and as one of the many activities that a programme seek to promote" (p.39). These groups under agency approach can be promoted where farmers' cooperatives are not operating.

The elements of special programmes advocated by NCEUS (2008) are the following :

(a) *Promotion of Marginal and Small Farmers' Groups :* In many states groups on lines of self -help groups (SHGs) are few. Special efforts have to be made to facilitate formation of such groups. The special programme proposes setting up of Marginal and Small Farmers' Development Society (MSFDS) for the promotion, capacity building and coordination of development of marginal and small farmers' groups.

(b) *Enabling Greater Access to Institutional Credit :* Linking Marginal and small farmers' groups to banks are an essential step towards needed credit flow to these farmers.

(c) *Training and Capacity Building :* The special programme aims at motivating and enabling marginal and small farmers to acquire skills by establishing Community Resource Centres, by promoting marginal and small farmer activists at the village, cluster and block levels.

(d) *Support for Strengthening and Creation of Non-farm Activities :* This aims to bridge the farm activities and non-farm activities of small holding agriculture as income from small farming is hardly sufficient to meet the basic needs of the farm households.

(e) *Gender-focused Activities :* It is known that the share of women is increasing in agriculture. This programme aims that the farmers' groups should have adequate representation of women farmers.

(f) *Planning for Development of Marginal and Small Farmers :* The Marginal and Small Farmer's Development Society would develop a medium term development strategy for these farmers.

CHAPTER II

LAND AND WATER USE PRACTICES OF SMALLHOLDERS : STATUS AND OPPORTUNITIES IN THE SAMPLE DISTRICTS

Identification of homogeneous agro-climatic zones for regional planning is beneficial for proper utilisation of land, water and other resources through transfer of suitable technology, choice of crops, adoption of uniform policy and distribution of management inputs etc., among the climatic analogues. With the diverse climate-soil-crop situations that exist in vast areas of the Indian continent, no single technology or practice satisfies overall planning of agricultural systems. Therefore, regional planning is much relevant on agro-climatic zonal basis to achieve higher crop production. In India, the treatment of land and water resources are dealt scientifically on watershed based approach.

Watershed is a geo-hydrological unit where excess water collected through rainfall drains to a common point in the form of surface runoff after infiltration into the top permeable layers of the earth. In general, watershed is an area between ridge and valley topography encircled by a ridge. It's physical dimension is not constant which varies from 4 to 10 ha and extends even up to 25000 ha. In order to achieve sustainable development of watershed i.e., from runoff (upper reaches) to recharge zone (downstream section) proper identification of existing surface water bodies, wastelands and commons (areas of potential sources of enhanced economic biomass) generating through user groups is a very important element. Similarly, individual farmers have to develop their own fields through various soil and moisture conservation measures like vegetative barriers, waste weirs in addition to various water harvesting structures along steep slopes and also across gullies.

Overview of Rainfed Dryland Issues

The term rainfed drylands refer to those areas which record less than 800 mm of rainfall in a year. The major problem with drylands is that they are under increased pressure due to poor agricultural practices and intensive use, over-exploitation, over-grazing in order to meet the basic needs of ever-growing population which resulted in accelerated soil erosion, soil fertility and also affected the productivity to a large extent. An assessment made by United Nations Environment Programme has revealed that about 4,500 million hectares (35 per cent) of the earth's surface is affected by desertification. Most of the poor people live in degraded environments and about 45 per cent of our country's foodgrain production is from rainfed drylands. Agricultural technologies and suitable practices have been developed particularly, to improve dryland agriculture effectively, in India during recent decades.

Constraints in Development of Rainfed Areas

The various constraints in the development of rainfed areas are (i) Socio-economic aspects (ii) Physical factors (iii) Technological aspects (iv) Institutional aspects.

Socio-economic Aspects

About 70 per cent of the resource poor farmers live in rainfed areas. Due to illiteracy among these farmers, awareness of new trends and development is also less. Most of the resource poor farmers' i.e. landless farmers in these areas are given class-IV lands which are supposed to be grown permanent vegetation but they tend to grow crops like rice for their sustenance. Moreover, the farmers in the dryland areas grow crops purely based on convention rather than conviction and there is a faster shift towards new crops and trees which are more on economic consideration. Due to this new concept farmers tend to grow crops like sunflower, soybean, pigeon pea, in good fertile agricultural lands which are suitable to grow sorghum which is considered as one of the important rainfed crops grown in India. The important point to be noted in this context is to achieve self-sufficiency in food production along with economic equity as a significant measure for social justice in the dryland areas.

Physical Factors

The major physical factors which influence the development of rainfed area are (a) environment and (b) energy.

Environment

Soil and water in the form of rainfall are the important elements in rainfed drylands. More than 70 per cent of dryland farmers have marginal lands. Particularly, in tropical and subtropical areas after harvest of crops due to lack of vegetation lands area is left fallow which leads to soil erosion. This problem arises mainly due to reasons like ownership (i.e. if the farmer is owner of a land, he will take all possible measures like vegetative and mechanical to check erosion, if he is a tenant the land will be definitely subjected to erosion). In such areas contour farming plays a very important role in harvesting rainwater as well as soil conservation. Similarly, land use conflict is also one of the important elements. Farmer tends to select crops out of economic compulsion. Due to labour problem in some cases farmers prefer to plant trees (commercial) rather than staple crops. Similarly, in good lands sunflower, pigeon pea, and soyabean are grown instead of sorghum.

Energy

Among the physical factors another important factor is energy which is estimated to be about 0.22 hp/ha in drylands. This is mainly due to economic problems of particularly, small and marginal farmers. Some solutions as suggested by technical guidelines, Ministry of Rural Development may be adopted to solve this problem.

They are

(i) Encourage tractorisation either through single ownership or community ownership or allow custom-hire service through governmental/private enterprises.

(ii) Off-season tillage for timely sowing is one step in this direction

(iii) Agronomic manipulations through wide row planting to permit wider coverage with each rain event and also to save energy.

Technological Aspects

Most of the research work is done in research rich situations but, many of the farmers are in resource poor situations. The results obtained in experimental farms axiomatically need further refinement for adoption by farmers.

Institutional Aspects

Institutional factors include input supply agents and credit system, crop production system, and marketing agent has to co-opt the user farmers and develop technologies in either area development or crop production. Similarly, crop production should be developed in conjunction with extension specialists, input supply agents and the user, the farmer. In order to achieve comprehensive development, costs of soil and water conservancy programmes should be brought under the budget for upkeep and maintenance.

Integrated Resource Survey of Watersheds

Particularly, for the sustainable development of rainfed dryland areas integrated resource surveys are useful to a greater extent. The development of these fragile areas is possible only through the identification of available /existing natural resources like (i) surface and groundwater resources (ii) soils (iii) nature of the terrain and (iv) biological features (flora and fauna include forest cover, crops, pastures, livestock and human beings). In addition to these natural resource surveys, climatic survey is the utmost important element which includes parameters like rainfall, temperature, humidity, wind and insolation (incoming solar radiation). Among all rainfall is the most essential feature which plays a vital role in deciding the growing season of vegetation. Similarly, soil resource surveys include the soil parameters like colour, depth of the soil profile, texture, permeability of the top as well as sub-soil, erosion status, land capability and fertility. Slope is also one of the important resource surveys which exhibits gradient of the terrain.

Hydro-geomorphic studies to understand type of landform and lithology is also an important element in natural resource surveys. Surveys under biological features include flora like type of forest cover, plantations, orchards, pastures and crops such as kharif and rabi, and fauna like livestock, details of male, female, children and total population of human beings. The advent of satellite remote sensing has greatly improved the quality of natural resource surveys in recent decades. Remote sensing techniques are very useful to obtain baseline information about natural resources timely and more precisely.

Soil and Moisture Conservation in Drylands – Overview

Drylands are more erosion prone areas. Conservation of soil and water natural resources simultaneously, particularly, in fragile areas like rainfed drylands is highly essential. The ever-growing population may lead to the depletion of these natural resources by their continued over-exploitation activities. Proper measures should be taken in order to avoid or at least minimise this environmental problem. In general, soil erosion due to lack of proper soil erosion management practices may lead to loss of agricultural production by reduced moisture holding capacity, soil depth and loss of soil nutrients. As a result of soil erosion, the following consequences like siltation of irrigation canals, farm lands, reservoirs, water bodies and also declined water quality occur in the downstream areas. Further, soil erosion may also lead to flooding and to decrease stream flow during dry seasons. The two important methods are (i) rainwater management through reduction of splash erosion, detachment and transport of soil particles and (ii) control of surface runoff by checking sheet, rill and gully erosion. The various soil and water conservation measures purely depend up on soils, slope of the land, rainfall and wind characteristics of a selected area. The basic measures to be adopted for arable and non-arable lands are different. Particularly, under arable land management the two important measures (i) Agronomical and (ii) Engineering measures are to be followed.

Again the agronomical measures are broadly divided into (i) wind erosion and (ii) water erosion.

The following methods may be adopted to prevent wind erosion :

* Vegetative cover
* Strip cropping
* Stubble cropping
* Tillage practices
* Sand dune stabilisation
* Wind breaks and shelter belts

For controlling water erosion the following water conservation measures may be adopted.

* Contour farming
* Strip cropping
* Field strip cropping
* Contour strip cropping
* Buffer strip cropping
* Conservation cropping system (ley farming)
* Mulching and crop residue management
* Critical area planning
* Vegetative barriers of live bunds
* Ridges and furrows/dead furrows

The mechanical/engineering measures include

* Contour and graded bunds
* Stone wall terrace
* Water ways with vegetative covers
* Gully plugging

Similarly, in non-arable areas and degraded land areas the following methods may be followed.

* Providing drainage lines
* In-situ moisture conservation measures
* Vegetative fencing (bio-fencing or hedge)
* Trench and mound fencing
* Stone wall fencing
* Mud-wall fencing
* Barbed wire fencing
* Social fencing
* Vegetative cover, pastures and afforestation

Soil and Moisture Conservation Measures

The following *in-situ* soil moisture conservation measures may be adopted on the land (outside the gully course) to harvest rainwater and soil conservation.

Determinants

Cropping Pattern

The rainfall pattern, the soil type (depth and texture) and the physiography largely determine the cropping pattern in rainfed agriculture. As rules of thumb we may adopt the following :

Rainfall (m.m.per annum)	Soil type	Season	Possible cropping pattern
< 375	Sandy, Loamy sand	Kharif	Single crop
375-600	Sandy loam, Heavy clay, Clay loam	Kharif+Rabi	Single crop
600-800	Sandy loam, Loam, Heavy clay, Clay loam	Kharif	Inter-crop
800-1000	Sandy loam, Loam, Heavy clay, Clay loam	Kharif	Inter-crop
> 1000	Sandy loam, Loam, Heavy clay, Clay loam	Kharif + Rabi	Double Cropping

Crop Growing Period

Sustainable agricultural systems in any region mainly depend upon the assured amount of rainfall that can meet the crop water requirement during its growth and development. Assured rainfall is the most probability rainfall occurring at least in two-thirds of the years (67 per cent probability) satisfying the crop water requirement at different growth stages of the major crop of the region. Thus, the duration of crop growing period (CGP) depends upon the rainfall and crop water requirements. It is highly influenced by the quantum and distribution on monsoon rainfall. Within an agro-climatic region, the available CGP varies for shallow and deep soils as the latter has more water holding capacity and hence can provide additional moisture from soil reserve for growing the crop for longer period.

Though the quantum of rainfall at a specified growing life cycle in a given location is same, different crops respond to the available water for its growth differently depending upon its water requirements and stage of the crop. Studies were made on the influence of water availability on the yields of some crops. In case of mug bean and cowpea, the moisture availability conditions during 6th to 9th week coinciding with pod formation and development have strongly influenced the yields. So also water availability conditions during 7th to 11th week and 6th to 10th week have profound influence on grain yields of pearl millet and sesame, respectively. Keeping in view the water availability as the key factor determining the yield level, the CGP analysis using simple criteria for some selected locations were carried out and presented.

Methodology

The analysis of weekly rainfall to identify the crop growing period (CGP) involves the following steps:

1. Weekly rainfall data of the station for a period of 30 years are to be collected.

2. The major soil type of the area is to be identified to find out soil depth and water holding capacity. (For example, the available soil water for loamy sandy soils of shallow depth is 60 mm and for deep soil of 1m depth, it is about 100 mm).

3. Sowing week is considered as the week (at the beginning of the rainy season in the area) which receives rainfall greater than 25 mm.

4. The CGP of the area is computed on weekly basis as given below.

a) The weekly water requirement for the major crops of the region are taken as follows : Examples : 25 mm/week for pearl millet, sorghum, short duration pulses, 40 mm/week for maize and pigeon pea , 50 mm/week for rice.

b) If the rainfall in the week is greater than the weekly water requirement of the crop in the region, it is assumed that three-fourths of the excess water goes to soil recharge and one-fourth is lost as runoff. Example: If the crop is pearl millet with water requirement of 25 mm/week and if the rainfall in the week is 35 mm, then out of the excess 10 mm, an amount of 7.5 mm goes to recharge and 2.5 mm is lost as runoff. (If the soil moisture at the beginning of this week is say 70 mm it will now become 77.5 mm).

c) In a week when rainfall is less than the crop water requirements, the difference is met from the available soil moisture (ex:- If the next week does not get rain, the water for the crop i.e., 25 mm is met from soil moisture. Thus, the soil moisture at the end of this week would be 77.5-25.0=52.5 mm). On the other hand, if this week had received say 18.0 mm rain, then the rest 7 mm is taken from soil and in such case the soil moisture at the end of week is 77.5-7.0 = 70.5 mm).

d) The soil moisture recharge can occur till the soil attains fields capacity (e.g. for deep loamy sand soils, FC = 150 mm, for shallow soils = 100 mm). Any additional water beyond this value is lost as deep drainage i.e., soil moisture recharge after meeting the weekly crop water need is limited up to field capacity only. Out of this amount, the water available to the crop in case of no rainfall is limited to the available soil water (field capacity – wilting point value which is about 100 mm and 60 mm, respectively as mentioned earlier). This moisture can support the crop for a few weeks depending on the amount of rainfall and crop water requirement/week.

The assured moisture availability period is otherwise known as crop growing period (CGP). The rainfall pattern, the soil depth and texture have a bearing on the CGP. The type of crop tells on the water demands. Rice may need 50 mm/week while bajra would survive with 25 mm/week. This could come through rain and through the stored water in the soil. By combining the rainfall per week with stored water in the soil we can find out the CGP. Fine soil holds less water (100-150 mm/meter) while heavy soil holds more water (200-300 mm/meter).

Traditional Land and Water Use Practices

India is bestowed with several traditional land and water use practices. Broadly these can be grouped into three viz., runoff farming, groundwater, and river based systems.

Runoff Farming

Among others they include: Khadin, Ad-bandh, Submergence banch, Conservation ditch, Embankment, Farm ponds, Rela, Hill side conduit system and Zabo system.

Khadin

When an ephemeral stream, carrying runoff from the rocky catchment areas comes down into a low lying plain or valley area, a check dam is constructed across the plain/valley area to retain the runoff. The bund is provided with wastewier/spill way. The runoff submerges the plain/valley area, which is bestowed with relatively deep silty clay loam. The ratio between the rocky catchment and cultivable khadin area varies from 12:1 to 15:1. The detained water percolates the deep soil and a part of it also evaporates. A part of the water recharges the groundwater and the wells in the lower reaches would be benefited. By November the area would be generally ready for sowing Rabi crops like wheat or gram.

The area so submerged is known as khadin and had been the main source of agriculture in the low rainfall region of west Rajasthan particularly Jaisalmer district. Some contingent situations can arise in the system. One is, the ponded rainwater may not evaporate fully and need to be removed for timely sowing of Rabi crops. So the farmers breach the bund damaging the areas below the bund. Even the wells in the lower reaches would be affected. Another is, the rain may be inadequate to spread all over the khadin area, which could be 25-100 hectares, averaging the 50 ha. In such a case contingent cropping is needed, as the water would be receding faster as the quantum would be relatively less. Crops like mustard may have to be grown. The khadin system has been adopted by the Government of Rajasthan and replicated in the non-bearing districts like Jalore, Pali and Jodhpur. The structures were placed in cultivated areas. In most places the adopted system had failed. The primary reason is the catchment area, which is rocky in the original system while in the adapted system it is in cultivated area leading to more siltation of the khadin area. Moreover, in the traditional area, the group of farmers who own the khadin largely belong to a community which it is not so in the adapted systems. Presently khadin areas adjacent to the Indira Gandhi Nahar Project are now made dysfunctional as the silt is now being used for brick making.

Ad-Bandh

This is rainwater harvesting in the arable black soils of Gujarat. In slopes of 1.0 to 2.0 per cent the runoff rainwater moves as a sheet. It is collected at the lower reaches with the help of a bund and waste-wier/spill way. The spread of water is very large, the depth of submergence varying from a few cm to even 1.0 to 2.0 meters. As the water recedess, cropping is practised. In a way it is recession cropping starting with sorghum, pearl millet, short pulses, cotton, sunflower, mustard, gram and finally wheat. As in khadin system, the downstream area would be recharged with increase in groundwater. And in case the rainwater does not percolate or evaporate, the bund may be breached.

Submergence Bandh

This is an unique system in the Bundelkhand region of Madhya Pradesh and adjacent to Uttar Pradesh. Water is impounded by constructing big dykes at lower elements of slope. The soils are generally medium to deep with 1-3 per cent slope. The height of the dyke could be 2-5m with 10-12m base and 1.5 – 2.0 meter top dimension, slope being 1.5:1. These bunds could be 2-3 km long and at 2 to 4m vertical interval. They also assist in groundwater recharge. Evidently kharif crop is sacrificed and an assured rabi crop of wheat or gram is taken nearer to away of the bandh. These bandhs are pur to permanent vegetation like Acacia nilotica.

Conservation Ditches

These are something similar to inverted contour bunds. They are constructed between fields of farmers of the Vidarbha region. It is in deep black soils of medium to high rainfall region. These ditches are maintained by the adjoining farmers in alternate years by a mutual agreement. These ditches not only collect runoff but also some sediment (up to 1.0 to 1.5t/ ha). The water stored in these ditches is primarily used for livestock. It can also be considered for a critical irrigation as shown by the researchers at Soil Conservation Centre, Bellary. The finetuning of the technology by them and the details thereof are provided below:

Conservation ditching consists of laying out shallow trapezoidal ditches on contour at the usual terrace (bund) spacing of the locality. It works on the principle that when suitably designed, the ditch intercepts and stores within its confines all or most of the inter-ditch runoff from a design rainstorm. The upstream side face is kept flat (5:1) so as to be safe against the scouring action of the incoming runoff. The downstream side slope is kept steeper (1.5:1) to conform to the angle of repose of the soils. Due to better fertility and moisture regime the ditch banks can be utilised for growing fodder grasses. Due to the low permeability of the black soils, substantial quantities of the stored water become available till a week to ten days for utilising the same for supplemental irrigation to downstream crops. The low lifts at which the water is available enable its easy lifting by traditional hand operated lifting devices like swing baskets, arch median screws and handpumps.

Advantages of Ditch Over Bunds

From the above discussion. It may be seen that all the problems incidental to the traditional bunds in the deep black soils are due to the fact that they are embankments, or above ground level constructions. Thus, water stagnation in contour bunds occurs due to the backing up of water behind the bunds. The impounded water enters the summer cracks on the bunds and gushes out causing extensive breaches. Waste weirs, constructed at a substantial cost, result in channelised erosion in the inter-bunded area.

Other graded bunds drain out the excess water far beyond the reach of small farmers. All these problems are solved by the ditch which is a wholly below ground construction. As water does not backup upstream of the ditch, there is no water stagnation; water entering the cracks on the sides of the ditches causes no breaches but helps to charge the soil profile with moisture to a distance of 4 to 5m on the downstream side benefiting the crops in the area and waste weirs are dispensed with as the surplus water flows as a thin sheet over a major portion of the length of the ditch on the downstream side. The ditch being on contour and lying wholly below the ground, rainwater is stored in situ without the problems associated with contour/graded bunds as explained above. The ditch is thus a suitable conservation structure in the deep black soils.

Embankment Type Reservoirs

Other means of water harvesting and re-use is the embankments. These are embankments provided over gullies or streams at lower reaches to impound water for using the stored runoff water for a critical irrigation. The water spread would be 1/8 to 1/6th of the catchment with depth of about 1.5m pounding area. At the catchment to pond age ratio of 5:1 resulted in enough storage to reduce flood peaks by 9 per cent with almost no sediment movement. This approach can be mechanised and considered in catchment areas for desalting purposes and for retading the aggressive velocity of the runoff water. This is also useful in agricultural watersheds in high rainfall zones with deep soils as in Palamau, Bihar. Such embankments were erected in Pune district of Maharashtra through Pani Panchayats on barren hills and water provided at the rate of 0.5 cu.m per person or 1.0 ha per family through light irrigation for growing crops other than paddy. But the problems are too many. As long as the pond is in a no cultivable Government land, this concept could be implemented. When the catchment is a cultivated area, more than one farmer is to be involved if the size of the farm pond is, say 2000m. The location of the pond and sharing of runoff for critical irrigation are the main issues. The minimum size of pond that could still have payoff is not clearly known. Further, the sealant for light soils is not fully resolved. So also the lifting and use of such stored water.

Ponds

Farm ponds are water bodies of variable size constructed by excavating a pit, or as an embankment across a water course or a combination of both. The water so stored can be utilised for irrigation, a limited area (eg. Nursery).It can be a source of drinking water, particularly for livestock. Also it can be a part of arresting the erosion of the runoff water. The ponds need to be shallow (3.0m deep) so that water can be normally lifted by a pedal operated pump, say up to 1.0 to 1.5m depth, the rest being left for percolation to enhance groundwater recharge. So the best places would be near the water courses (drainage). Side slope should be about 1:1. The size of the pond depends on the following criteria : runoff, catchment area and water needs (depends on the purpose). There should be a provision for a spillway. Small ponds can have grassed spillway. Bigger ones may be provided with mechanical spillways strengthened with grassing. The commonly used spillway with farm ponds is the 'drop inlet' spillway. This type of spillway may be used to drain the pond as well as to supply water for irrigation by providing a sluice gate arrangement for the inlet well/riser. For this, the size of the barrel and riser should be kept more than 15 and 20m in diameter, respectively. The spillway should discharge into a grass waterway or a natural drain. Care need to be taken to avoid excessive erosion.

Rela Farming

This is a diversion system. In a situation where a potential arable area lies adjacent to an ephemeral stream, but whose banks have no higher elevation with respect to flow level a more intricate dam need to be built to first raise the water level and subsequently divert it to get spread the ephemeral stream flow of kharif season on to the adjoining fields. This kind of diversion is practised in Sanchor Tehsil of Jalore district in west Rajasthan. It is called 'Rela' farming. The prerequisites for the success of 'Rela' farming are: the streambed should not be sandy, Stream must be a in spate with the monsoon rains.

Hill-side Conduit Systems

In both hot as well as cold arid areas, hill side conduit systems are in vogue. In arid Rajasthan, stonewall conduit is built to collect and channelise the runoff water. The runoff would be in their sheets over a catchment of sloping plain surface. Then it would get dispersed and infiltrated and lost before reaching the agricultural fields. In Jodhpur district, under such conditions, farmers build numerous conduit channels to concentrate and channelise the runoff rainwater. This helps in increasing the velocity of the runoff and reduces transit loss. The conduits are of either stone walls or ditches. In the sub-mountane/mountainous region of N.W.Himalays (Jammu & Kashmir, Himachal Pradesh, N.W.Uttar Pradesh) similar conduit formations would be seen as 'Gools' or 'Kuhls'. These are narrow channels connected to the naturally occurring springs located on higher elevations. The inflow varies with the season, being more in the rainy season. The transmission losses are also heavy. This being the sole source of irrigation in hinterlands and also the main stay for agriculture in the cold arid areas more attention is needed for fine-tuning the system.

Zabo System

It is indigenous to Nagaland (Pheh district). Zabo means impounding of water. It is an excellent system of rainwater harvesting. It is generally practised in holdings of 2.0 to 2.5ha. The catchment area is under permanent vegetation. Water body is 0.2ha area pond of 1.5 to 2.5m (shallow) located below the catchment area with a suitable silt trap. The bottom and sides of the pond are rammed and compacted to reduce seepage losses. The water so stored is let into the paddy fields located in the lower elements of the slope. This area would be 0.2 to 0.8ha.

Indigenous Water Harvesting Structures

In tropical and subtropical regions, runoff is inevitable. It varies between 10-40 per cent of the total rainfall. From earlier times this runoff water is managed by the farmers in different ways. The tank technology prevalent in several parts of India particularly below the Vindhyan region is a case in point. Water is held against an embankment in this case. But what is more important is the management of the water so held. There was strict vigil on proper maintenance of the catchment area and differential rates for various economic groups in the use of the water. All this was done by the beneficiaries or users. The charges levied were used for the maintenance of the embankment as well as the catchment area.

In situ Rainwater Harvesting Systems

Rainwater is the primary source of water for rainfed production systems. And soil is the base through which plants primarily draw their water needs. So the root profile need to be charged with water, in this case rainwater, for efficient crop production. The entry of rainwater into the soils is through its surface. The entry could be slowed down due to various processes. Among others, they include : sloppy terrain, capping/crusting of the surface, and large plots without any barrier.

One way to enhance rainwater entry into the soil is to have terraces of various types to contain the water. These measures are discussed elsewhere. The other is to provide more opportunity for the rainwater to enter the soil in situ. These include, among others, summer/off-season ploughing, contour farming, sowing on contour and ridging later, dead-furrow, inter-row water harvesting, and inter-plot water harvesting

i) *Summer/Off-season Ploughing :* Immediately after the harvest of the kharif or rabi crop several farmers do plough up their lands. Some plough on receipt of pre-monsoon rains. This practice should be encouraged as it a) opens up the soil surface for rainwater to enter the root profile with the subsequent rains, b) enhances the surface area for more and more water to enter the soil, and c) also eliminates the weeds with any subsequent harrowing that is taken up for seed bed preparation.

ii) *Contour Farming :* For uniform distribution of moisture in the fields, contour farming should be practised. Otherwise the moisture would be inequitably distributed in any given field leading to poorer yields. Sowing on contour and ridging later: There is a traditional practice of criss-cross ploughing in castor fields of Telangana with the good September rains. This aims at root pruning and forming furrows to capture subsequent rains in-situ. Similarly, bueshening is done in upland rice to thin the plant stands and plough in the thinned rice plants as well as weeds as green manure. This is done about six weeks after seeding.

iii) *Dead Furrows :* In the red soils of Rayalaseema and southern Karnataka furrows are opened while sowing, across the slope at 2.0 to 4.0 meters distance. In Karnataka on either side of the dead furrow redgram is sown as an interap with groundnut. The dead furrow is also a method for capturing rainwater.

iv) *Inter-row Water Harvesting :* In arid Rajasthan, ridge and furrow system is recommended, crops being sown in the furrows. The system works well.

v) *Intra-plot Water Harvesting :* In high rainfall Doon valley this system is suggested. The upper reaches of the plot is sown to non-rice kharif crops like maize, soybean or finger millet and the conservation bench is put to an assured rice crop.

vi) *Other Practices :* These include deep ploughing, land smoothing, zing terraces, compartmental bunds, tie-ridging and scooping.

a) *Deep Ploughing :* It not only enhances infiltration of rainwater into the root profile, but also helps in breaking down the hard pans, removing persistent weeds, and bringing out the illuminated clay to the surface, all leading to enhanced productivity. Also the deep ploughing has residual effects, particularly in areas with textural profiles (i.e. more clay in the lower depths of the profile). Further, the type of crop also reflects on the benefits of deep ploughing. Generally speaking the yield increase is more in deep soils growing kharif crops. Deep rooted crops responded better over shallow rooted crops.

b) *Land Smoothing :* This is done primarily to level the field from small bumps and gullies in between field bunds or contour/graded bunds. This helps in normal agricultural operations and also normal rainwater movement on the surface without concentrating at one place.

a) *Zing Terracing :* In bunded areas to prevent concentration of rainwater nearer the lower bund, the lower one-third area between bunds is leveled to help the runoff water spread in larger portion between bunded area. This ensures better availability of rainwater to the crops.

b) *Compartmental Bunding :* In deep black soils the entire field is laid out into small bunded compartments varying in size from 6 x 6m to 10 x 10m. Kharif rains are collected, allowed to percolate and rabi crop taken.

c) *Tie-ridging :* The soil is thrown into ridges and furrows. The adjacent ridges are, then, joined at regular intervals by barriers or ties of the same height to allow the rainwater infiltrate and thus prevent runoff except during intense heavy rains. This is practicable in all situations except steep slopes. It is said to work in low to medium rainfall zones.

d) *Scooping :* Scooping out soil from small basins with basin lister or similar equipment, helps in retaining the rainwater on the surface for a longer time, thereby allowing more of it to percolate into the soil. In the process the soil erosion would be reduced. So if runoff.

Watershed Based Land and Water Use Practices

Vegetative Barriers

This is a semi-permanent soil and water conservation structural measure which can be adopted in almost all areas irrespective of rainfall and soil type. Vegetative barriers are closely spaced stiff-stemmed dense plantations like grasses, legumes or shrubs grown in a few narrow parallel rows along contours for erosion in agricultural lands with flat and undulating topography in order to prevent soil erosion and also silting of percolation tanks, check-dams and minor irrigation tanks. These act as barriers in concentrated surface runoff areas to reduce the velocity thereby to prevent sheet, rill and gully formation (ephemeral gully formation), to trap sediment to maintain soil fertility and allow more water to recharge the ground.

Site Condition

Vegetative barriers can be established in all types of lands with flat and undulating topography except in class-VII lands and also in desertic environments. Vegetative species can be selected on the basis of soil type and climatic conditions.

Design Criteria

The most important item in designing vegetative barriers in addition to the selection of vegetative species is spacing (interval) between rows which depends upon the vertical drop of the land. Vertical interval of vegetative barriers should be nearly half of the mechanical barriers. Depending upon the habitat of species selected, number of rows and plant to plant spacing will be decided. The following points should be taken into consideration while selecting vegetative species. The vegetative species should be perennial with stiff stems that remain intact throughout the year, tolerant of both dry and wet soil conditions and should have ability to penetrate several inches of sediment and capability to grow even from buried stem nodes with rhizomatous or stoloniferous growth characteristics.The following species like *vetiver, agave, swithgrass,(Panicum Virgatum L., leucaena, lemongrass, cenchrus ciliaris* and *eastern gamagrass(Tripsacum dactyloides)* are the suitable warm-season plants, can be selected for soil conservation. In addition to these plants, grass strips of 1 to 2 m wide can also be used in cultivated areas, pasture and also in forest areas to prevent soil erosion.

Farm Ponds

Farm ponds are man-made water reservoirs built in agricultural lands by constructing an embankment across a water course or excavating a pit with small diameter and moderate depth. This is one of the best measures particularly, in rainfed dryland areas to store rain water during monsoon period in order to provide drinking water for livestock, human beings and irrigation purpose.

Site Condition

Farm ponds are effective especially in black soil areas. Dug out farm ponds are suitable in areas having flat topography where water table is very close to the ground level. Similarly, impounding type (embankment) of farm pond is ideal in places of well defined waterways and low soil permeability with rolling topography.

Design Criteria

The size of the farm pond can be decided based on the total requirement of water for irrigation, livestock and also for domestic use. In addition to these, the total runoff entering the pond also should be taken into consideration while designing the pond. The pond capacity can be estimated based on the equation given below.

Pond capacity = Irrigation requirement + Livestock requirement + Domestic requirement + 20 per cent of the sum of the above towards evaporation and other losses.

In general, in low rainfall areas 1 ha catchment area can provide 100m^3 of runoff and similarly, in medium rainfall areas 1 ha of catchment can yield 200m^3 runoff The actual size of the farm pond should be one half or less than the total amount of annual runoff taking into consideration the above observation. One farm pond can be recommended for every 25 ha of land.

Excavated farm ponds can be constructed either in square or rectangular shape whereas embankment type will be determined purely based upon the physiography of the area. The side slopes of the excavated farm ponds should be preferably flatter (1:1) which will be decided based on the type of the soil. 'Drop inlet' type of spillways is generally used for farm ponds. Each farm pond should have 'Sod' type spillway or emergency spillway in order to dispose overflow during heavy rains. For watersheds ranging 4 to 12 ha require a combination of both mechanical and vegetative spillways.

Bunds

Bunds are small earthen barriers constructed in agricultural lands on 1-6 per cent sloping lands to avoid gully formation by reducing velocity of run-off, percolation into the soil and to reduce sand deposition in downstream areas. These are semi-permanent mechanical measures built all along the contours for erosion by means of earthen to delay surface runoff in order to allow more water to be infiltered into the earth (soil layers as well as groundwater recharge). Here the velocity of the surface runoff will be reduced and delayed by converting long slope splitting into several smaller ones. This measure will be useful to undertake agronomic operations for man and animals by field to field access.

Bunds are broadly divided into (i) Graded bunds and (ii) Contour bunds which can be adopted to suite different environments depending upon the annual rainfall.

Site Condition

Both graded and contour bunds can be built on 1-6 per cent sloping agricultural lands to avoid gully formation, to reduce surface run-off velocity thereby increase recharge to the groundwater and reduce sand deposition particularly, in lower lands.

(i) Graded Bunds

Graded bunds are suitable in areas with medium to high rainfall (i.e. annual rainfall of 600 mm and above) and soils with poor permeability and soils of crust formation nature.

(ii) Contour Bunds

Contour bunds are suitable in low rainfall areas (i.e. annual rainfall less than 600 mm) and areas with light textured soils. Vegetation can be grown on these bunds.

Design Criteria

(i) Graded Bunds

Graded bunds can be constructed in two ways, one with providing a channel and the other one without channel. Graded bund without channel is found to be effective. The minimum cross section area for shallow soils is $0.3m^2$, for red and alluvial soils $0.5m^2$ and for heavier soils $0.675m^2$. The minimum cross section area can be considered as $0.5m^2$. The following equation can be used to fix the distance between successive beds.

$$V.I = (s/a + b)\ 0.3$$

Where V.I is the vertical interval in metres

s = slope in percentage

a = constant value ranging from 3 to 4 for permeable soils

b = constant with average value of 2

(ii) Contour Bunds

The design of contour bunds can be made considering water storage equivalent to 50 mm of rainfall. The contour bund specifications which are suitable for different soil environments are presented here. For gravelly soils cross section area of the bund is 0.45 m^2, for red soil areas 0.72 m^2, for shallow to medium black soils 1.07 m^2 and for deep soils 1.32 m^2.

Contour Furrow/Ridge and Furrow

This is a mechanical and vegetative barrier. Contour furrows are trapezoidal/ V-shaped trenches dug all along the contours for erosion. This measure is effective in reducing surface runoff to increase infiltration particularly, at high sloping areas.

Site Condition

This measure is suitable for areas where slope of the cultivated land is more than 5 per cent to conserve rainwater.

Design Criteria

These V-shaped trenches should have a width of 0.6 to 1 m at the top and 0.4 m at the bottom with a depth of 0.4 m. These trenches can be made as continuous or staggered and they may be planted as well.

Irrigation and Water Management

In dryland agriculture water management plays a very important role. The efficient method is to economise water application through drip and sprinkler method. Similarly, planting of horticultural species on field bunds can reduce water through evaporation from crops and also act as shelter-belt in preventing wind erosion at specific locations.

Water Harvesting Measures

Water harvesting measures are purely dependent upon rainfall and soil type in a selected area. Several indigenous practices as well as in-situ rainwater harvesting measures are available for water harvesting to implement in different parts of the country. The indigenous practices include (i) runoff farming (ii) groundwater recharge and (iii) river based systems. The indigenous water harvesting structures are suitable for several tropical and sub-tropical regions where runoff is only 10-40 per cent.

In dryland areas rainwater is the only source for agriculture production. The infiltration of water into the soil layers affected by various parameters like (i) slope of the terrain (ii) capping of the surface and (iii) large areas without any barriers which require various methods in the form of vegetative/mechanical barriers to stop surface runoff to some extent in order to allow infiltration to recharge ground (top layers of the earth). The following gully control measures may be adopted to recharge ground-water in the upstream and middle reaches of the streams.

Check-Dam

A check-dam is also known as an anicut which intercepts the rain-water from the upstream of the local catchment and stores for direct use and / or groundwater recharge of the downstream wells. A check-dam has an earthen dam with a masonry spillway. Under permanent check-dams concrete or masonry or earth dams to store and slow down water are suggested.

Site Condition

Check-dams will be constructed across 1st and 2nd order streams particularly, in medium sloping areas (0-5 per cent). Temporary check-dams are suggested in the case of head ward erosion of gullies where gullies encroach into the adjoining agricultural lands.

Design Criteria

These structures are designed based on the analysis of recurrence interval of rainfall over a period of about 50 years. Local guidelines should be followed while designing structures. One check-dam with a capacity of 0.5mcft for about 25 ha of land is sufficient to recharge groundwater and also as points for cattle.

The water thus retained at check-dams may be also used for irrigation crops. Synthetic bags filled with sand or loose boulders can also be used instead of earthen structure. Particularly, in areas with high rainfall and medium black soils gabions (wire boxes filled with stones) are suggested.

Loose Boulder Check-dams/Rock Fills Dams

This is a semi-permanent mechanical structure constructed across stream/nala with variable sizes of stones (boulders) or over burnt bricks to check the velocity of watershed, recharge the ground and also to arrest silt. This is one of the most effective and economic measures for gully control and it is an arrangement of loose boulders across stream/nala. These structures are of permeable type in order to arrest suspended sediment load.

Site Condition

This structure is effective in all areas irrespective of rainfall and soil type. This measure is successful in the reclamation of broad and shallow gullies by promoting vegetative growth. These are suitable in places where width of the gullies are not wider than 10 metres and where loose bouders are available locally and cheaply. Gabions are preferred where foundation conditions are unstable. Rock fill dams need better foundation conditions rather than earthen dams or earthen gully plugs.

Design Criteria

Rock fill dams need special design because gullies with origin from hill slopes, normally have high velocity during peak flows. Rock fill dams should be constructed at a vertical interval of 1.5 to 2 m along the gully bed and also at gully heads. The stones used for rock fill dams should be larger than 30 x 30 x 30 cm. The average height of the rock fill dam should be 4 to 5 metres. The minimum rock fill in the dam should be not less than 0.5 m., the side slope of the dam should be 2:1 or flatter. The central portion of the rock fill dam should be low or a rectangular free board in order to allow peak flows. The trapezoidal or tapering cross section of this type dams reduces the friction and resultant damage during peak floods. In order to reinforce the dam the down slope side should be constructed with rock rubble. Cut-off walls with a thickness of about 20cm should be provided at the upstream and they should extend into the rock surface or disintegrated material. The structure should have strong foundation with adequate notch capacity and sizeable anchorage into the gully walls. Voids in the dam can be filled with small size metals also. For notch portion dimensions the following weir formula can be used.

$$Q = 1.75\ LH^{3/2}$$

Where Q = Peak discharge, $m^{3/}sec$

L = Length of rectangular waste weir, m and

H = Depth of flow of water over the waste weir, m
(Depth of flow of 0.3 m can be used)

The hydraulic structures including side walls, wing walls and aprons should be constructed similar to masonry drop structures.

Wire-gabion Structures

Wire gabion structure is a semi-permanent mechanical structure suitable in steep sloping gully areas to prevent sediment erosion and also to recharge groundwater. In wire gabion structures loose boulders are enclosed with wire mesh to reinforce the structure.

Site Condition

These structures are suitable in areas with high rainfall and steep slopes. This measure is not effective in boulder strewn gullies with high rock mass flow. These semi-permanent check-dams should be constructed across steep sloped gullies.

Design Criteria

In this structure wire-woven baskets should be filled with pebbles and cobbles and built across gullies to prevent sediment erosion during heavy rains. These structures should have openings less than the average size of the rocks. The wire mesh reduces the corrosive action by rock mass flow.

Gully Plug

Gully plugs are generally earthen embankments or loose boulder bunds with a spillway and some vegetative cover built across active gullies with less than a metre depth where active erosion is prevalent. Gully plugs act as grade stabilisation structures by depositing silt load which creates micro-environment for establishing vegetative cover. Gully plugging is generally adopted to prevent down cutting of gully heads and also to prevent silt load movement towards downstream areas.

Site Condition

Gully plugs are suitable in small and medium gullies where runoff velocity is low and the slope of the gullies ranges between 2-3 per cent. Gully plugs are suggested particularly where foundation conditions are unfavourable for loose or masonry structures.

Design Criteria

The designing of gully plugs includes an embankment, a mechanical spillway and a grass ramp. The grass ramp should be constructed with a crest about 60cm below the top of the embankment. A pipe outlet should be installed 30cm below the ramp level. The minimum cross section of the embankment of earthen dam for gully plugs is 1.25m^2 and it should range between 2.5 to 25 m^2.

The specifications for type of gully plug up to 10 per cent slope, infiltration materials and the location of the gully plug are presented in the Table.

Slope of the gully	Location	Width of gully bed in metres	Type of gully plug	Vertical interval in metres
0-5%	Gully bed	up to 4.5	Brushwood	up to 3
5-10%	Gully bed	up to 4.5	Brush wood	up to 3
	Gully bed	4.5 to 6	Earthen and side branch	1.5 to 3
	Confluence of two gullies	7.5 to 15	Sand bags	2.25 to 3

Nala Bunds and Percolation Tanks

Nala bunds and percolation tanks are the permanent mechanical recharge structures constructed across nalas to check the velocity of run-off and to increase water percolation in order to improve soil moisture regime. Nala bunds and percolation tanks are similar structures used alternatively at different places. Percolation tanks are small storage tanks constructed across the streams and minor valleys by means of earthen bunds mainly to recharge the irrigation wells in the downstream sections.

Site Condition

Percolation tanks are suitable in relatively flatter areas where the slope of the nala should be less than 2 per cent. There should be a nala bund for every 40 ha of catchment area. The sub-strata at this location should be preferably hard rock and soils of the nala bund should be permeable or they should be disintegrated if it is composed of hard rock at greater depths.

Design Criteria

The top width of the nala bund should not be less than 1 m(1/3rd of the impounding depth). The bund section should comprise a core wall and a puddle trench. Similarly, an emergency spillway may be provided by the side of the nala bund. The width of the cut outlet varies depending upon the rainfall variation as presented in Table. The capacity of the percolation tank can be about 5 to 20mcft.

Sunken Pit

This is one of the structures adopted in recent watershed development activities which occupy less area and less submergence of land. This structure acts as a water point for cattle, human beings in addition to recharge water table through deep percolation.

Site Condition

These are dug along nala/streams at certain selected locations.

Design Criteria

Sunken ponds do not have any problem of breaching as they are constructed in the ground. A spillway may be provided to allow excess water to be flown into the drainage line.

Vegetative Barriers

This is a semi-permanent structure which can be adopted in almost all areas irrespective of rainfall and soil type. Vegetative barriers are closely spaced stiff-stemmed dense plantations like grasses, legumes or shrubs grown in a few narrow parallel rows along contours for erosion in agricultural lands with flat and undulating topography in order to prevent soil erosion and also silting of percolation tanks, check-dams and minor irrigation tanks. These act as barriers in concentrated surface runoff to reduce the velocity thereby to prevent sheet, rill and gully formation (ephemeral gully formation), to trap sediment to main soil fertility and allow more water to recharge the ground.

Site Condition

Vegetative barriers can be established in all types of lands with flat and undulating topography except class-VII lands and also in deserted conditions. Vegetative species can be selected based on soil type and climatic conditions.

Design Criteria

The most important item in designing vegetative barriers in addition to the selection of vegetative species is spacing (interval) between rows which depends upon the vertical drop of the land. Vertical interval of vegetative barriers should be nearly half of the mechanical barriers. Depending upon the habitat of species selected number of rows and plant to plant spacing will be decided. The following characteristics should be followed while selecting vegetative species. They are : Vegetative species should be perennial with stiff stems that remain intact throughout the year, tolerant of both dry and wet soil conditions and should have ability to penetrate several inches of sediment and capability to grow even from buried stem nodes with rhizomatous or stoloniferous growth characteristics.

The following species like vetiver, agave, swithgrass,(Panicum Virgatum L.) and eastern gamagrass (Tripsacum dactyloides) are the suitable warm-season plants that can be planted for soil conservation. These grass strips of 1 to 2 m width can also be used in cultivated areas, pasture and also in forest areas to prevent soil erosion.

Challenges of Land and Water : Keeping with the pace of different practices available in the literature, the land and water resources face several challenges in the recent past. These challenges are;

* Over the last 50 years, land and water management has met rapidly rising demands for food and fibre. In particular, input-intensive, mechanised agriculture and irrigation have contributed to rapid increases in productivity. India's agricultural production has grown between 2.5 and 3 times over the period while the cultivated area has grown only by 12 per cent (FAO, 2011). More than 40 per cent of the increase in food production came from irrigated areas, which have doubled in area. In the same period, the cultivated area of land per person gradually declined to less than 0.25 ha, a clear measure of successful agricultural intensification.

* The distribution of land suitable for cropping is skewed against those different parts of the country which have most need to raise production. This is a troubling finding given that the growth of demand for food production, as a function of population and income, is expected to be concentrated in the country in coming years. The main implication is that a global adjustment of agricultural production will need to be anticipated in order to compensate for these facts of geography.

* Rainfed agriculture is India's predominant agricultural production system, but also hosts majority of the rural poor. Unpredictable soil moisture availability over the course of a growing season reduces nutrient uptake and, consequently, yields. Taken with low soil fertility and carbon content of tropical soils, yields in rainfed systems are little more than half the achievable potential in the country. While improved land and nutrient management can result in higher yields, these can prove difficult to sustain if the threat of erratic rainfall remains. The rural poor on marginal lands with limited access to improved seed, fertiliser and information remain vulnerable.

* The tendency to locate high-input agriculture on the most suitable lands for cropping relieves pressure on land expansion and limits encroachment on forests and other land uses. Groundwater use in irrigation is expanding quickly, and almost 40 per cent of the irrigated area is now reliant upon groundwater as either a primary source, or in conjunction with surface water.

* In many places, however, achievements in production have been associated with management practices that have degraded the land and water systems upon which the production depends. In some of these areas, the accumulation of environmental impacts in key land and water systems has now reached the point where production and livelihoods are compromised. Intensive agricultural practice has, in some cases, resulted in serious environmental degradation, including the loss of biodiversity and surface and groundwater pollution from the improper use of fertilisers and pesticides.

* Groundwater abstraction has provided an invaluable source of ready irrigation water but has proved almost impossible to regulate. As a result, locally intensive groundwater withdrawals are exceeding rates of natural replenishment in key cereal producing locations. Because of the dependence of many key food production areas on groundwater, declining aquifer levels and continued abstraction of non-renewable groundwater present a growing risk to local and food production, and finally

* There is a strong linkage between poverty and the lack of access to land and water resources. The poor in the country have the least access to land and water and are locked in a poverty trap of small farms with poor quality soils and high vulnerability to land degradation and climatic uncertainty. Technologies and farming systems within reach of the poor are typically low management, low input systems that can contribute to land degradation or buffer rainfall variability. Highest trends in land degradation are associated with the poor.

Policies, Institutions and Investments in Land and Water

1. The lack of clear and stable land and water *rights* as well as *weak regulatory* capacity and *enforcement* have contributed to conflict over land access and competition for water use. In particular, the systematic inclusion of customary and traditional use rights in national legislation is a necessary first step in order to protect rural livelihoods and provide incentives for responsible land and water use.

2. Agricultural development policies have tended to focus on investments in high-potential areas and on irrigation, mechanisation and crop specialisation (mono-cropping) for marketed commodities and export crops.

3. Effective collaboration between land and water institutions has lagged behind patterns of use and consumption. Although land and water function as an integrated system, many institutions deal with them separately.

4. Levels of public and private investment in basic agricultural infrastructure and institutions have declined over the past two decades.

5. Large-scale land acquisitions are on the increase in parts of India where land and water resources appear abundant and available.

By 2050, rising population and increase of income of various sections of the people in the country are expected to result in a 70 per cent increase in demand for foodgrains. Hence, it is imperative to examine the present practices of land and water use so that both the irrigated and rainfed agriculture respond to rising demand. Most of future growth in crop production in India is likely to come from intensification, with irrigation playing an increasingly strategic role through improved water services, water-use efficiency improvements, yield growth and higher cropping intensities. The present study has examined how various practices of land and water in 16 sample villages of four states enhance the livelihood security of small and marginal farmers.

Land Use Pattern in Sample Villages

Natural resources, particularly land, water and biomass, which form the basis for sustainable development, have reached a critical point by the anthropogenic pressures posed by the rapidly growing human population in India. Land use pattern in particular area provides the base for natural resources development and thereby livelihood security. The study areas are predominant with agriculture and common pool resources (CPRs), most people in these 16 sample villages across four states directly or indirectly depend on agriculture and CPRs for their livelihood (see Table 2.1). Interestingly, one of the villages in our samples villages of Gujarat has predominantly tribal population where 67.6 per cent of the area is under forest and most of the people depend upon the forest. The data also show that considerable area is under forest in sample villages of Jharkhand and West Bengal. However, except in Jharkhand and West Bengal, there is considerable area under wastelands where practices of land and water use impact are seen.

The total cropped area is prominent in almost all the sample villages. The irrigated area is more in Gujarat and Tamil Nadu whereas un-irrigated area is prominent in almost all the sample villages. It reflects that rainfall depended agriculture is very high (Table 2.1). The land use pattern gives scope for resilience capacity of natural resources base in almost all the sample villages.

Table 2.1 : Land use Pattern in Sample Villages (Area in Ha.)

Villages	Total Geo-graphical Area	Forests (Perma-nent, Current)	Fallows Cropped Area	Total Area	Irrigated	Rainfed/ Un-irrigated Area	Waste-lands
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gujarat							
Village-I	1251.15 (100)	NA	206.0 (16.4)	805.0 (64.3)	280.0 (22.4)	525.0 (42.0)	240.15 (19.2)
Village-II	700.2 (100)	NA	27.2 (3.8)	613.0 (87.5)	232.0 (33.3)	381.0 (54.4)	60.0 (8.6)
Village-III	1947.6 (100)	1317.6 (67.6)	159.0 (8.16)	462.5 (23.7)	254.4 (13.1)	208.1 (10.7)	48.5 (2.5)
Village-IV	329.4 (100)	NA	60.4 (18.3)	257.7 (78.2)	104.0 (31.6)	153.7 (46.7)	11.3 (3.4)
Tamil Nadu							
Village-I	516.96 (100)	NA	148.81 (28.8)	281.38 (54.5)	84.62 (16.4)	352.79 (68.3)	86.77 (16.8)
Village-II	315.9 (100)	NA	20.0 (6.3)	147.98 (46.8)	37.62 (11.9)	110.36 (34.9)	148.31 (46.9)
Village-III	1340.92 (100)	NA	538.74 (38.7)	755.46 (56.3)	419.16 (31.3)	444.97 (33.2)	46.72 (3.5)
Village-IV	1560.52 (100)	NA	219.27 (14.1)	1018.65 (65.3)	298.81 (19.1)	719.84 (46.1)	322.6 (20.7)
Jharkhand							
Village-I	800.0 (100)	40.0 (5.0)	40.0 (5.0)	720.0 (90.0)	200.0 (25.0)	320.0 (40.0)	NA

(Contd.)

Table 2.1 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Village-II	580.0	200.0	80.0	300.0	100.0	200.0	NA
	(100)	(34.5)	(13.8)	(51.7)	(17.2)	(34.5)	
Village-III	120.0	10.0	12.0	88.0	10.0	60.0	10.0
	(100)	(8.3)	(10.0)	(73.3)	(8.3)	(50.0)	(8.3)
Village-IV	300.0	25.0	75.0	125.0	50.0	75.0	75.0
	(100)	(8.3)	(25.0)	(41.7)	(12.5)	(25.0)	(25.0)
West Bengal							
Village-I	150.0	-	10.0	140.0	70.0	60.0	NA
	(100)		(6.7)	(93.3)	(46.7)	(40.0)	
Village-II	1300.0	70.0	NA	1230.0	NA	1230.0	NA
	(100)	(5.4)		(94.6)		(94.6)	
Village-III	60.0	6.0	10.0	44.0	NA	44.0	NA
	(100)	(10.0)	(16.7)	(73.3)		(73.3)	
Village-IV	70.0	30.0	NA	40.0	15.0	25.0	NA
	(100)	(42.9)		(57.1)	(21.4)	(35.7)	

Source : Village Records; NA : Not Available.

Occupational Pattern

The occupational pattern of the sample households surveyed by their primary occupations is given in Table 2.2 below. The workforce constitutes more in Gujarat and Tamil Nadu. However, the present study looked at marginal workers, cultivators and agricultural labourers. Except Gujarat, in the other sample village households across Tamil Nadu, Jharkhand and West Bengal a considerable population constitute agricultural labour. Marginal workers constitute more in Gujarat and Tamil Nadu, it reflects the initiation of livelihoods through group as well as individual interventions which are required for meeting the needs of different poor people especially marginal workers.

Table 2.2 : Occupational Pattern in Sample Villages

Village	Number of HHs	Total Population	Total Workers	Main Workers	Cultivators	Agri. Labour	HH Industry Workers	Others	Marginal Workers	SC/ST
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	171	1005	574	332	140 (14.0)	76 (7.6)	-	47	242 (24.1)	26
Village-II	328	1740	841	837	245 (14.1)	4 (0.22)	12	44	4 (0.22)	NA
Village-III	381	1915	921	272	213 (11.1)	13 (0.7)	-	46	649 (33.9)	1732 (ST)
Village-IV	222	1225	480	138	53 (4.3)	40 (3.3)	2	43	342 (27.9)	1111 (ST)
Tamil Nadu										
Village-I	397	1645	1634	1610	58 (3.5)	690 (41.9)	11	8	969 (58.9)	742

(Contd.)

Table 2.2 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-II	290	1157	1126	1119	42 (3.6)	456 (39.4)	7	1	469 (40.5)	310
Village-III	903	4291	1322	NA	345 (8.0)	552 (12.9)	169	82	1279 (29.8)	831
Village-IV	819	1719	778	NA	230 (13.4)	338 (19.7)	158	30	688 (40.0)	277
Jharkhand										
Village-I	195	978	678	479	298 (30.4)	65 (6.6)	-	23	345 (35.3)	325
Village-II	600	3110	1476	1010	102 (3.3)	150 (4.8)	105	89	1,222 (39.3)	1025
Village-III	35	222	129	114	28 (12.6)	50 (22.5)	-	11	89 (40.1)	45
Village-IV	79	395	301	275	31 (7.8)	110 (27.8)	6	18	168 (42.5)	102

(Contd.)

Table 2.2 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
West Bengal										
Village-I	100	550	355	300	67 (12.2)	160 (29.1)	9	20	256 (46.5)	15
Village-II	300	1525	1223	768	300 (19.7)	180 (11.8)	25	47	678 (44.5)	125
Village-III	136	680	520	340	17 (2.5)	280 (41.2)	11	35	378 (55.6)	-
Village-IV	67	272	232	112	19 (7.0)	62 (22.8)	-	12	147 (54.0)	-

NA: Not Available.

Physical Characteristics of Sample Villages

The rainfall characteristics have looked at average annual rainfall, average number of rainy days and number of drought years in all 16 sample villages. The average annual rainfall (rainy days) is very high in West Bengal and Jharkhand whereas it is moderate in Tamil Nadu but when compared to these three States, the sample State of Gujarat receives very low rainfall (Table 2.3). Generally, 11 rains/precipitation occurrences (or exceeding 20mm precipitation) contribute to surface runoff and soil erosion. But in our sample villages, the sample villages of West Bengal, and in a couple of sample villages in Gujarat the runoff is very high to total rainfall. Runoff is assumed to be around 25-30 per cent of the runoff producing precipitation due to a larger area of the watershed (our sample villages especially Tamil Nadu and Jharkhand and parts of Gujarat State sample villages) falling in the slope group of 1.5 to 5 per cent.

Table 2.3 : Physical Characteristics of Sample Villages

Villages	Rainfall Characteristics			Hydrological Characteristics			
	Average Annual Rainfall (mm)	Average No. of Rainy Days/Year	No. of Drought Years during past 10 years	Type of Soil (Red; Laterite; Black; Alluvial)	Runoff (as % of total rainfall)	Potential for Ground-water re-charge (as annual increase in ft. after cessation of rains)	Water storage and conservation structures
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gujarat							
Village-I	1100	60	03	Alluvial	10%	35	Ponds, Check-Dams and Percolation Tanks
Village-II	200	15	04	Alluvial	10%	35	Land leveling, Tank repair, construction of Farm ponds,
Village-III	400	25	06	Black Soil	5%	20	Land leveling, Tank repair, Farm ponds, and Check-Dams
Village-IV	450	15	04	Black Cotton Soil	5%	15	Land leveling, Tank repair, construction of Farm ponds

(Contd.)

Table 2.3 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tamil Nadu							
Village-I	679.65	35	05	Black Cotton Soil	3%	12	Farm Ponds, Deepening of Tank, Clearing of Supply Channel
Village-II	183.88	25	04	Black Cotton Soil	2%	10	Farm Ponds, Deepening of Tank, Clearing of Supply Channel
Village-III	890.60	40	02	Black Cotton Soil	1.5%	25	Farm Ponds, Deepening of Tank, Clearing of Supply Channel
Village-IV	887.95	40	02	Black Cotton Soil	1.5%	30	Farm Ponds, Deepening of Tank, Clearing of Supply Channel
Jharkhand							
Village-I	1100	70	03	Red Soil	2%	04	(Check-Dams, Farm Ponds, Bunding and Clearance of Drainage lines and checks across drains)

(Contd.)

Table 2.3 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Village-II	1000	100	01	Red Soil	2%	25 (20 per cent)	(Check-Dams, Farm Ponds, Bunding and Clearance of Drainage lines and checks across drains)
Village-III	700	90	01	Red Soil	2%	25	Repair of Tanks, Farm Ponds
Village-IV	600	75	04	Red Soil	2%	20-25	Repair of Tanks, Farm Ponds, Bunding
West Bengal							
Village-I	1400	100	-	Loam Soil	5%	35-40	Repair of Tanks, Farm Ponds, Bunding
Village-II	1400	100	-	Alluvial	6%	35-40	Farm Ponds, Bunding
Village-III	1165	90	02	Red, Laterite	8%	40	Renovation of Small Tanks, Farm Ponds
Village-IV	1200	90	-	Laterite and Sandy	8%	35	Renovation of Small Tanks, Farm Ponds

Table 2.4 : Distribution of Rainfall (mm) in Sample Districts

District	Normal (mm)	Actual (mm)	Average (mm)
Gujarat-Sabarkantha	803	450	627
Jharkhand- Deoghar	1203	1395	1288
Tamil Nadu-Ramanathapuram	827	869	587
West Bengal- Burdwan	1442	1173	1157

The rainfall pattern further reveals that, on an average there are 4 to 6 droughts in Gujarat, 2 to 5 in Tamil Nadu and 1 to 3 in Jharkhand whereas it is nominal in West Bengal and the period of droughts varies across 16 sample villages. Due to occurrences of drought situations crops suffer from severe moisture stress. The potential evapo-transpiration as well as the precipitation from the data reveals a possible crop-growing period from mid-April to third week of October and from first week of November to last week of February. In the sample districts of Gujarat and Tamil Nadu only single crop is possible since the actual rainfall occurrences was 71 and 57 per cent of normal rainfall, respectively (Table 2.4). Further, the distribution of rainfall in sample district was also observed. Since village level distribution of rainfall is not available, the study relied upon district level distribution of rainfall. In the sample districts of Jharkhand and West Bengal intercrop and double crop is possible as the actual rainfall occurrence was more than 800mm. Thus, water is the major natural constraint in increasing and stabilising agricultural production in these sample areas. The land and water use practices/watershed model adapted in these areas provides for proper management of all the precipitation by way of collection, storage and efficient utilisation of runoff rainwater as also the use of groundwater in view of type of soil and potential for groundwater recharge.

The topography of land is also an important factor for selection and design of different structures of land and water use practices for better rain water harvesting; for groundwater recharge as well as improving the moisture in the soil. The topography of land lie mostly in high as well as medium

Table 2.5 : Topography of Land (in acres)

Villages	Gujarat (in acres)			Tamil Nadu (in acres)			Jharkhand (in acres)			West Bengal (in acres)		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Village-I	25	-	375	243.5	446.5	122	200	320	150	150	130	70
Village-II	367.5	796.3	306.3	313.3	210.2	114.0	150	150	200	-	-	3185
Village-III	1176	-	294	678.2	300.8	602.0	40	60	10	35	20	05
Village-IV	367.5	122.5	188.7	206.9	678.7	263.6	100	40	60	30	-	40

areas in almost all 12 sample villages except in the State of West Bengal where the area mostly lie in low area (Table 2.5). The data reveal that the topography of land itself reflects the need for proper practices of land and water use in upper and middle reaches of catchment area of the watershed.

Table 2.6 : Land Available for Agriculture and Different Purposes (in acres)

Villages	Land Use Capability Classification and Slope		
	Class I to III & Slope 6% Arable Cropping	Class IV & Slope 6-30% Tree Fencing Horticulture	Class V & Slope >30% Forestry-Silvipasture
Gujarat			
Village-I	160.0	50.0	20.0
Village-II	1347.5	150.0	82.0
Village-III	1500.0	500.0	450.0
Village-IV	192.5	125.0	375.0
Tamil Nadu			
Village-I	2495.8	548.3	NA
Village-II	3143.4	2531.0	NA
Village-III	630.0	141.0	NA
Village-IV	703.5	342.0	30.2
Jharkhand			
Village-I	1764.0	98.0	98.0
Village-II	735.0	196.0	490.0
Village-III	171.5	30.0	24.5
Village-IV	312.5	183.75	49.0
West Bengal			
Village-I	343.0	24.5	NA
Village-II	3013.5	NA	171.5
Village-III	107.8	24.5	14.7
Village-IV	98.0	NA	73.5

The land available for agriculture and other purposes is also important for better management of land, water and biomass. As the data reveal the arable land with the slope of 6 per cent and tree fencing cum horticulture with the slope of 6 to 30 per cent is very high in almost all the sample villages (Table 2.6). The land with the slope of >30 per cent is for development of forestry and silvipasture. It reveals that agriculture cum horticulture type of natural resource management is very viable in our sample villages.

Table 2.7 gives the landholding pattern of small and marginal farmers in the sample villages. The mean value of landholding for small and marginal farmers in Gujarat, Tamil Nadu, Jharkhand and West Bengal were 1.95, 1.90, 1.66 and 1.81 ha, respectively. There was no much difference when compared to their respective median values.

Traditional/Institutional Conservation Practices in Sample Villages

In almost all the sample villages, the data reveal that both the practices of traditional as well as modern were taken up. In traditional practice, the traditional knowledge which is the key for conservation of resources should be protected. The protection of natural resources cannot be done and managed properly by codified laws, but traditional and customary practices can play an important role in its protection and conservation, through social norms, sanctions and codes. For example, every village in Garhwal region has its 'Bhumyal'(God of Land), 'Bandeo'(God of Forest), and also God of water bodies (Gadhera). Each 'Naula' (Spring) or drinking water source has the temple or symbol of God & Goddess above it (to protect them from any damage or deterioration), also no body was allowed to go for any construction activity above these water bodies (so there were less chances of any anthropocentric water pollution or deterioration). There is a fair, equitable and transparent system of scarce water distribution among the villagers in Garhwal region for agriculture purposes, where the people elect a water official, generally known as 'Kulao'. The responsibility of the person is to release water for required time in the field of each family for irrigation purposes, and this tradition has been followed since ancient times (K N Vajpai and Ms. Bhawna Maheshwari,

Table 2.7 : Landholdings of Small and Marginal Farmers (SMF) in Sample Villages

Villages	Landholdings in Sample Villages (Area in Hectare)					Mean	Median	Mode (ascending order)
	Total Cultivated Area	Number of Holdings	Total Small and Marginal Farmers	Total Area of Small and Marginal Farmers	Average area per Holding (SMF)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	805.0	140	123	226.23	1.84	1.95	1.95	1.80, 1.84, 2.06, 2.1
Village-II	613.0	245	189	341.01	1.80			
Village-III	462.5	213	156	321.56	2.06			
Village-IV	257.7	53	27	55.43	2.1			
Tamil Nadu								
Village-I	281.38	58	21	32.55	1.55	1.90	1.91	1.55, 1.88, 1.93, 2.25
Village-II	147.98	42	17	38.23	2.25			
Village-III	755.46	345	201	389.11	1.93			
Village-IV	1018.65	230	178	335.78	1.88			

(Contd.)

Table 2.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jharkhand								
Village-I	720.0	298	198	302.98	1.53	1.66	1.64	1.42, 1.53, 1.74, 1.93
Village-II	300.0	102	79	112.0	1.42			
Village-III	88.0	28	15	29.0	1.93			
Village-IV	125.0	31	19	33.0	1.74			
West Bengal								
Village-I	140.0	67	37	71.11	1.92	1.81	1.88	1.43, 1.84, 1.92, 2.05
Village-II	1230.0	300	221	453.22	2.05			
Village-III	44.0	17	14	25.78	1.84			
Village-IV	40.0	19	16	22.90	1.43			

1Bigha = .625 acre=5/8 acre 16 bigha = 1 acre

1 Bigha is equal to 0.04 hectare

1 Hectare = 2.47105381 Acres

Source : Village Records

2000). Similar institutions also prevailed in some parts of India such as *'neerukatti (Southern part of India) warabandi (Irrigation management in North India) and pani panchayats (Maharashtra)* etc. Some such kind of traditional practices was institutionalised prevailed elsewhere in India. Collective action, riparian rights, maintenance, sharing benefits, contributions and monitoring are some ingredients in institutional practices. Traditional practices of water bodies such as tanks are prominent in our sample watersheds. From rooftop, water was collected and stored in tanks built in their courtyards. From open community lands, they collected the rain and stored it in artificial wells.

Modern practices mostly involve the techniques and patterns of investment that were developed and practised in the later part of 20th century. The watershed based approach is mostly based on scientific approach. The modern practices mostly are storage of rain water on surface for future use and recharge to groundwater with various practices such as farm ponds, check-dams gully plugs etc. In the arable land, farm ponds are prominent where groundwater recharges and irrigation is possible. Mechanisation and relying on exogenous inputs in agriculture are also part of modern practices. Considerable initiations such as renovation of traditional water bodies like tanks are also taken up in the sample villages (see Table 2.8). The land and water use practices of different re-harvesting mechanisms namely, tanks, farm ponds, contour bunds and structures such as gully plugs and surface detention have been taken up in these sample villages. Other activities performed in non-arable land are mostly agri-horticulture type of interventions, vegetative barriers and other plantations. These are the interventions where, livelihood opportunities for landless and destitute women involved much more. This intervention is crucial with creation of non-land based opportunities for poor people in watershed area. Class v land may be used for pastures and livestock rearing.

Table 2.8 : Land and Water Use Practices Carried out in Sample Villages

Villages	Land and Water Use Practices Carried out					
	Check-Dams (in No.)	Farm Ponds/ Orani (in No.)	Percolation Tanks (in No.)	Tank Renovation/ Repair (in No.)	Field Bunds/Land Leveling (in Ha.)	Vegetative Barriers/ Pasture Development/ Horticulture/ Plantations (in Ha.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gujarat						
Village-I	5	8	5	2	98	11
Village-II	6	4	2	3	67	5
Village-III	2	5	2	2	50	3
Village-IV	2	2	2	1	15	6
Tamil Nadu						
Village-I	2	5	1	3	19	4
Village-II	3	4	1	3	14	2
Village-III	8	7	4	8	108	8
Village-IV	11	15	2	3	56	13

(Contd.)

Table 2.8 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jharkhand						
Village-I	5	9		2	88	15
Village-II	2	5		2	34	8
Village-III	2	3		1	13	2
Village-IV	3	3		2	21	1
West Bengal						
Village-I	2	5	2	1	25	7
Village-II	5	10	8	2	66	8
Village-III	1	4	2	2	12	4
Village-IV	1	4	1	1	15	4

Table 2.8 shows the different practices of land and water in sample villages. Water harvesting practices like check-dams, farm ponds, and percolation tanks were carried out in almost all the sample villages. Further, these practices mostly were maintained by the user groups through collective action. Most of the traditional tanks were also renovated in sample villages. Considerable soil conservation measures such as formation of bunds, land leveling at individual fields were also taken up. Other soil conservation measures like vegetative barriers, plantations especially horticulture plantations and development of pasture land were mostly carried out in a community mode. The impact of these structures was positive, especially increase of groundwater level, drinking water availability and reduced run-off and thereby enhanced yields and increase of incomes of smallholders in the sample villages of Gujarat, Tamil Nadu, Jharkhand and West Bengal where the practices of land and water initiations are more practical and well managed by the villagers.

The treatment of water bodies and its status is also assessed. The data show that the location of the structure is proper. This was expressed by the beneficiaries in almost all the sample villages in the study area (see Table 2.9). Recharge efficiency of the farm ponds and percolation tanks varies between 50 and 60 per cent depending upon the prevailing hydro geological conditions. It is reflected in our 16 sample villages. As expressed by the farmers, the reducing rate of siltation and groundwater recharge works are proper and useful to their needs. The quality of works carried out was very much appreciated by the sample respondents while 70 per cent of the development of plantations including horticulture development and pasture development survived. The treatment of various land and water practices in sample villages made a good sign where the realisation of benefits from these works is significant.

Table 2.9 : Farmers' Opinion on Treatment of Various Land and Water Use Practices in Sample Villages

Villages	Reducing rate of Siltation/ Runoff (Tank Renovation/ Repair/ Bunding/ Land Leveling)		Groundwater Recharge Works (Percolation Tanks, Check-Dams, and Farm Ponds)		Location of the Structure		Sustainability	
	Yes	No	New	Renovation	Proper	Improper	Quality (Structures)	Survival (Plantations)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)	9 (75.0)	3 (25.0)	8 (66.7)	9 (75.0)
Village-II	7 (58.3)	5 (41.7)	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	9 (75.0)	9 (75.0)
Village-III	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	7 (58.3)	5 (41.7)	6 (50.0)	8 (66.7)
Village-IV	10 (83.3)	2 (16.7)	8 (66.7)	4 (33.3)	8 (66.7)	4 (33.3)	6 (50.0)	6 (50)
Tamil Nadu								
Village-I	9 (75.0)	3 (25.0)	10 (83.3)	2 (16.7)	11 (91.7)	1 (8.30)	12 (100)	12 (100)
Village-II	9 (75.0)	3 (25.0)	10 (83.3)	2 (16.7)	10 (83.3)	2 (16.7)	9 (75.0)	8 (66.7)
Village-III	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)	9 (75.0)	3 (25.0)	10 (83.3)	8 (66.7)
Village-IV	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)	9 (75.0)	3 (25.0)	9 (75.0)	10 (83.3)

(Contd.)

Table 2.9 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jharkhand								
Village-I	6	6	9	3	7	5	6	8
	(50.0)	(50.0)	(75.0)	(25.0)	(58.3)	(41.7)	(50.0)	(66.7)
Village-II	5	7	5	7	7	5	7	6
	(41.7)	(58.3)	(41.7)	(58.3)	(58.3)	(41.7)	(58.3)	(50.0)
Village-III	4	8	8	4	6	6	6	7
	(33.3)	(66.7)	(66.7)	(33.3)	(50.0)	(50.0)	(50.0)	(58.3)
Village-IV	4	8	8	4	7	5	6	7
	(33.3)	(66.7)	(66.7)	(33.3)	(58.3)	(41.7)	(50.0)	(58.3)
West Bengal								
Village-I	7	5	9	3	8	4	10	9
	(58.3)	(41.7)	(75.0)	(25.0)	(66.7)	(33.3)	(83.3)	(75.0)
Village-II	8	4	7	5	9	3	8	8
	(66.7)	(33.3)	(58.3)	(41.7)	(75.0)	(25.0)	(66.3)	(66.3)
Village-III	8	4	7	5	9	3	8	9
	(66.7)	(33.3)	(58.3)	(41.7)	(75.0)	(25.0)	(66.3)	(75.0)
Village-IV	5	7	8	4	6	6	8	9
	(41.7)	(58.3)	(66.7)	(33.3)	(50.0)	(50.0)	(66.3)	(75.0)

CHAPTER III

ENABLING MEASURES FOR LAND AND WATER CONSERVATION

A number of innovative actions/initiatives pursued by our 16 sample villagers spreading across four States at local level are demonstrated to some extent to tackle poverty alleviation and resource sustainability. These responses provide a base to enhance resilience capacity to future impacts of climate change/climate variability. Positive local efforts include strengthening production systems, building economic assets, improving access to markets and information, diversifying to less climate-sensitive livelihoods, reducing disaster risks through local planning and preparation, and building foundations for all of these initiatives through more effective institutions of local governance and resource management.

Local approaches to land and water management have focused on improving production systems in order to increase productivity while reducing damage to land and water resources. Agricultural production systems are being strengthened through diversification of cultivars, improved soil and water management practices, identification and development of drought-tolerant, water-resistant and saline-tolerant varieties and management practices, as well as demand-responsive water management for agriculture such as drip irrigation. Innovations in integrated water resources management, with approaches in both supply and demand management, have led to improvements in water resource sustainability. Improved management of irrigation channels and pond construction, combined with soil erosion control and rainwater harvesting have improved efficiency of water management systems.

Table 3.1 : Farmers' Opinion on Working Condition of the Interventions and Satisfaction Level (No. of Respondents)

Villages	Gujarat			Tamil Nadu			Jharkhand			West Bengal		
	Good	Moderate	Low	Good	Moderate	Low	Good	Moderate	Low	Good	Moderate	Low
Village-I	8	3	1	9	1	2	5	4	3	6	2	4
	(66.7)	(25.0)	(8.30)	(75.0)	(8.30)	(16.7)	(41.7)	(33.3)	(25.0)	(50.0)	(16.7)	(33.3)
Village-II	5	4	3	7	4	1	4	7	1	8	4	NA
	(41.7)	(33.3)	(25.0)	(58.3)	(33.3)	(8.30)	(33.3)	(58.3)	(8.30)	(66.7)	(33.3)	
Village-III	11	1	NA	6	4	2	3	7	2	5	5	2
	(91.7)	(8.30)		(50.0)	(33.3)	(16.7)	(25.0)	(58.3)	(16.7)	(41.7)	(41.7)	(16.7)
Village-IV	9	2	1	7	3	2	7	5	NA	9	2	1
	(75.0)	(16.7)	(8.30)	(58.3)	(25.0)	(16.7)	(58.3)	(41.7)		(75.0)	(16.7)	(8.30)

The working conditions and satisfaction level of the different interventions in 16 sample villages across four States reveal that in almost all the villages these are mostly either good or moderate in condition (see Table 3.1). The same has been expressed by the villagers in 16 sample villages. The nature of ownership and use rights of land and water in sample villages are mostly individual when agriculture is concerned, whereas use of groundwater resources is purely private in nature. It is observed that over-exploitation of groundwater is taking place in almost all the sample villages. Interestingly, the use rights over common pool resources belong to village as a whole. It is further strengthened by group activity which depends upon livelihood activity. Activity-wise rights are assigned to different groups and individuals by the village institutions. The role of gram panchayat is prominent in Gujarat, Tamil Nadu and parts of West Bengal.

The cropping pattern as defined by area under different crops at a point of time has been changing across four States in our 16 sample states after initiation of land and water use practices. The sequences of crop diversification from food crops to commercial are not observed much in our sample villages. However, mixed cropping is more in Gujarat, Tamil Nadu and some parts of West Bengal. Detailed changes in area under different crops and yield have been discussed in brief in chapter IV.

The livestock population (total both milch animals and small ruminants) of 16 sample villages spreading across four States is shown in Table 3.2. There is no significant change in the number of sample households possessing livestock over the last six years. However, in Gujarat and Tamil Nadu, a significant gradual change is observed in having milch cows, buffaloes and sheep/goats. But overall, there is a considerable decrease of small ruminants in almost all the sample households. The reasons are many and alternative agriculture-horticulture based livelihoods are prominent among them in the sample villages. Another reason is the deterioration of fodder and pasture lands drastically in sample villages.

The possession of livestock population at the household level in our 16 sample villages is varied in nature. Some households are possessing the livestock, from more than four milch animals, whereas some others hardly

Table 3.2 : Total Livestock Population of Sample Households

Villages	Type of Livestock							
	Past				Present			
	Milch Animals		Small Ruminants		Milch Animals		Small Ruminants	
	Cows	Buffaloes	Sheep	Goat	Cows	Buffaloes	Sheep	Goat
Gujarat								
Village-I	55	64	33	24	74	121	42	20
Village-II	36	25	12	11	44	32	45	8
Village-III	22	12	24	14	18	21	33	33
Village-IV	65	37	23	15	133	55	34	45
Tamil Nadu								
Village-I	44	56	48	33	67	68	52	24
Village-II	66	44	56	26	110	58	46	22
Village-III	54	23	18	44	68	25	34	28
Village-IV	68	55	34	22	120	59	46	38
Jharkhand								
Village-I	36	44	37	44	54	49	26	32
Village-II	22	26	18	25	30	28	32	22
Village-III	18	12	25	20	24	16	21	12
Village-IV	31	20	14	22	38	16	22	08
West Bengal								
Village-I	45	39	28	12	57	46	33	16
Village-II	55	48	16	23	64	38	22	20
Village-III	22	18	12	06	20	14	21	14
Village-IV	32	16	23	12	36	23	26	12

one or two. Same is the situation for small ruminants also. It is also observed that 10 to 15 per cent of households do not possess livestock at all in 16 sample villages.

Table 3.3 : Farmers' Opinion on Nature of Practices at Natural Resource Management (No. of Respondents)

Villages	Soil Conservation		Practices Adopted		Transfer of Management Skills		Proper Land Use Systems		Effects	
	Traditional	Institutional	Traditional	Institutional	Positive	Negative	Yes	No	Positive	Negative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	9 (75.0)	3 (25.0)	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	11 (91.7)	1 (8.30)	10 (83.3)	2 (16.7)
Village-II	11 (91.7)	1 (8.30)	6 (50.0)	6 (50.0)	NA	NA	8 (66.7)	4 (33.3)	8 (66.7)	4 (33.3)
Village-III	10 (83.3)	2 (16.7)	6 (50.0)	6 (50.0)	NA	NA	8 (66.7)	4 (33.3)	10 (83.3)	2 (16.7)
Village-IV	10 (83.3)	2 (16.7)	8 (66.7)	4 (33.3)	2 (16.7)	10 (83.3)	9 (75.0)	3 (25.0)	10 (83.3)	2 (16.7)
Tamil Nadu										
Village-I	8 (66.7)	4 (33.3)	10 (83.3)	2 (16.7)	4 (33.3)	8 (66.7)	10 (83.3)	2 (16.7)	8 (66.7)	4 (33.3)
Village-II	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)	4 (33.3)	NA	7 (58.3)	5 (41.7)	9 (75.0)	3 (25.0)
Village-III	9 (75.0)	3 (25.0)	6 (50.0)	6 (50.0)	4 (33.3)	8 (66.7)	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)
Village-IV	9 (75.0)	3 (25.0)	7 (58.3)	5 (41.7)	2 (16.7)	NA	8 (66.7)	4 (33.3)	10 (83.3)	2 (16.7)

(Contd.)

Table 3.3 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Jharkhand										
Village-I	6 (50.0)	6 (50.0)	3 (25.0)	9 (75.0)	1 (8.30)	NA	6 (50.0)	6 (50.0)	7 (58.3)	5 (41.7)
Village-II	5 (41.7)	7 (58.3)	6 (50.0)	6 (50.0)	2 (16.7)	NA	7 (58.3)	5 (41.7)	6 (50.0)	6 (50.0)
Village-III	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	2 (16.7)	NA	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)
Village-IV	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	-	NA	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)
West Bengal										
Village-I	7 (58.3)	5 (41.7)	8 (66.7)	4 (33.3)	5 (41.7)	NA	7 (58.3)	5 (41.7)	9 (75.0)	3 (25.0)
Village-II	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	4 (33.3)	NA	9 (75.0)	3 (25.0)	10 (83.3)	2 (16.7)
Village-III	6 (50.0)	6 (50.0)	7 (58.3)	5 (41.7)	4 (33.3)	NA	8 (66.7)	4 (33.3)	10 (83.3)	2 (16.7)
Village-IV	6 (50.0)	6 (50.0)	6 (50.0)	6 (50.0)	4 (33.3)	NA	8 (66.7)	4 (33.3)	7 (58.3)	5 (41.7)

Community-based resource management or co-management between communities, groups and among individuals and governments is the key area where management of land and water practices reflects its effectiveness. The nature of practice in tune with development and management of land and water resources and biomass reflects positive in almost all the sample villages (Table 3.3). The level of practice adaptation, proper land and water use systems and their effects are more positive in the sample States like Gujarat, Tamil Nadu and West Bengal. Even in the sample State of Jharkhand the data have shown positive while adopting the nature of management of natural resources. The watershed management policies that relied mostly on traditional water and land rights were no longer appropriate as water demand and conflicts increased. However, stringent efforts were made by some of PIAs and other village institutions at gram panchayat level. These conflict resolution mechanisms and proper regulations at village level over natural resources are effectively managed.

The type of technology and proper use of land and water use practices in the 16 sample villages reveal that there is close correlation with location-specific as well as local cultures, size and homogeneousness of the community.

Table 3.4 : Farm System : Population Density and Changes in Agricultural and Socio-economic Systems

Villages	Population per km2		Agricultural System		Fertility Management		Land Availability for Cultivation		Typical Problem	
	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	655	970	Traditional	Value addition increased	Very low	Increased with local potential	Low	Increased	Yield is low	Agriculture production established
Village-II	775	1140	Subsistence	Diversified	NA	Organic	Low	Additional area brought under	Drinking water Ground-water table is very low	Managed
Village-III	710	1415	Subsistence	Diversified	NA	Increased with local potential	Low	Additional area brought under	Drinking water Ground-water table is very low	Managed

(Contd.)

Table 3.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-IV	801	998	Subsistence	Diversified	NA	Increased with local potential	Low	Increased	Drinking water Ground water table is very low	Managed
Tamil Nadu										
Village-I	890	1245	Subsistence	Diversified	NA	Organic	Low	Increased	Drinking water	Overcome
Village-II	790	1001	Subsistence	Diversified with new crops and additional area	Tradi-tional	Traditional and prone to organic	Low	Additional area brought under	Drinking water Low producti-vity	Managed with better land and water practices
Village-III	2890	3912	Traditional/ subsistence	Traditional Cum modern	Tradi-tional	Organic Farmers' own choice and cost-effective	Low	No visible impact	Soil erosion and irriga-tion and drinking water problem	Managed with better land and water practices

(Contd.)

Table 3.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-IV	980	1419	Traditional/ subsistence	Traditional cum modern	Tradi-tional	Organic	Low	No visible impact	NA	NA
Jharkhand										
Village-I	560	978	Low	Increased	Same	Same	Low	Increased	No	Improved
Village-II	1889	3110	Traditional (subsistence level)	Diversified	Not effec-tive	Farm based (organic)	Low	Increased	Soil erosion and runoff is more	Reduced/ controlled
Village-III	154	222	Traditional	Traditional	Pancha-yat	Individual, community and panchayat	No change	No change	Water logging	Water logging
Village-IV	288	395	Ownership and tenancy	Tenancy system has gone	Not effec-tive	Farm based (organic)	Very low	Increased	No markets, no water	Ground-water recharge and availability of water is plenty

(Contd.)

Table 3.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
West Bengal										
Village-I	300	350	NA	NA	NA	NA	NA	NA	No water	Water available
Village-II	324	379	Traditional (subsistence level)	Diversified	Not effec-tive	Farm based (organic)	Low	Increased	Lack of irrigation and capital	Improved
Village-III	375	450	Traditional (subsistence level)	Diversified	Not effec-tive	Farm based (organic)	Low	Increased	Lack of know-ledge, No irrigation	Employment opportunities available
Village-III	400	425	Traditional (subsistence level)	Diversified	Not effec-tive	Farm based (organic)	Low	Increased	Lack of know-ledge, No irrigation	Employment opportunities available

Table 3.4 *(Contd)* **: Farm System : Population Density and Changes in Agricultural and Socio-economic Systems**

Villages	Investments per km2		Tenure System		Market Access Management		Technology/ Information/Education		Family size	
	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now	Past (10 years)	Now
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	Low	Doubled	NA	NA	No	Established	No	Through village institution	5	3
Village-II	Low	Increased	NA	NA	low	Cooperative society	No	Krushi vigyan kendra	5	2
Village-III	Low	Increased	Same	Same	Low	Increased	NA	Agri. Dept.	NA	NA
Village-IV	Low	Increased	Same	Same	Low	Increased	NA	Agri. Dept.	6	2
Tamil Nadu										
Village-I	Low	Increased	Low	No Visible Impact	No Access	Cooperative Society	No	Available from extension agricultural officer	5	4

(Contd.)

Table 3.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-II	Low	Increased	Low	No visible impact	No access	Cooperative society	No	Available from extension agricultural officer	5	2
Village-III	Low	Increased	Low	No visible impact	No access	Cooperative society	No	Available from extension agricultural officer	5	2
Village-IV	Low	Increased	Low	No visible impact	No access	Cooperative society	No	Available from extension agricultural officer	6	4
Jharkhand										
Village-I	Low	Increased	Same	Same	Low	Increased	No	Improved	5	7
Village-II	Low	Increased	Same	Same	Low	Increased	No	Improved	5	4
Village-III	Low	Increased	Same	Same	Low	Increased	No	Improved	Constant	Declined

(Contd.)

Table 3.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-IV	Low	Increased	Na	Na	Negligible	Visible	No	Yes	High	Has come down
West Bengal										
Village-I	NA	NA	Same	Same	Low	Increased	No	Improved	Very high	Slightly Decreased
Village-II	Low	Increased	Same	Same	Low	Increased	No	Improved	Very high	Slightly decreased
Village-III	Low	Increased	Same	Same	Low	Increased	No	Improved	Very high	Decreased
Village-IV	Low	Increased	Same	Same	Low	Increased	No	Improved	Very high	Decreased

Table 3.4 shows the overall effectiveness and related practices of land and water use in 16 sample villages across four sample States. It gives clear indication of additional area brought under cultivation, investment pattern and typical problems faced by the different villages where adoption of land and water use practices/watershed initiatives provided effective re-harvesting of rain runoff in order to maximise agricultural production. It provides for effective water management plan (due to increase in groundwater table, and meeting the needs of drinking water in some of the sample villages), with approved practices and design. In this regard, quantity and costs of soil and water conservation measures coupled with proper management of manure and agricultural knowledge with specific location were also observed. It contributed to a significant change in land use by covering more area under cultivation. The adoption of organic and dryland practices has shifted cropping patterns with market facilities. Promotion of animal husbandry activities has resulted in providing subsidiary occupations for communities.

Further, the traditional practices in the study areas observed were harvested runoff by capturing water from swollen streams and rivers during the monsoon season and storing in various forms of water bodies such as tanks. Another practice observed was collecting water from rooftop and storing in open community lands, in tanks and artificial wells. The modern practices mostly are, storage of rain water on surface for future use and recharge to groundwater with various practices such as farm ponds, check-dams, and gully plugs etc.

Table 3.5 : Farmers' Opinion on Soil and Water Conservation Methods and Alternatives (No. of Respondents)

Villages	Soil Erosion		Changes in Farming Practices		
	Traditional	Institutional	Traditional	Institutional	Alternatives
(1)	(2)	(3)	(4)	(5)	(6)
Gujarat					
Village-I	4 (33.3)	8 (66.7)	3 (25.0)	11 (91.7)	7 (58.3)
Village-II	3 (25.0)	9 (75.0)	2 (16.7)	9 (75.0)	5 (41.7)
Village-III	2 (16.7)	10 (83.3)	4 (33.3)	9 (75.0)	5 (41.7)
Village-IV	2 (16.7)	10 (83.3)	4 (33.3)	8 (66.7)	8 (66.7)
Tamil Nadu					
Village-I	6 (50.0)	6 (50.0)	5 (41.7)	9 (75.0)	5 (41.7)
Village-II	5 (41.7)	7 (58.3)	6 (50.0)	8 (66.7)	4 (33.3)
Village-III	3 (25.0)	9 (75.0)	6 (50.0)	8 (66.7)	4 (33.3)
Village-IV	3 (25.0)	9 (75.0)	4 (33.3)	4 (33.3)	5 (41.7)
Jharkhand					
Village-I	5 (41.7)	7 (58.3)	4 (33.3)	3 (25.0)	2 (16.7)

(Contd.)

Table 3.5 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)
Village-II	6 (50.0)	6 (50.0)	6 (50.0)	4 (33.3)	3 (25.0)
Village-III	4 (33.3)	8 (66.7)	6 (50.0)	4 (33.3)	3 (25.0)
Village-IV	7 (58.3)	5 (41.7)	3 (25.0)	2 (16.7)	1 (8.30)
West Bengal					
Village-I	3 (25.0)	9 (75.0)	5 (41.7)	7 (58.3)	7 (58.3)
Village-II	3 (25.0)	9 (75.0)	4 (33.3)	5 (41.7)	8 (66.7)
Village-III	5 (41.7)	7 (58.3)	3 (25.0)	5 (41.7)	8 (66.7)
Village-IV	6 (50.0)	6 (50.0)	3 (25.0)	3 (25.0)	2 (16.7)

Table 3.5 : *(Contd.)*

Villages	Farmers' Attitude		Farmers' Risk Assessment		Incentives/ Subsidies			
	Positive	Negative	High	Low	Price	Institutional Framework	Technologies	Direct interventions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	9 (75.0)	3 (25.0)	4 (33.3)	8 (66.7)	5 (41.7)	4 (33.3)	2 (16.7)	2 (16.7)
Village-II	11 (91.7)	1 (8.30)	5 (41.7)	7 (58.3)	3 (25.0)	3 (25.0)	4 (33.3)	2 (16.7)

(Contd.)

Table 3.5 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Village-III	9 (75.0)	3 (25.0)	6 (50.0)	6 (50.0)	2 (16.7)	4 (33.3)	4 (33.3)	3 (25.0)
Village-IV	8 (66.7)	4 (33.3)	6 (50.0)	6 (50.0)	4 (33.3)	5 (41.7)	5 (41.7)	3 (25.0)
Tamil Nadu								
Village-I	7 (58.3)	5 (41.7)	9 (75.0)	3 (25.0)	8 (66.7)	5 (41.7)	4 (33.3)	2 (16.7)
Village-II	6 (50.0)	6 (50.0)	8 (66.7)	4 (33.3)	6 (50.0)	6 (50.0)	3 (25.0)	2 (16.7)
Village-III	8 (66.7)	4 (33.3)	8 (66.7)	4 (33.3)	7 (58.3)	1 (8.30)	3 (25.0)	3 (25.0)
Village-IV	5 (41.7)	7 (58.3)	11 (91.7)	1 (8.30)	7 (58.3)	4 (33.3)	2 (16.7)	1 (8.30)
Jharkhand								
Village-I	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	2 (16.7)	NA	NA	NA
Village-II	3 (25.0)	9 (75.0)	1 (8.30)	11 (91.7)	5 (41.7)	2 (16.7)	2 (16.7)	2 (16.7)
Village-III	2 (16.7)	10 (83.3)	4 (33.3)	8 (66.7)	3 (25.0)	NA	NA	NA
Village-IV	2 (16.7)	10 (83.3)	4 (33.3)	8 (66.7)	3 (25.0)	NA	NA	NA
West Bengal								
Village-I	7 (58.3)	5 (41.7)	6 (50.0)	6 (50.0)	4 (33.3)	2 (16.7)	NA	NA
Village-II	9 (75.0)	3 (25.0)	7 (58.3)	5 (41.7)	3 (25.0)	1 (8.30)	2 (16.7)	NA
Village-III	4 (33.3)	8 (66.7)	3 (25.0)	9 (75.0)	NA	NA	NA	NA
Village-IV	8 (66.7)	3 (25.0)	5 (41.7)	7 (58.3)	4 (33.3)	3 (25.0)	2 (16.7)	3 (25.0)

The perceptions of beneficiaries in the 16 sample households reveal that the structures (both traditional as well as institutional) raised have directly helped to increase the soil erosion, moisture conservation in the soil and changes of these practices to raise groundwater table as reported by the sample households across the four States (Table 3.5). The perception on farmers' attitude and risk assessment reveal that majority of the sample households reported their attitude and risk assessment as positive and need based. On the sample households' perception to strengthen the activities relating to incentives, the suggestions pointed out are, remunerative price, strong institutional framework at grassroots level, access to newly available technologies and interventions.

Collective Action/Community Participation : (Other than the Soil and Water Conservation/Water Harvesting Measures)

Some of the practices collectively implemented by the farmers in our 16 sample villages spread across four States as follows,

First intervention is Through SHGs (Tamil Nadu and Gujarat)

The practice is applying timely land augmenting technologies and put the land suitable for fodder cultivation. PIA has intervened into the fodder cultivation and made fund availability to the SHGs. This is the first experience for them to cultivate *cholam (Ramanathapuram-TN)* on their own as fodder crop. They felt that their animals got good quality fodder in time and they felt no shortage of fodder for their animals during this period. It is also observed that certain norms were evolved collectively for contribution, maintenance and sharing of benefits. They plan and promise to adopt this strategy in future even after the exit of DPAP activities.

Second Intervention is Through Agri.-horticultural Model (Tamil Nadu, Gujarat-Village Garden) and West Bengal)

The farmers planted horticultural seedlings (different varieties) on their small holdings through watershed interventions and developed their lands as agri.-horticulture model (especially in West Bengal). These farmers used to cultivate chillies and rainfed paddy every year. A pioneering effort was made in this region. Farmers collectively have planted mango, guava, sapota and amla in their land as rainfed horticulture. They planted all the seedlings in 10x10m spacing by taking pits to the size of 1 ½ x 1 ½ feet (Tamil Nadu). The soil type in their farms is varied in nature. They themselves made available the farm yard manure and filled the pit and then planted the seedlings during June, September and October 2002 & 2003 immediately after the first rains. Now the plants started bearing and harvesting of the produce is done regularly. Further, they were also cultivating chillies, vegetables and paddy as rainfed crops.

Third Intervention is Soil and Water Conservation Activities by User Groups

In sample villages of Tamil Nadu, the main problems are low productivity, unfavourable climatic conditions and degradation of land due to unscientific management of water harvesting structure and very poor rainwater retention. To meet out these problems, measures were adopted to preserve soil cover and to retain moisture. Emphasis was laid on low cost replicable technologies of which the sample village watershed is facing the problems of siltation in the channel. The type of soil is sandy in nature, rainwater takes away precious top soil every year and the channel lead to the nearby tanks is being spoiled due to heavy siltation. The length of the supply channel is about 800 m and width is about 2 m. Desiltation activity has been taken up and also generated employment for about 922 mandays. After the work was over, rain started and it was found that water was flowing freely and loss of water is being avoided. Hence the tank nearer to this village is filled up quickly and wastage of water also avoided. The water is used not only for recharging the nearby wells but also for the critical irrigation of the nearby drylands (locally they called the structure *Orani*).

Fourth Intervention is Water Harvesting Structures by User Groups (Jharkhand, Gujarat, Tamil Nadu and West Bengal)

While taking up the formation of farm pond, the WDT members persuaded the people to prepare to construct farm pond in the farmers' as well as users groups' fields. Small farmers could not spare lands for construction of farm pond. Hence, in some of the sample villages it was observed that the farmers agreed to spare some area for construction of farm pond. Based on the soil type of the area and siltation rate, the formation of farm ponds was designed by the farmers themselves with the help of WDT members in the watershed areas. User groups desilted whenever siltation occurred and made as bunds along the periphery of the ponds to hold more water during rainy days. In some of the sample villages in these states, the soil type of the watershed i.e. below the subsoil is calcareous, hence the water quality is very poor and it is not potable. Hence people use the stored water in the farm pond for drinking purpose and also for cattle drinking. The farm ponds were constructed with proper vent as the soil is loose (black soil). The farmers used locally available boulders to control erosion. Further, vettiver and agaves were also planted on the vent to prevent soil erosion.

Enabling Measures and Practices for Development

However, the practices are not new and the present study highlights these existing practices which are effectively implemented elsewhere.

The *first practice* is risk management and asset building; Poor farmers have limited tools to manage the higher risks associated with the impacts of greater climate variability on production systems. Small and marginal farmers can have the alternative choice "hedging" production choices to manage these risks (farmers are responding to increasingly unpredictable rainfall by dividing their rice plots: on one half, using conventional wet-paddy rice techniques (resistant to heavy precipitation) and, on the other half, applying a system of rice intensification (SRI) requiring much less water). This may involve strengthening the accessibility and reach of formal lending institutions, women's self-help saving groups and micro credit banks for poor.

The *second practice* is improved access to markets : Market accessibility can substantially increase returns to poor producers, reducing poverty and enabling more sustainable production. Value-added practices such as improved primary processing, drying, storage and sorting or grading will often increase economic returns to agriculture, livestock, fisheries and forestry activities. Improving linkages to markets through creating economies of scale by linking women and men producers through cooperatives and improving transport facilities will also facilitate small producers to compete in markets and to strengthen economic assets.

The *third practice* is : information, education and communication: Campaign activities using accessible media such as community radio or local events are useful (farmer filed schools renowned in the region for supporting application of new agricultural practices).

The *fourth practice* is use of Remittance properly : A few poor farmers rely on local resource production, and many have at least one family member sending remittances from migrant labour abroad. Remittance economies are crucial to the survival of rural families, and may also be used as investment in land and water management.

The *final and fifth practice* is participatory community-based management of common pool resources to link knowledge and perceptions with scientific assessments: These two domains of knowledge are not easily reconciled because of different fundamental assumptions and world views. These call for discussion among stakeholders of different perceptions of existing water and socio-economic issues, generation and discussion of scenarios, and collaborative planning and coordination among users.

CHAPTER IV

EFFECTIVENESS OF LAND AND WATER USE PRACTICES

Land and water use practices/watershed development initiatives aim to establish an enabling framework for the integrated use, regulation and development of land and water resources in a particular area in order to reduce poverty. The area of operation can be defined at various physical scales : at one extreme watershed covers whole regions or countries, at the other they occur within individual farms. The selection of watershed areas should be based on a combination of biophysical criteria (e.g. levels of erosion, rainfall, groundwater potential, and livestock numbers), social and economic criteria (e.g. landholding size, migration levels, literacy rates) and institutional criteria (e.g. functioning of self-help groups, history of collective action, presence of NGOs) (DFID-key sheets, January,1999).

Over the past 10 years, the typical goals of land and water use practices include:

* raising the productivity of rainfed agriculture and non-arable lands;
* encouraging the sustainable management and optimal use of surface and groundwater;
* reducing soil erosion and land development
* conserving forests and other natural vegetation;
* creating employment (both directly and indirectly); and
* promoting increased individual and collective responsibility for natural resource management and strengthening social institutions.

Local communities play a central role in the planning, implementation and funding of activities within the realm of natural resources management.

The exact composition of any given programme should be determined in conjunction with them. It is important to ensure that programme activities:

* do not provoke conflict between resource users (where conflict is unavoidable, conflict resolution mechanisms should be specified early on);
* do not further isolate small and marginal households (may not be able to participate in activities which demand labour or financial contribution);
* do not undermine viable indigenous soil and water conservation techniques;
* are informed by an understanding of existing management practices (e.g. they do not immediately promote group activity if there is no history of communal working);
* are feasible given current capacity within the community and external organisations; and
* take into account underlying climatic, hydrological, soil and land use characteristics.

The effectiveness of land and water use practices/watershed development in eliminating poverty will depend on the distribution of costs and benefits in the short and long term. Particular attention should be paid to understanding and supporting the livelihood strategies of women and the landless. These strategies may be as follows,

* Which resources are most important to the poor? (Access should be safeguarded wherever possible.)
* How are land and water resources distributed within the community? If proposed activities affect this distribution who gains and who loses?

* What non-land-based activities can be promoted to benefit landless households (e.g. livestock, non-farm employment)?

* What impact will proposed activities have on women's workloads? Can these be reduced by introduction of drudgery-reducing alternatives (e.g. improved energy sources, better water supplies)?

* Will women have access to wage-earning opportunities within the programme? If so, what can be done to help ensure that they retain control over the money they earn?

Specific capacity building efforts may be required to ensure that women, indigenous people and other marginal groups are involved in decision-making about natural resource management and the use of project funds. Capacity building may also be required in order to improve awareness of local technologies and how to adapt new technologies to local contexts; ensure that groups are able to manage finances effectively; and enable local people to be fully involved in monitoring and evaluating programmes.

The enabling environment of land and water use practices and its effectiveness has been assessed in four States across India, keeping in view the above key strategies. Our 16 sample villages spreading across four States reveal that effective management of land and water use practices and thereby livelihood security is possible through proper institutional arrangements, collective action of all stakeholders and timely availability of PIA to the local level institutions and groups.

Process

In the light of common property theory, and to promote collective action of different stakeholders in the realm of natural resource management, our study findings reveal diverse results regarding the land and water use practices in 16 sample villages across four States in India. Functioning and effectiveness of institutions in the village and dealing with the practices of land and water (including biomass) by these institutions mostly depend on the process of their evolution. Both pre and post-implementation processes play an important role in this regard. Very few farmers are involved in the pre-planning phase of the watershed related activities, though a majority of them expressed that the formation of village level institutions (informal as well as formal committees like watershed committees, user groups and SHGs, etc.) is appropriate to solve the problems of irrigation, drinking water and mitigate drought conditions and thereby ensuring livelihood security. The involvement of local community was much less in the down reaches especially Jharkhand and in some parts of Gujarat and Tamil Nadu sample villages. In the absence of local community participation, the main lacuna observed in the pre-planning process was: limited devolution of powers to these institutions in almost all States (16 sample villages) and selection of good leaders. It is observed that caste, gender and activity did not play an important role in the formation of village level institutions. The proportion of women members in these village institutions is very marginal in sample villages of Jharkhand and some parts in West Bengal also.

The first aspect as seen through our study is about type of works carried out by different institutions in the sample villages. People are aware of the work carried out and the maintenance of quality. Most of the works are carried out by the village institutions and also by the villagers with the help of PIA (see Table 4.1). The major works carried out in the sample villages are repair/ renovation/restoration of the existing structures of land and water bodies, bunding/land leveling, siltation, plantation and construction of check-dams/farm ponds and percolation tanks. These structures are in tune with rainfall and dry spells in the sample villages.

Rainfall Risks and Adaptation Methods in Sample Villages

In recent past, with productivity gains from irrigated areas slowing down in the country, the only alternative is to enhance productivity levels from rainfed areas. Rainfed areas need to contribute significantly towards second Green Revolution to alleviate poverty and ensure food and economic security and therefore, by 2020 the average productivity in rainfed areas must upscale to 2 t ha^{-1} from current level of 1.2 t ha^{-1}.

Risks

- Rainfall is undependable both in timing and amount
- Soils are generally degraded in quality and marginal in fertility
- Dryland farmers are economically weak with little ability to withstand risk
- Timely adoption of crop management strategies is not happening
- Holdings are small and marginal
- Hurdles for farm mechanisation
- High tech, high value agriculture is not feasible unless water sources are well developed
- Poor extension services, and non- availability of good seed are the major bottlenecks

Keeping in view the above rainfed risks, the structures are also so designed to mitigate negative impacts of drought situations. These risks are well known to some village institutions and PIA. Accordingly, the works have been carried out by village institutions and individuals in some of the sample States.

Table 4.1 : Farmers' Opinion about Works Carried Out by Different Institutions/Involvement of Institutions for Implementation of Works (No. of Respondents)

Village	Works Carried out by Institutions (Check-Dams, Farm Ponds, Percolation Tanks and Tank Renovation/Repair)			Bunding/Land Leveling			Siltation		
	Village Institution	Own	Contractor	Village Institution	Own	Contractor	Village Institution	Own	Contractor
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gujarat									
Village-I	8 (66.7)	4 (33.3)	NA	8 (66.7)	4 (33.3)	NA	7 (58.3)	NA	5 (41.7)
Village-II	10 (83.3)	2 (16.7)	NA	7 (58.3)	5 (41.7)	NA	9 (75.0)	NA	3 (25.0)
Village-III	9 (75.0)	3 (25.0)	NA	6 (50.0)	6 (50.0)	NA	7 (58.3)	NA	5 (41.7)
Village-IV	7 (58.3)	5 (41.7)	NA	7 (58.3)	5 (41.7)	NA	10 (83.3)	NA	2 (16.7)
Tamil Nadu									
Village-I	10 (83.3)	2 (16.7)	NA	7 (58.3)	5 (41.7)	NA	8 (66.7)	4	NA (33.3)
Village-II	11 (91.7)	1 (8.30)	NA	9 (75.0)	3 (25.0)	NA	10 (83.3)	2 (16.7)	NA
Village-III	10 (83.3)	2 (16.7)	NA	8 (66.7)	4 (33.3)	NA	9 (75.0)	3 (25.0)	NA
Village-IV	9 (75.0)	3 (25.0)	NA	8 (66.7)	4 (33.3)	NA	9 (75.0)	3 (25.0)	NA

(Contd.)

Table 4.1 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Jharkhand									
Village-I	5	3	4	6	6	NA	8	2	2
	(41.7)	(25.0)	(33.3)	(50.0)	(50.0)		(66.7)	(16.7	(16.7)
Village-II	7	2	3	7	5	NA	9	2	1
	(58.3)	(16.7)	(25.0)	(58.3)	(41.7)		(75.0)	(16.7)	(8.30)
Village-III	9	2	1	8	4	NA	7	2	3
	(75.0)	(16.7)	(8.30)	(66.7)	(33.3)	(58.3)	(16.7)	(25.0)	
Village-IV	5	3	4	8	4	NA	7	2	3
	(41.7)	(25.0)	(33.3)	(66.7)	(33.3)		(58.3)	(16.7)	(25.0)
West Bengal									
Village-I	9	2	1	8	4	NA	8	2	2
	(75.0)	(16.7)	(8.30)	(66.7)	(33.3)		(66.7)	(16.7)	(16.7)
Village-II	8	2	2	7	5	NA	6	6	NA
	(66.7)	(16.7)	(16.7)	(58.3)	(41.7)		(50.0)	(50.0)	
Village-III	8	2	2	7	5	NA	6	6	NA
	(66.7)	(16.7	(16.7)	(58.3)	(41.7)		(50.0)	(50.0)	
Village-IV	7	3	2	9	2	1	7	3	2
	(58.3)	(25.0)	(16.7	(75.0)	(16.7	(8.30)	(58.3)	(25.0)	(16.7)

Table 4.1 : *(Contd.)*

Village	Plantation			Construction of (Check-Dams, Farm Ponds, Percolation Tanks			Any other (specify)		
	Village Institution	Own	Contractor	Village Institution	Own	Contractor	Village Institution	Own	Contractor
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gujarat									
Village-I	9 (75.0)	3 (25.0)	NA	3 (25.0)	NA	9 (75.0)	NA	NA	NA
Village-II	7 (58.3)	5 (41.7)	NA	4 (33.3)	NA	8 (66.7)	NA	NA	NA
Village-III	7 (58.3)	5 (41.7)	NA	4 (33.3)	NA	8 (66.7)	NA	NA	NA
Village-IV	8 (66.7)	4 (33.3)	NA	5 (41.7)	NA	7 (58.3)	NA	NA	NA
Tamil Nadu									
Village-I	10 (83.3)	2 (16.7)	NA	5 (41.7)	NA	7 (58.3)	NA	NA	NA
Village-II	6 (50.0)	6 (50.0)	NA	5 (41.7)	NA	7 (58.3)	NA	NA	NA
Village-III	6 (50.0)	6 (50.0)	NA	3 (25.0)	NA	9 (75.0)	NA	NA	NA
Village-IV	9 (75.0)	3 (25.0)	NA	3 (25.0)	NA	9 (75.0)	NA	NA	NA

(Contd.)

Table 4.1 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Jharkhand									
Village-I	8 (66.7)	NA	NA	NA	4 (33.3)	4 (33.3)	NA	NA	NA
Village-II	5 (41.7)	NA	NA	NA	NA	6 (50.0)	NA	NA	NA
Village-III	5 (41.7)	NA	NA	NA	NA	3 (25.0)	NA	NA	NA
Village-IV	4 (33.3)	NA	NA	NA	NA	2	NA (16.7)	NA	NA
West Bengal									
Village-I	7 (58.3)	5 (41.7)	NA	10 (83.3)	NA	2 (16.7)	NA	NA	NA
Village-II	8 (66.7)	4 (33.3)	NA	9 (75.0)	NA	3 (25.0)	NA	NA	NA
Village-III	8 (66.7)	4 (33.3)	NA	9 (75.0)	NA	3 (25.0)	NA	NA	NA
Village-IV	8 (66.7)	4 (33.3)	NA	11 (91.7)	NA	1 (8.30)	NA	NA	NA

These low cost and time as well as risk saving structures like farm ponds are feasible in drought-prone areas where rainfall is scanty in nature. The relevance of farm ponds in some of the sample villages, explores the potential of water harvesting and possibility of convergence with line departments especially with Rashtria Krushi Vikas Yojana (RKVY) and National Agricultural Innovative Project (NAIP – Component-3 (Livelihoods) (Table 4.2). These farm ponds were developed at community as well as individual level. Through NAIP scheme, funds were used for digging of farm pond while the farmers contributed for lifting and utilisation of water for growing vegetables on small patches of plots.

Table 4.2 : Volume and Catchment Area of Different Storage Structures

S. No.	Farm pond/ Percolation pond	Location	Catmt. area (ha)	Dimensions Top-Bottom- Depth (m)	Excav. Volume (m^3)	Storage capacity (m^3)
1	Farm pond-1	Field No.5	2.0	16 x 16m 8.4 x 8.4; 3.8m	580	500
2	Farm pond-2	Field No.6	2.5	16.5 x 16.5m 8.5 x 8.5; 4.0m	645	550
3	Farm pond-3	Field No.6	3.7	16.5 x 16.5m 8.5 x 8.5; 4.0m	(645) 1575	(600) 1275
4	Farm pond-4	Field No.9	4.7	32.5 x 19.0m + * 23.5 x 8.0; 4.5m	(2300) 2950	(1900) 2570
5	Farm pond-5	Field No.8	2.0	16.5 x 16.5 m 8.5 x 8.5 ; 4.0 m	645	580
6	Farm pond-6	Field No.1	2.7	16.5 x 16.5 m 8.5 x 8.5 ; 4.0m	645	560
7	Percolation pond-1	Field No.11B Old dugout renovated	3.0	18.5 x 18.5m 8 x 8; 4.5m	900	790
8	Percolation pond-2	Field No.6 Defunct well renovated	2. 5	18.5 x 18.5m 8 x 8; 7.0m	(900) 1400	(750) 1065
9	Percolation pond-3	Field No.8 Defunct well renovated	3.9	19.5 x 18.5 m 8.5 x 8.5; 6.5 m	1000	800
			27.0		10340	8690

Awareness

Awareness level regarding the land and water conservation practices is quite high among the communities especially in Tamil Nadu, Gujarat and parts of West Bengal. Greater awareness in the communities could be due to the smaller coverage, often pertaining to one village and PIA closeness to these communities. However, the high awareness is not due to any systematic campaigning by the department or village panchayats. It is mainly spread among the farmers (Table 4.3). It is observed through the field study that the awareness level of households is high in the sample villages about purpose of institution, role of Institution, effectiveness of institution, problems associated with the institution, fund availability, and relationship with the village panchayat/other formal/informal institution. The effectiveness of institutions in these sample villages as observed, is higher in sample villages of Tamil Nadu and Gujarat and some villages of West Bengal, while it is very low profile in the States of Jharkhand sample villages. Most of the suggestions pertained to devolution of powers and proper repair of works. It is also observed that working together with village institutions and panchayats induces better results in some of the sample villages.

Table 4.3 : Opinion of the Existing Institutions and Their Role in Different Practices of Land and Water

Village	Purpose of Institution			Role of Institution		Effectiveness of Institution		
	Clear	Partial	Not Clear	Aware	Partial	Can't say	Very Effective	Not Effective
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	7 (58.3)	5 (41.7)	NA	7 (58.3)	5 (41.7)	3 (25.0)	7 (58.3)	2 (16.7)
Village-II	8 (66.7)	2 (16.7	2 (16.7)	8 (66.7)	4 (33.3)	3 (25.0)	9	NA (75.0)
Village-III	9 (75.0)	3 (25.0)	NA	9 (75.0)	3 (25.0)	2 (16.7)	9 (75.0)	1 (8.30)
Village-IV	11 (91.7)	1 (8.30)	NA	12 (100)	NA	2 (16.7	10 (83.3)	NA
Tamil Nadu								
Village-I	10 (83.3)	NA	NA	9 (75.0)	NA	NA	7 (58.3)	NA
Village-II	9 (75.0)	NA	NA	8 (66.7)	NA	NA	6 (50.0)	NA
Village-III	9 (75.0)	NA	NA	8 (66.7)	NA	NA	6 (50.0)	NA
Village-IV	11 (91.7)	NA	NA	10 (83.3)	NA	NA	8 (66.7)	NA
Jharkhand								
Village-I	5 (41.7)	NA	7 (58.3)	5 (41.7)	7 (58.3)	NA	2 (16.7)	NA
Village-II	4 (33.3)	NA	8 (66.7)	4 (33.3)	8 (66.7)	NA	3 (25.0)	NA

(Contd.)

Table 4.3 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Village-III	6 (50.0)	NA	6 (50.0)	6 (50.0)	6 (50.0)	NA	3 (25.0)	NA
Village-IV	6 (50.0)	NA	6 (50.0)	6 (50.0)	6 (50.0)	NA	NA	NA
West Bengal								
Village-I	8 (66.7)	4 (33.3)	NA	8 (66.7)	4 (33.3)	2 (16.7)	8 (66.7)	2 (16.7)
Village-II	7 (58.3)	5 (41.7)	NA	7 (58.3)	5 (41.7)	3 (25.0)	7 (58.3)	2 (16.7)
Village-III	4 (33.3)	5 (41.7)	NA	6 (50.0)	6 (50.0)	3 (25.0)	6 (50.0)	3 (25.0)
Village-IV	5 (41.7)	7 (58.3)	NA	6 (50.0)	6 (50.0)	3 (25.0)	5 (41.7)	4 (33.3)

Table 4.3 : *(Contd.)*

Village	Problems Associated with the Institution			Fund Availability			Suggestions for Improvement		
	No Problems	Problems with some minor issues	Not responded	Sufficient	Insufficient	Proper repair/ management	No suggestions related solutions	Devolution of powers	Financial/ revenue
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gujarat									
Village-I	7 (58.3)	3 (25.0)	2 (16.7)	7 (58.3)	5 (41.7)	7 (58.3)	NA (66.7)	8 (50.0)	6
Village-II	8 (66.7)	4 (33.3)	NA	4 (33.3)	6 (50.0)	6 (50.0)	NA	9 (75.0)	4 (33.3)

(Contd.)

Table 4.3 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Village-III	9 (75.0)	2 (16.7)	1 (8.30)	6 (50.0)	6 (50.0)	4 (33.3)	NA (75.0)	9 (58.3)	7
Village-IV	5 (41.7)	7 (58.3)	NA	6 (50.0)	6 (50.0)	7 (58.3)	NA	6 (50.0)	7 (58.3)
Tamil Nadu									
Village-I	8 (66.7)	4 (33.3)	NA	7 (58.3)	5 (41.7)	5 (41.7)	NA	2 (16.7)	8 (66.7)
Village-II	5 (41.7)	7 (58.3)	NA	10 (83.3)	2 (16.7)	6 (50.0)	NA	2 (16.7)	8 (66.7)
Village-III	6 (50.0)	6 (50.0)	NA (66.7)	8 (33.3)	4 (50.0)	6 (66.7)	NA (75.0)	8	9
Village-IV	9 (75.0)	3 (25.0)	NA	8 (66.7)	4 (33.3)	8 (66.7)	NA	8 (66.7)	7 (58.3)
Jharkhand									
Village-I	3 (25.0)	9 (75.0)	NA	4 (33.3)	8 (66.7)	9 (75.0)	NA	8 (66.7)	10 (83.3)
Village-II	6 (50.0)	6 (50.0)	NA	3 (25.0)	9 (75.0)	10 (83.3)	NA	3 (25.0)	9 (75.0)
Village-III	5 (41.7)	7 (58.3)	NA	3 (25.0)	5 (41.7)	5 (41.7)	NA	7 (58.3)	9 (75.0)
Village-IV	2 (16.7)	2 (16.7)	NA	6 (50.0)	6 (50.0)	7 (58.3)	NA	7 (58.3)	5 (41.7)
West Bengal									
Village-I	NA	10 (83.3)	2 (16.7)	NA	12 (100)	7 (58.3)	NA	6 (50.0)	9 (75.0)
Village-II	2 (16.7)	9 (75.0)	1 (8.30)	2 (16.7)	10 (83.3)	10 (83.3)	NA	3 (25.0)	10 (83.3)
Village-III	NA	7 (58.3)	5 (41.7)	NA (83.3)	10 (58.3)	7 (25.0)	NA (83.3)	3	10
Village-IV	6 (50.0)	6 (50.0)	NA	NA	12 (100)	7 (58.3)	NA	3 (25.0)	12 (100)

Table 4.3 : *(Contd.)*

Village	Relationship with Village Panchayat / Other Formal / Informal Institutions		
	Very good	Not satisfactory	Moderate
(1)	(2)	(3)	(4)
Gujarat			
Village-I	9 (75.0)	2 (16.7)	1 (8.30)
Village-II	2 (16.7)	2 (16.7)	8 (66.7)
Village-III	5 (41.7)	NA	7 (58.3)
Village-IV	3 (25.0)	NA	9 (75.0)
Tamil Nadu			
Village-I	10 (83.3)	NA	2 (16.7)
Village-II	11 (91.7)	NA	1 (8.30)
Village-III	9 (75.0)	3 (25.0)	NA
Village-IV	10 (83.3)	2 (16.7)	NA
Jharkhand			
Village-I	3 (25.0)	4 (33.3)	NA
Village-II	1 (8.30)	7 (58.3)	NA

(Contd.)

Table 4.3 : *(Contd.)*

(1)	(2)	(3)	(4)
Village-III	1 (8.30)	6 (50.0)	NA
Village-IV	2 (16.7)	6 (50.0)	NA
West Bengal			
Village-I	7 (58.3)	2 (16.7)	3 (25.0)
Village-II	9 (75.0)	2 (16.7)	1 (8.30)
Village-III	5 (41.7)	4 (33.3)	3 (25.0)
Village-IV	7 (58.3)	3 (25.0)	2 (16.7)

* Wherever the Columns are Blank-the Farmers did not Respond.

Process on Decision Making, Involvement of Farmers and Contributions

Democratic process is measured in terms of conducting, attending meetings and decision-making process (collective / majority). Democratic decision-making is more in Tamil Nadu, Gujarat and West Bengal. But it is more or less absent in the State of Jharkhand. Important issues like fund collection and allocation are hardly discussed. Even on simple issues decisions were made either by President or by Government Officials except in Tamil Nadu and Gujarat (Table 4.4). When enquired about the functioning of the village level institutions, the opinion of the sample farmers is divided. Political interference appears to be the dominant reason for the members' dissatisfaction, especially in the State of Jharkhand. On the contrary, more people are happy about the performance of the previous president in both the cases and across the locations. This indicates that the unanimous selection process of the presidents is not very faulty. The limited dissatisfaction with the previous presidents was mainly incompetence. There are disputes among different stakeholders/users regarding works carried out and distribution of water. This indicates that the involvement and influence of the department has not declined. Interestingly, majority of the farmers do not have any suggestion for improving the performance of the watershed committees though some of them have expressed the need for cooperation among the farmers. This clearly reflects the poor awareness and commitment of the farmers, indicating weak institutional structure in terms of social capital except in Tamil Nadu and Gujarat States.

Lack of commitment and ownership also comes out clearly from the farmers' involvement in the maintenance of the systems. Farmers' involvement is limited to participation in elections, attending general body meetings (conducted when necessary) and to some extent water distribution. Their involvement in the important works like rehabilitation and resettlement and joint assessment survey is found to be marginal (Table 4.4).

Table 4.4 : Process on Decision-making in Sample Villages Regarding Land and Water Use Practice

Village	Who took the decision in various activities			Were the decisions taken in the meeting implemented		What are the powers of the institution		
	President	Demo-cratic process	Govt. Officials	Yes	No	Conducting meetings, taining	Maintain-enace	Getting funds from the Govern-ment
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)
Gujarat								
Village-I	1 (8.30)	8 (66.7)	3 (25.0)	10 (83.3)	2 (16.7)	11 (91.7)	10 (83.3)	5 (41.7)
Village-II	3 (25.0)	9 (75.0)	NA	12 (100)	NA	9 (75.0)	9 (75.0)	NA
Village-III	1 (8.30)	6 (50.0)	5 (41.7)	9 (75.0)	2 (16.7)	8 (66.7)	7 (58.3)	3 (25.0)

(Contd.)

Table 4.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)
Village-IV	NA	5 (41.7)	7 (58.3)	7 (58.3)	5 (41.7)	7 (58.3)	8 (66.7)	4 (33.3)
Tamil Nadu								
Village-I	6 (50.0)	4 (33.3)	2 (16.7)	10 (83.3)	2 (16.7)	7 (58.3)	11 (91.7)	1 (8.30)
Village-II	3 (25.0)	7 (58.3)	2 (16.7)	9 (75.0)	3 (25.0)	11 (91.7)	9 (75.0)	4 (33.3)
Village-III	4 (33.3)	5 (41.7)	3 (25.0)	9 (75.0)	3 (25.0)	9 (75.0)	11 (91.7)	4 (33.3)
Village-IV	4 (33.3)	6 (50.0)	2 (16.7)	11 (91.7)	1 (8.30)	7 (58.3)	10 (83.3)	6 (50.0)
Jharkhand								
Village-I	3 (25.0)	NA	9 (75.0)	5 (41.7)	7 (58.3)	8 (66.7)	5 (41.7)	3 (25.0)
Village-II	4 (33.3)	2 (16.7)	6 (50.0)	9 (75.0)	3 (25.0)	7 (58.3)	7 (58.3)	3 (25.0)
Village-III	1 (8.30)	4 (33.3)	7 (58.3)	6 (50.0)	6 (50.0)	9 (75.0)	6 (50.0)	3 (25.0)
Village-IV	3 (25.0)	5 (41.7)	4 (33.3)	8 (66.7)	4 (33.3)	6 (50.0)	9 (75.0)	2 (16.7)
West Bengal								
Village-I	3 (25.0)	6 (50.0)	3 (25.0)	8 (66.7)	4 (33.3)	7 (58.3)	9 (75.0)	5 (41.7)
Village-II	8 (66.7)	8 (66.7)	NA (91.7)	11 (8.30)	1 (50.0)	6 (91.7)	11 (25.0)	3
Village-III	3 (25.0)	9 (75.0)	NA	6 (50.0)	6 (50.0)	8 (66.7)	9 (75.0)	2 (16.7)
Village-IV	4 (33.3)	6 (50.0)	2 (16.7)	9 (75.0)	3 (25.0)	9 (75.0)	8 (66.7)	2 (16.7)

Table 4.4 : *(Contd.)*

Village	Has your new institution conducted meetings		If Yes how often meetings took place			Are all the institution members participating in the implementation		What sort of issues were generally discussed in the meetings?	
	Yes	No	Quarterly	Yearly	When necessary	Yes	No	Fund collec-tion and develop-ment	Tank/ canal/ crop develop-ment/ any other
Gujarat									
Village-I	8 (66.7)	4 (33.3)	2 (16.7)	1 (8.30)	9 (75.0)	5 (41.7)	7 (58.3)	4 (33.3)	8 (66.7)
Village-II	11 (91.7)	1 (8.30)	1 (8.30)	3 (25.0)	8 (66.7)	6 (50.0)	7 (58.3)	4 (33.3)	8 (66.7)
Village-III	8 (66.7)	4 (33.3)	2 (16.7)	2 (16.7)	8 (66.7)	7 (58.3)	5 (41.7)	5 (41.7)	7 (58.3)
Village-IV	7 (58.3)	5 (41.7)	1 (8.30)	3 (25.0)	8 (66.7)	7 (58.3)	5 (41.7)	5 (41.7)	7 (58.3)
Tamil Nadu									
Village-I	11 (91.7)	1 (8.30)	NA	NA	12 (100)	9 (75.0)	3 (25.0)	5 (41.7)	7 (58.3)
Village-II	9 (75.0)	3 (25.0)	1 (8.30)	NA	11 (91.7)	11 (91.7)	1 (8.30)	3 (25.0)	9 (75.0)
Village-III	9 (75.0)	3 (25.0)	1 (8.30)	NA (91.7)	11 (91.7)	11 (8.30)	1 (25.0)	3 (75.0)	9
Village-IV	9 (75.0)	3 (25.0)	1 (8.30)	NA	11 (91.7)	10 (83.3)	2 (16.7)	4 (33.3)	8 (66.7)

(Contd.)

Table 4.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)
Jharkhand									
Village-I	7 (58.3)	NA	NA	NA	7 (58.3)	5 (41.7)	7 (58.3)	5 (41.7)	7 (58.3)
Village-II	8 (66.7)	NA	NA	NA	8 (66.7)	8 (66.7)	4 (33.3)	4 (33.3)	8 (66.7)
Village-III	7 (58.3)	NA	NA	NA	7 (58.3)	6 (50.0)	6 (50.0)	5 (41.7)	7 (58.3)
Village-IV	7 (58.3)	NA	NA	NA	7 (58.3)	9 (75.0)	3 (25.0)	5 (41.7)	7 (58.3)
West Bengal									
Village-I	9 (75.0)	NA	NA	NA	9 (75.0)	9 (75.0)	3 (25.0)	3 (25.0)	9 (75.0)
Village-II	11 (91.7)	1 (8.30)	NA	NA	10 (83.3)	10 (83.3)	2 (16.7)	5 (41.7)	7 (58.3)
Village-III	8 (66.7)	-	NA	NA	9 (75.0)	9 (75.0)	3 (25.0)	4 (33.3)	8 (66.7)
Village-IV	8 (66.7)	NA	NA	NA	8 (66.7)	8 (66.7)	4 (33.3)	4 (33.3)	8 (66.7)

Table 4.4 : *(Contd.)*

Village	Are you satisfied with the functioning of the institution		If No. Why			Were there any disputes / conflicts among the members		If yes, did they resolve		Any suggestions for effective implementation			
	Yes	No	Presently not functioning	Political interference	Any other	Yes	No	Involve-ment of depart-ment	President and other elders	Equal distribu-tion of benefits	Any particu-lar repair needed	Coopera-tion and coordi-nation	Any other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Gujarat													
Village-I	8 (66.7)	4 (33.3)	NA	3 (25.0)	NA	7 (58.3)	5 (41.7)	9 (75.0)	3 (25.0)	9 (75.0)	3 (25.0)	5 (41.7)	NA
Village-II	9 (75.0)	3 (25.0)	NA	7 (58.3)	NA	6 (50.0)	6 (50.0)	4 (33.3)	8 (66.7)	8 (66.7)	5 (41.7)	7 (58.3)	NA
Village-III	9 (75.0)	3 (25.0)	NA	6 (50.0)	NA	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	9 (75.0)	3 (25.0)	6 (50.0)	NA
Village-IV	9 (75.0)	3 (25.0)	NA	6 (50.0)	NA	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	9 (75.0)	3 (25.0)	7 (58.3)	NA

(Contd.)

Table 4.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Tamil Nadu													
Village-I	9 (75.0)	3 (25.0)	NA	3 (25.0)	NA	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	9 (75.0)	3 (25.0)	9 (75.0)	NA
Village-II	10 (83.3)	2 (16.7)	NA	5 (41.7)	NA	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	7 (58.3)	5 (41.7)	9 (75.0)	NA
Village-III	9 (75.0)	3 (25.0)	NA	4 (33.3)	NA	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	5 (41.7)	7 (58.3)	9 (75.0)	NA
Village-IV	8 (66.7)	4 (33.3)	NA	4 (33.3)	NA	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	4 (33.3)	8 (66.7)	8 (66.7)	NA
Jharkhand													
Village-I	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)	NA	3 (25.0)	NA	4 (33.3)	8 (66.7)	7 (58.3)	5 (41.7)	9 (75.0)	NA
Village-II	6 (50.0)	6 (50.0)	5 (41.7)	7 (58.3)	NA	7 (58.3)	NA	3 (25.0)	9 (75.0)	8 (66.7)	4 (33.3)	8 (66.7)	NA
Village-III	8 (66.7)	4 (33.3)	4 (33.3)	8 (66.7)	NA	6 (50.0)	NA	3 (25.0)	9 (75.0)	6 (50.0)	5 (41.7)	7 (58.3)	NA

(Contd.)

Table 4.4 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Village-IV	8	4	4	8	NA	6	NA	3	9	7	3	9	NA
	(66.7)	(33.3)	(33.3)	(66.7)		(50.0)		(25.0)	(75.0)	(58.3)	(25.0)	(75.0)	
West Bengal													
Village-I	9	3	NA	3	NA	5	7	3	9	9	3	6	NA
	(75.0)	(25.0)	(25.0)	(41.7)	(58.3)	(25.0)	(75.0)	(75.0)	(25.0)	(50.0)			
Village-II	8	4	NA	4	NA	7	5	5	7	7	5	9	NA
	(66.7)	(33.3)		(33.3)		(58.3)	(41.7)	(41.7)	(58.3)	(58.3)	(41.7)	(75.0)	
Village-III	9	3	NA	3	NA	6	6	4	8	6	5	7	NA
	(75.0)	(25.0)		(25.0)		(50.0)	(50.0)	(33.3)	(66.7)	(50.0)	(41.7)	(58.3)	
Village-IV	9	3	NA	3	NA	7	5	4	8	6	5	7	NA
	(75.0)	(25.0)		(25.0)		(58.3)	(41.7)	(33.3)	(66.7)	(50.0)	(41.7)	(58.3)	

Contributions

As far as user contributions are concerned, 10 per cent contribution in cash or kind for activities or investment on private land was envisaged. The rate was scaled down to 5 per cent for socially disadvantaged participants. The contribution rate was also 5 per cent for the activities to be taken up on open access or community owned resources and activities. The idea was to induce a thinking process in the minds of participants of evaluating pros and cons of activities since their investments were also involved. If an activity was totally financed from the public funds they would normally demand anything without keeping in mind ultimate utility. Contributions in the form of labour or material (in kind) were generally monetised in the records. Sharing of cost inculcated a sense of belonging and sustainability of the development process. These contributions constituted a corpus fund for the future use by the village institutions in the sample villages. Our field data show that except sample villages of Jharkhand and some villages of Gujarat and West Bengal, other sample watershed beneficiaries contribute both in cash as well as in kind (Table 4.5). It was observed that the nature of contributions is associated with interaction with the people (collective action) and the PIA. If PIA is close to the watershed committee and other beneficiaries, the understanding of the watershed concept has positive impact over contributions by the beneficiaries.

Table 4.5 : Farmers' Involvement in Maintenance

Village	Contribution to the maintenance		If no why?			If yes. what were the forms of contribution		
	Yes	No	Nobody asked me	Not contri-buted due to lack of money	Not contri-buted because others have not contributed	Cash	Labour	Both
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	8 (66.7)	4 (33.3)	NA	NA	3 (25.0)	NA	NA	9 (75.0)
Village-II	9 (75.0)	3 (25.0)	NA	2 (16.7)	1 (8.30)	NA	NA	9 (75.0)
Village-III	9 (75.0)	3 (25.0)	NA	2 (16.7)	1 (8.30)	NA	NA	9 (75.0)
Village-IV	9 (75.0)	3 (25.0)	NA	NA	1 (8.30)	NA	NA	10 (83.3)
Tamil Nadu								
Village-I	9 (75.0)	3 (25.0)	NA	1 (8.30)	NA	NA	NA	9 (75.0)
Village-II	11 (91.7)	1 (8.30)	NA	NA	NA	NA	NA	11 (91.7)
Village-III	11 (91.7)	1 (8.30)	NA	NA	NA	NA	NA	11 (91.7)
Village-IV	10 (83.3)	2 (16.7)	NA	NA	NA	NA	NA	10 (83.3)

(Contd.)

Table 4.5 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jharkhand								
Village-I	5 (41.7)	7 (58.3)	NA	NA	NA	NA	NA	5 (41.7)
Village-II	4 (33.3)	8 (66.7)	NA	4 (33.3)	2 (16.7)	NA	2 (16.7)	4 (33.3)
Village-III	5 (41.7)	7 (58.3)	NA	3 (25.0)	NA	NA	3 (25.0)	5 (41.7)
Village-IV	5 (41.7)	7 (58.3)	NA	2 (16.7)	1 (8.30)	NA	NA	5 (41.7)
West Bengal								
Village-I	9 (75.0)	3 (25.0)	NA	2 (16.7)	NA	NA	2 (16.7)	9 (75.0)
Village-II	8 (66.7)	4 (33.3)	NA	1 (8.30)	NA	NA	NA	8 (66.7)
Village-III	7 (58.3)	5 (41.7)	NA	1 (8.30)	NA	NA	NA	7 (58.3)
Village-IV	9 (75.0)	3 (25.0)	NA	3 (25.0)	NA	NA	3 (25.0)	9 (75.0)

Table 4.5 : *(Contd.)*

Village	Were you satisfied with the maintenance of the system		If no, give reasons			Have you got sufficient benefit		Farmer Participation in			
	Yes	No	No progress in work	Lack of improve-ment of the system	President has become contractor	Yes	No	Election	Repair works	General Body Meeting	Joint Survey
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Gujarat											
Village-I	9 (75.0)	3 (25.0)	NA	2 (16.7)	NA	7 (58.3)	5 (41.7)	9 (75.0)	7 (58.3)	4 (33.3)	2 (16.7)
Village-II	7 (58.3)	5 (41.7)	2 (16.7)	1 (8.30)	3 (25.0)	7 (58.3)	5 (41.7)	7 (58.3)	8 (66.7)	5 (41.7)	3 (25.0)
Village-III	8 (66.7)	4 (33.3)	2 (16.7)	1 (8.30)	NA	6 (50.0)	6 (50.0)	8 (66.7)	6 (50.0)	6 (50.0)	4 (33.3)
Village-IV	8 (66.7)	4 (33.3)	3 (25.0)	NA	NA	5 (41.7)	7 (58.3)	8 (66.7)	7 (58.3)	7 (58.3)	4 (33.3)

(Contd.)

Table 4.5 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Tamil Nadu											
Village-I	9 (75.0)	3 (25.0)	NA	3 (25.0)	NA	8 (66.7)	4 (33.3)	9 (75.0)	8 (66.7)	5 (41.7)	3 (25.0)
Village-II	11 (91.7)	1 (8.30)	NA	NA	NA	9 (75.0)	3 (25.0)	11 (91.7)	7 (58.3)	4 (33.3)	5 (41.7)
Village-III	11 (91.7)	1 (8.30)	NA	NA	NA	9 (75.0)	3 (25.0)	11 (91.7)	8 (66.7)	5 (41.7)	4 (33.3)
Village-IV	10 (83.3)	2 (16.7)	NA	NA	NA	9 (75.0)	3 (25.0)	10 (83.3)	8 (66.7)	5 (41.7)	4 (33.3)
Jharkhand											
Village-I	7 (58.3)	5 (41.7)	NA	3 (25.0)	NA	7 (58.3)	5 (41.7)	3 (25.0)	4 (33.3)	2 (16.7)	NA
Village-II	8 (66.7)	4 (33.3)	NA	4 (33.3)	NA	8 (66.7)	4 (33.3)	7 (58.3)	3 (25.0)	NA	NA
Village-III	6 (50.0)	6 (50.0)	NA	5 (41.7)	NA	6 (50.0)	6 (50.0)	6 (50.0)	3 (25.0)	2 (16.7)	NA

(Contd.)

Table 4.5 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Village-IV	7 (58.3)	5 (41.7)	NA	3 (25.0)	NA	7 (58.3)	5 (41.7)	6 (50.0)	3 (25.0)	NA	2 (16.7)
West Bengal											
Village-I	8 (66.7)	4 (33.3)	NA	3 (25.0)	NA	8 (66.7)	4 (33.3)	5 (41.7)	3 (25.0)	2 (16.7)	NA
Village-II	7 (58.3)	5 (41.7)	NA	2 (16.7)	NA	7 (58.3)	5 (41.7)	4 (33.3)	5 (41.7)	3 (25.0)	NA
Village-III	8 (66.7)	4 (33.3)	NA	2 (16.7)	NA	8 (66.7)	4 (33.3)	5 (41.7)	4 (33.3)	2 (16.7)	3 (25.0)
Village-IV	8 (66.7)	4 (33.3)	NA	2 (16.7)	NA	8 (66.7)	4 (33.3)	5 (41.7)	4 (33.3)	3 (25.0)	-

Farmers' participation in the planning, execution and maintenance of works and time spent by the user groups and watershed committee in watershed area is also one of the positive indicators of the sustainability of watersheds. Our field observations revealed that the stakeholder processes especially by PIAs of the watershed helped the UGs and WCs for maintenance and attending meetings whenever necessary. In our sample villages of Tamil Nadu, Gujarat and parts of West Bengal stringent efforts were made by the PIAs as well as multi-disciplinary team. Confidence and capacity building measures were established among women and marginal sections of the people. This helped them to spend time in watching/looking after development of watershed activity whenever necessary (Table 4.5). But in our sample villages in Jharkhand and some parts of West Bengal, due to lack of institutional strength (collective action), looking/watching after the watershed development activities/structures/plantations/fodder/ fuel in common property resources by the panchayat/ watershed committee is lacking.

Farmers' Participation

During the implementation process, it is observed that the quality of PIA's work /WC and commitment is revealed clearly as positive in the perceptions of the farmers/beneficiaries. As far as farmers are concerned, they opted for continuation of these initiatives and maintenance of programmes in the long run and also that the PIA should not withdraw from the watershed – almost all the sample watershed beneficiaries expressed the same (Table 4.6). Same order is followed in the case of the increased sense of ownership of watershed activities and benefits from the common assets of watershed activity. However, such wide variations are not observed on the perceptions of the beneficiaries on increase of political dominance, increase of internal conflicts among members and no encouragement. The process of implementation of watershed and involvement of different stakeholders is directly influenced by the kind of PIA implementing the land and water use practices. The committed and honest PIA certainly had made visible positive impact in some of our sample villages. In most of the cases, as we observed, implementation is followed in a mechanical way without any emphasis on social capital development. Further, merits and demerits were also assessed in our sample watersheds in terms of good quality of works, increased access to irrigation facilities, equal distribution and increased public awareness, except Jharkhand sample villages the other sample villages of three States have shown positive impact (Table 4.6). The demerits mostly observed were increase of political interference, internal conflicts, and improper utilisations of funds and lack of capacity building. It is observed in almost all the sample villages that the prevalence of demerits was prominent.

Table 4.6 : Farmers' Views

Village	Merits				Demerits					
	Good quality of work done	Improving of irrigation facility/ productivity	Equal distribution	Increased public awareness	Increase of political interference	Increase of internal conflicts among members	Funds are not utilised properly	No encouragement	Involvement of contractor	Lack of Capacity Building
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	9 (75.0)	5 (41.7)	4 (33.3)	7 (58.3)	3 (25.0)	NA	3 (25.0)	NA	NA	5 (41.7)
Village-II	7 (58.3)	4 (33.3)	3 (25.0)	8 (66.7)	4 (33.3)	2 (16.7)	2 (16.7)	3 (25.0)	NA	4 (33.3)
Village-III	8 (66.7)	6 (50.0)	3 (25.0)	6 (50.0)	5 (41.7)	2 (16.7)	2 (16.7)	NA	2 (16.7)	5 (41.7)
Village-IV	8 (66.7)	5 (41.7)	3 (25.0)	7 (58.3)	3 (25.0)	3 (25.0)	2 (16.7)	3 (25.0)	NA	5 (41.7)

(Contd.)

Table 4.6 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Tamil Nadu										
Village-I	8 (66.7)	5 (41.7)	3 (25.0)	7 (58.3)	4 (33.3)	4 (33.3)	3 (25.0)	NA	NA	3 (25.0)
Village-II	9 (75.0)	6 (50.0)	5 (41.7)	8 (66.7)	3 (25.0)	5 (41.7)	-	NA	NA	3 (25.0)
Village-III	9 (75.0)	8 (66.7)	4 (33.3)	6 (50.0)	3 (25.0)	4 (33.3)	-	NA	NA	-
Village-IV	9 (75.0)	8 (66.7)	4 (33.3)	7 (58.3)	3 (25.0)	4 (33.3)	3 (25.0)	NA	NA	4 (33.3)
Jharkhand										
Village-I	5 (41.7)	3 (25.0)	2 (16.7)	2 (16.7)	3 (25.0)	4 (33.3)	3 (25.0)	NA	NA	4 (33.3)
Village-II	4 (33.3)	4 (33.3)	3 (25.0)	3 (25.0)	5 (41.7)	4 (33.3)	2 (16.7)	NA	NA	4 (33.3)

(Contd.)

Table 4.6 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-III	6 (50.0)	5 (41.7)	2 (16.7)	2 (16.7)	6 (50.0)	5 (41.7)	3 (25.0)	3 (25.0)	4 (33.3)	3 (25.0)
Village-IV	5 (41.7)	3 (25.0)	3 (25.0)	2 (16.7)	5 (41.7)	5 (41.7)	NA	2 (16.7)	3 (25.0)	2 (16.7)
West Bengal										
Village-I	7 (58.3)	7 (58.3)	5 (41.7)	4 (33.3)	NA	3 (25.0)	NA	4 (33.3)	NA	3 (25.0)
Village-II	8 (66.7)	4 (33.3)	4 (33.3)	3 (25.0)	NA (25.0)	3 (25.0)	3 (25.0)	3 (16.7)	NA	2
Village-III	6 (50.0)	6 (50.0)	6 (50.0)	3 (25.0)	NA	NA	3 (25.0)	NA	3 (25.0)	4 (33.3)
Village-IV	7 (58.3)	7 (58.3)	5 (41.7)	3 (25.0)	NA	4 (33.3)	2 (16.7)	NA	3 (25.0)	4 (33.3)

IMPACT

Changes in Area and Irrigated Crops

The initiation of land and water use practices has led to significant changes in the additional area brought under cultivation, which is the prime impact for bringing changes in crop production diversification. It is observed that the extent and proportion of area under different crops has increased tremendously, across sample households in all the sample villages, especially in Gujarat, Tamil Nadu, West Bengal and even in the State of Jharkhand also after initiation of these practices of land and water and more so the advent of watershed development activities in these sample villages (Table 4.7). Despite the increase in area, substantial shifts in cropping pattern in terms of new crops have taken place, though there were changes in the area allocations towards different crops. Maize, wheat, paddy, vegetables, chana, cotton, sugarcane, blackgram and horticulture crops are the major crops grown in the sample villages, which continue to dominate even after the advent of watershed. There are cases where farmers have shifted to horticulture vegetable crops especially in some of the sample village households of Tami Nadu and West Bengal.

Though there were substantial shifts in cropping pattern, land productivity has increased considerably in some sample villages and marginally in some other cases. Yield rates per acre have gone up for almost all crops (Table 4.7). The performance of watershed initiatives is quite impressive and the increases in yield rates are more prominent among all categories of the households in most of the cases reflecting the improved quality of life as well as derived sustainable income to some extent among these households.

Table 4.7 : Changes in Area Irrigated and Crops (in bigha/acres)

Changes in Area Irrigated and Crops	Village-I		Village-II		Village-III		Village-IV	
	BW	AW	BW	AW	BW	AW	BW	AW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Maize								
Area under different crops (in bigha)	112	350	150	308	56	124	1555	2010
% Change	212.5		105.3		121.4		29.3	
Area Irrigated (in bigha)	68	255	80	230	40	94	1250	1845
% Change	275.0		187.5		135.0		47.6	
Average Productivity (in qtls. per bigha)	3	4.5	1.2	4	3.5	5	3	5
% Change	50.0		233.3		42.9		66.7	
Cost of Cultivation (per bigha ₹)	1500	1475	1200	1200	1300	1350	1650	1540
% Change	-1.7		0		3.84		-6.67	
Annual Average Income (per bigha in ₹)	2200	3800	1950	2850	2100	3000	2050	3750
% Change	72.7		-56.4		42.9		82.9	

(Contd.)

Table 4.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Wheat								
Area under different crops (in bigha)	105	320	NA	210	65	156	108	1500
% Change	104.8		NA		NA		1288.9	
Area Irrigated (in bigha)	100	345	NA	187	50	121	78	1234
% Change	245.0		NA		NA		1482.1	
Average Productivity (in qtls.per bigha)	6	8	NA	4	3.5	5.5	4	6
% Change	66.7		NA		NA		50.0	
Cost of Cultivation (per bigha ₹)	1875	1660	NA	1700	1730	1700	1820	1910
% Change	-11.5		NA		NA		5.0	
Annual Average Income (per bigha in ₹)	2500	3400	NA	2900	2400	3500	2210	3800
% Change	36.0		NA		45.8		71.9	

(Contd.)

Table 4.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tamil Nadu								
Paddy								
Area under different crops (in acres)	234	298	146	215	312	415	268	295
% Change	27.4		47.3		33.0		10.1	
Area Irrigated (in acres)	98	178	75	145	180	215	112	190
% Change	44.9		93.3		19.4		69.6	
Average Productivity (in qtls. per acre)	12.75	14.00	16.0	17.5	14.74	16.0	13.45	17.25
% Change	9.80		9.4		8.54		28.3	
Cost of Cultivation (per acre in ₹)	5450	5700	4700	6500	5500	6300	4890	5400
% Change	4.6		38.3		14.5		57.3	
Annual Average Income (per acre in ₹)	9500	11110	8400	10300	9050	12110	7900	12350
% Change	16.9		22.62		33.8		56.3	

(Contd.)

Table 4.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tamil Nadu								
Vegetables (Tomato and Chilies)								
Area under different crops (in acres)	10	200	25	245	NA	170	30	195
% Change	1900.0		1833.3		NA		550.0	
Area Irrigated (in acres)	8	180	12	195	NA	162	17	155
% Change	2150.0		1525.0		NA		811.8	
Average Productivity (in kgs. per acre)	2,500	4000	1990	4555	NA	3890	1890	4235
% Change	60.0		128.9		NA		28.12	
Cost of Cultivation (per acre in ₹)	3000	3400	3500	4550	NA	3900	3200	4100
% Change	13.3		30.0		NA		28.12	
Annual Average Income (per acre in ₹)	7500	12000	8500	13500	NA	12900	9800	14000
% Change	60.0		58.8		NA		42.9	

(Contd.)

Table 4.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jharkhand								
Paddy								
Area under different crops (in acres)	120	189	94	134	24	56	111	159
% Change	57.5		42.6		133.3		43.2	
Area Irrigated (in acres)	45	102	35	78	10	42	45	69
% Change	126.7		122.9		320.0		53.3	
Average Productivity (in qtls. per acre)	9.2	11.5	7.9	10.0	8.9	12.34	9.5	11.0
% Change	25.0		26.6		38.7		15.8	
Cost of Cultivation (per acre in ₹)	3450	4700	3900	4500	3890	4300	3500	4900
% Change	36.2		15.4		10.5		40.0	
Annual Average Income (per acre in ₹)	7000	10110	7400	11300	8050	11110	8900	12000
% Change	44.4		52.7		38.0		34.8	

(Contd.)

Table 4.7 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
West Bengal								
Paddy								
Area under different crops (in acres)	170	222	101	205	145	234	11	26
% Change	30.6		103.0		61.4		136.4	
Area Irrigated (in acres)	95	185	55	180	89	201	-	18
% Change	94.7		227.3		125.8		-	
Average Productivity (in qtls. per acre)	9.0	12.0	8.2	10.9	9.5	10.34	9.8	12.0
% Change	33.3		32.9		11.5		22.5	
Cost of Cultivation (per acre in ₹)	3550	4275	3400	4900	3390	4500	3300	4700
% Change	20.4		44.1		32.7		42.4	
Annual Average Income (per acre in ₹)	7900	10000	8400	12300	8980	12100	8800	12700
% Change	26.5		46.4		34.7		44.3	

(Contd.)

Drinking Water

One of the important environmental impacts expected from any reforms is improvement in and accessibility of drinking water facility. In the recent past, the prevailing drought conditions have negatively impacted on the environment, such as decline of livestock population, depletion of fodder availability and fuel, and also depletion of groundwater as well as drinking water. This study examined the impact in terms of availability of drinking water. Improvement in groundwater table will ease the drinking water problems. A major impact of this would be on the sources of drinking water, depth of the water table and time spent in fetching water. As far as the sources of drinking water are concerned, the number of sources such as open wells and tanks has come down drastically while public taps and tubewells increased in different locations of 16 sample villages across four States in India (Table 4.8). Accessing the public taps and tubewells is one way of going for safe drinking water, but the concern here is depletion of groundwater though it is not unique to the sample villages. Time spent in fetching water also has gone up especially under tank areas (TN) indicating the gravity of the situation.

Table 4.8 : Status of Drinking Water

Drinking Water Source	Village-I		Village-II		Village-III		Village-IV	
	BW	AW	BW	AW	BW	AW	BW	AW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
No.(Public taps-Handpumps, Tubewells and Borewells)	05	12	04	11	03	09	06	13
% Change	140		175		200		116.7	
Quantity of Water (Lt./Day/hh)	6.6	8.34	11.8	12.4	13.34	14.2	12.6	14.0

(Contd.)

Table 4.8 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Change	26.4		5.1		6.4		11.1	
Time spent in fetching drinking water (hrs./Day/hh)	0.5	0.4	0.48	0.33	0.75	0.50	0.73	0.38
% Change	-20.0		-31.3		-33.3		-47.9	
Depth of water table (in ft.)	230	175	160	115	70	65	124	98
% Change	-23.9		-28.1		-7.14		-21.0	
Tamil Nadu								
No. (Public taps- Handpumps, Tubewells and Borewells)	09	21	11	24	06	17	06	20
% Change	113.3		118.2		183.3		66.7	
Quantity of Water (Lt./Day/hh)	10.1	11.8	9.4	11.1	13.5	15.03	12.8	14.5
% Change	16.8		18.1		11.3		13.3	
Time spent in fetching drinking water (hrs./Day/hh)	0.6	0.75	1.2	1.2	1.13	0.84	1.2	0.65
% Change	25.0		0		-25.7		-45.8	
Depth of water table (in ft.)	320	240	225	210	250	180	350	200
% Change	-25.0		-6.7		-28.0		-70.0	

(Contd.)

Table 4.8 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jharkhand								
No. (Public taps- Handpumps, Tubewells and Borewells)	03	8	03	10	03	11	03	09
% Change	166.7		233.3		266.7		200	
Quantity of Water (Lt./Day/hh)	4.8	9.5	8.8	11.4	9.45	13.2	11.6	15.0
% Change	98.0		29.45		39.7		29.3	
Time spent in fetching drinking water (hrs./Day/hh)	0.45	0.40	0.57	0.48	0.68	0.53	0.89	0.80
% Change	-11.1		-15.8		-22.1		-10.1	
Depth of water table (in ft.)	250	225	200	195	200	190	210	200
% Change	-10.0		-2.5		-5.0		-4.8	
West Bengal								
No. (Public taps- Handpumps, Tubewells and Borewells)	06	14	05	15	08	13	04	09
% Change	133.3	200	62.5	125				

(Contd.)

Table 4.8 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quantity of Water (Lt./Day/hh)	6.0	8.5	10.5	13.0	11.0	14.0	12.0	15.5
% Change	41.7		23.8		27.3		29.2	
Time spent in fetching drinking water (hrs./Day/hh)	0.8	0.4	0.5	0.3	0.7	0.5	0.8	0.2
% Change	-50.0		-40.0		-28.6		-75.0	
Depth of water table (in ft.)	158	120	125	110	95	78	110	89
% Change	-24.1		-12.0		-17.9		-19.1	

(-) Sign indicates positive.

Impact on groundwater is the major positive externality of land and water use practices. The major outcome expected is to have one of the prime objectives, a positive impact on ground water availability. This study examined the impact in terms of drinking water availability. Improvement in groundwater table situation will ease the drinking water problems. This aspect is clearly reflected in the sample villages (Table 4.8). Taking the before and after scenarios, as sources of drinking water for beneficiary sample households within the watershed area, use of drinking water has increased in all villages after the advent of watershed. Along with the increasing in the quality consumed and the time spent in fetching water has gone down in seven sample villages. This indicates substantial improvement in the drinking water situation.

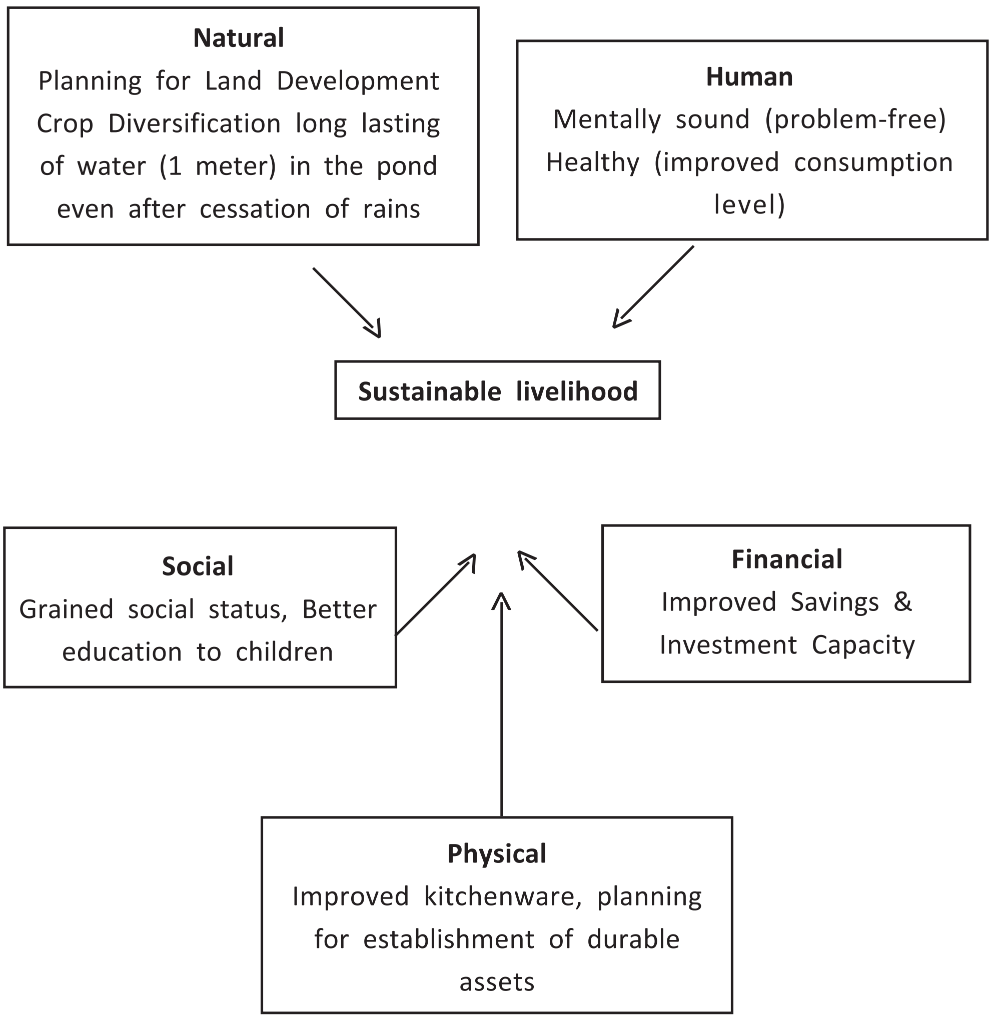
Data show that in almost all states, especially the States like Gujarat and Tamil Nadu, the impact is positive. Effectiveness of land and water use practices has shown through the trends that it has positive impact on drinking as well as groundwater availability and recharge. The overall impact of the initiation of participatory land and water use conservation and different practices regarding land, water and biomass through watershed approach has led to positive indication on groundwater table in sample villages. Improvement in groundwater table situation has substantiated the time spent in fetching of drinking water in some of the sample village watersheds.

Construction of check-dams, percolation tanks and rock-fill dams under the watershed development programme is likely to result in soil and water conservation leading to a positive impact in water level in wells in watershed areas. The impact of watershed on borewells as well as open well irrigation is assessed in terms of number of wells and the changes in the water table. On both these accounts, the impact on groundwater is positive. Number of wells increased in some of the sample villages (see Table 4.8). Most of the sample villages in Tamil Nadu used to have open wells before as well as after watershed also. The impact of watershed on rising groundwater table as the trend was showing positively in most of the sample villages (especially open wells). But in the sample villages of Gujarat, West Bengal and Jharkhand bore wells have increased in number in all the watersheds. The data reveal that in all the watersheds the economic as well as social class-wise households own a well (open/bore well) indicating the uneven distribution of access to irrigation water (wells). In most of the cases it is the medium and large farmers who own majority of the wells. The number of wells and an increase in water table are giving a clear sign of practices of land, water and biomass initiated by the villagers in four sample States.

Livelihood Security

The practices of land and water use in 16 sample villages across four States reveal the impact of drudgery on poverty as positive. The data show that number of households below poverty line (it is a still debatable issue, however the study followed a simple norm. The norms were 2400 calories per capita per day for rural areas and 2100 calories for urban areas. These calorie norms have been expressed in monetary terms as ₹ 49.09 and ₹ 56.64 per capita per month for rural and urban areas, respectively at 1973-74 prices) has come down. The small and viable practice has been developed at village, community as well as individual level in some of the sample villages, the study had documented and looked at their livelihood framework (see below Framework). The interventions of land and water use practices in these sample villages influence ultimately their livelihoods positively.

Livelihood Framework



Issues

When it comes to the question of management of these community assets and attributes, how to manage and maintain sustainable livelihoods from these community assets is a big issue. The main poverty-stricken initiatives in the sample villages are five capitals as shown above. The livelihood framework has worked within the realm of collective action and addresses the following issues.

- Sharing of water in community farm ponds and thereby timely water application and cropping systems
- Lifting of water (a costly proposition) acted as collectively
- Identifying correct locations
- Farmers' reluctance in the beginning : Through collective action some sorts of convincing mechanism has been adopted by the PIAs
- Lack of supporting data and working models : These are worked out collectively by community as a whole.

The effects of these practices influenced positively and the number of people below poverty line reduced significantly (Table 4.9). The evidences reveal that there is a tremendous impact in Tamil Nadu, Gujarat and West Bengal and even in some of the sample villages in Jharkhand also. This in turn affects their asset generation like increase of pacca houses and houses got electrified significantly. Interestingly, goods and devices traded by the people in the sample villages increased, agricultural products and dairy products are marketed by the villages after initiation of these land and water use practices in these villages. Positive impact is observed where subsistence level of agriculture has diversified in some sort of healthy way of commercialisation of agriculture and other related dairy development activities.

Table 4.9 : Land and Water Use Practices: Effects on Poverty

Villages	No. of HH below Poverty Line		No. of HH with Pucca Houses		No. of Houses Electrified		Agricultural Product for Market	
	Before	After	Before	After	Before	After	Before	After
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	98	22	11	65	34	67	Less Quantity of Agricultural Products	Agricultural Products & Dairy Products
Village-II	125	18	18	50	79	328 (100%)	Less Quantity of Agricultural Products	Maize, Wheat and Dairy Products
Village-III	122	45	26	70	111	225	Less Quantity of Agricultural Products	Agricultural Products & Dairy Products
Village-IV	94	21	12	50	136	312	Less Quantity of Agricultural Products	Agricultural Products & Dairy Products
Tamil Nadu								
Village-I	301	225	79	150	178	300	Own consumption (Subsistence level)	Paddy and Chilies

(Contd.)

Table 4.9 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Village-II	312	175	98	220	101	170	Own consump-tion	Paddy, Groundnut, Chilies and Cotton
Village-III	780	500	145	350	225	730	(Subsistence level)	Paddy, Chilies and Cotton
Village-IV	380	186	58	100	125	390	Own consumption	Paddy
Jharkhand								
Village-I	22	80	15	30	18	64	Own consumption	Vegetables
Village-II	425	200	7	20	10	28	(Subsistence level)	Vegetables
Village-III	55	35	-	-	-	-	Own consumption	Vegetables
Village-IV	135	40	-	10	-	20	(Subsistence level)	Agricultural Products
West Bengal								
Village-I	77	33	12	30	30	100 (100%)	Own consumption	Vegetables
Village-II	235	90	-	15	14	80	(Subsistence level)	Vegetables
Village-III	120	34	-	-	5	20	Own consumption	Vegetables
Village-IV	62	38	-	-	-	5	(Subsistence level)	Vegetables

Emergence of new occupations and establishment of livelihoods is visible in almost all sample villages, but varied in nature (see Table 4.10). These impacts are mainly because of collective action of different stakeholders and the initiations of land and water use practices at micro environment locations. Though the initiations are small, these are all sustainable in nature. The sizes of the intervention and group dynamics also cause positive impact on livelihood security. In almost all the sample villages across four States, the data reveal that new occupations/livelihoods increased ranging between 58 and 75 per cent in Gujarat, while it is 75 per cent and above 90 per cent in Tamil Nadu and 75 and 83 per cent in West Bengal. There is a considerable change in sample villages of Jharkhand where it ranged from 42 to 68 per cent. The poor performance in Jharkhand when compared to other states is mainly due to low profile of collective action and PIA role is nominal.

Diversification of farming and co-agricultural activities has also shown positive impact on almost all the sample villages. Self-consumption of agricultural and sale of agricultural, dairy related products has increased. Significant impact has also been seen through our study that the status of wage labour increased. Migration status has been marginalised where dependency ratio decreased to some extent due to the initiation of land and water use practices which have been taken collectively in some of the sample villages.

Changes in the Poverty and Income

Increase of income from different sources i.e. agriculture, livestock, horticulture, hiring out labour have been established significantly in almost all the sample villages. The study has worked out poverty and income levels social class-wise (Income Poverty) both in numbers as well as their average income per family per annum from agriculture, livestock and other sources including non-land based activities (see Table 4.11).

Two Basic Ingredients in Measuring Poverty

(1) Poverty Line: definition of threshold income or consumption level. (2) Data on size distribution of income or consumption (collected by a

Table 4.10 : Effects of Land and Water Use Practices on New Occupations/Livelihoods

Villages	New occupations and Livelihoods		Diversification of Farming		Co-agriculture Activities		Status of Wage Labour		Migration Status	
	Increase	No Change	Self-Consumption	Sale	Improved	No Change	Increased	No Change	Dependency Decreased	No Change
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat										
Village-I	7 (58.3)	5 (41.7)	4 (33.3)	8 (66.7)	8 (66.7)	4 (33.3)	6 (50.0)	6 (50.0)	9 (75.0)	3 (25.0)
Village-II	8 (66.7)	4 (33.3)	3 (25.0)	9 (75.0)	8 (66.7)	4 (33.3)	5 (41.7)	7 (58.3)	8 (66.7)	4 (33.3)
Village-III	9 (75.0)	3 (25.0)	6 (50.0)	6 (50.0)	10 (83.3)	2 (16.7)	8 (66.7)	4 (33.3)	7 (58.3)	5 (41.7)
Village-IV	8 (66.7)	4 (33.3)	5 (41.7)	7 (58.3)	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	7 (58.3)	5 (41.7)

(Contd.)

Table 4.10 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Tamil Nadu										
Village-I	11 (91.7)	1 (8.30)	4 (33.3)	8 (66.7)	7 (58.3)	5 (41.7)	8 (66.7)	4 (33.3)	9 (75.0)	3 (25.0)
Village-II	9 (75.0)	3 (25.0)	3 (25.0)	9 (75.0)	7 (58.3)	5 (41.7)	10 (83.3)	2 (16.7)	7 (58.3)	5 (41.7)
Village-III	9 (75.0)	3 (25.0)	4 (33.3)	8 (66.7)	9 (75.0)	3 (25.0)	7 (58.3)	5 (41.7)	6 (50.0)	6 (50.0)
Village-IV	10 (83.3)	2 (16.7)	4 (33.3)	8 (66.7)	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	8 (66.7)	4 (33.3)
Jharkhand										
Village-I	5 (41.7)	7 (58.3)	7 (58.3)	5 (41.7)	7 (58.3)	5 (41.7)	8 (66.7)	4 (33.3)	4 (33.3)	8 (66.7)
Village-II	6 (50.0)	6 (50.0)	8 (66.7)	4 (33.3)	9 (75.0)	3 (25.0)	8 (66.7)	4 (33.3)	5 (41.7)	7 (58.3)

(Contd.)

Table 4.10 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Village-III	8	4	6	6	8	4	6	6	5	7
	(66.7)	(33.3)	(50.0)	(50.0)	(66.7)	(33.3)	(50.0)	(50.0)	(41.7)	(58.3)
Village-IV	7	5	9	3	8	4	7	5	6	6
	(58.3)	(41.7)	(75.0)	(25.0)	(66.7)	(33.3)	(58.3)	(41.7)	(50.0)	(50.0)
West Bengal										
Village-I	9	3	5	7	8	4	4	8	6	6
	(75.0)	(25.0)	(41.7)	(58.3)	(66.7)	(33.3)	(33.3)	(66.7)	(50.0)	(50.0)
Village-II	9	3	5	7	8	4	5	7	4	8
	(75.0)	(25.0)	(41.7)	(58.3)	(66.7)	(33.3)	(41.7)	(58.3)	(33.3)	(66.7)
Village-III	10	2	3	9	7	5	8	4	7	5
	(83.3)	(16.7)	(25.0)	(75.0)	(58.3)	(41.7)	(66.7)	(33.3)	(58.3)	(41.7)
Village-IV	10	2	3	9	9	3	7	5	7	5
	(83.3)	(16.7)	(25.0)	(75.0)	(75.0)	(25.0)	(58.3)	(41.7)	(58.3)	(41.7)

sample survey representative of the population). The study has followed the first definition in sample villages - Absolute poverty line - refers to a threshold income (consumption) level defined in absolute terms. Persons below a pre-defined threshold income are called poor (Government of India (1993): Report of Expert Group).

Poverty Line

A minimum level of living is necessary for physical and social development of a person. It is estimated as the total consumption expenditure level that meets energy (calorie) need of an average person. Poverty line comprises both food and non-food components of consumption. Based on monthly per capita expenditure (MPCE) the study has followed the poverty line of ₹320 per capita per month (Government of India (1993): Report of Expert Group).

The data on income from various sources were derived through personal interview schedules and corroborated with focus group discussions. Impact on household income due to land and water use practices collectively can be attributed to a number of factors. In our sample villages some of them include cropping pattern, animal husbandry and employment diversification. Cropping pattern in turn is governed by involvement of risk and prices of different crops in the market. Animal husbandry is an alternative livelihood, which is mostly influenced by availability of CPRs in that area and suitability of weather conditions. In the study regions agriculture is the dominant source of income, followed by livestock. The relative shares of income have positively changed after the introduction of different practices not only from agriculture, livestock, and horticulture but also from labour in different locations of farmers. However, one should not attribute this positive trend solely to these practices, as other factors also contribute in this regard.

The percentage decrease of poverty before and after scenario shows that there is significant impact among different sections of people social-class-wise in all sample households in four States.

Table 4.11 : Changes in Poverty and Income Levels of the Sample Villages

Villages	Poverty Levels (Social Class-wise) (in No. %)						Income Levels (Social Class-wise) (in ₹) Average per family per annum					
	SC/ST		OBC		Others		SC/ST		OBC		Others	
	Past (10 years)	Present	Past (10 years)	Present	Past (10 years)	Present	Past (10 years)	Present	Past (10 years)	Present	Past (10 years)	Present
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Gujarat												
Village-I	66.3	45.5	58.5	33.0	22.0	12.0	5,000	9,000	5,500	11,500	9,500	15,000
Village-II	-	-	52.0	41.0	29.0	18.9	-	-	7,000	18,000	11,000	21,000
Village-III	70.5	40.0	56.0	39.3	35.0	24.0	6,800	12,000	11,000	22,000	14,000	24,000
Village-IV	67.0	37.0	62.0	33.5	45.0	31.0	5,900	12,500	9,900	20,000	13,500	22,000
Tamil Nadu												
Village-I	59.0	32.0	45.0	29.0	34.0	27.0	6,000	13,500	11,000	21,500	12,500	25,500
Village-II	45.0	29.0	47.0	33.0	41.0	26.8	8,000	15,700	10,700	24,600	11,000	24,600
Village-III	49.8	30.1	38.6	24.0	38.0	23.6	9,600	15,200	12,500	22,900	14,900	27,000
Village-IV	43.6	29.0	36.0	26.0	42.0	25.0	7,500	13,900	10,000	23,500	12,900	25,700

(Contd.)

Table 4.11 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Jharkhand												
Village-I	63.2	44.5	51.9	34.0	48.0	22.0	5,600	9, 000	7,900	11, 000	9, 800	15, 400
Village-II	58.8	40.1	54.0	31.0	48.0	29.5	4,690	8,500	6,700	10, 900	9, 200	14,500
Village-III	55.9	38.0	51.4	30.9	45.1	28.0	4,900	8, 900	8,100	12,100	8, 575	13,500
Village-IV	54,9	33.9	48.9	29.0	44.9	24.9	4,350	8,100	8,450	12,000	9, 000	15,100
West Bengal												
Village-I	55.0	38.0	47.0	32.9	43.9	29.0	6,800	12,000	11,600	18,000	16,000	29,000
Village-II	49.0	33.0	44.0	30.9	39.0	24.0	7,000	15,000	14,000	21,000	18, 000	32, 000
Village-III	42.5	30.3	37.6	27.0	34.0	22.4	8,500	15,500	13, 000	23,000	17, 900	30,200
Village-IV	52.0	34.5	33.4	26.7	36.5	23.2	7,900	16,000	12, 500	24,400	16, 700	27,000

Table 4.11 : *(Contd.)*

Percentage Change (%) in Income Levels (Social Class-wise) (in ₹) : Average per family per annum

Villages	Income Levels (Social Class-wise) (in ₹) Average per family per annum		
	SC/ST	OBC	Others
	% Change	% Change	% Change
Gujarat			
Village-I	80.0	109.1	57.9
Village-II	-	157.1	90.9
Village-III	76.5	100.0	71.4
Village-IV	111.9	102.0	63.0
Tamil Nadu			
Village-I	125.0	95.5	100.0
Village-II	96.3	129.9	123.6
Village-III	58.3	83.2	81.2
Village-IV	85.3	135.0	99.2
Jharkhand			
Village-I	60.7	39.2	57.1
Village-II	81.2	62.7	57.6
Village-III	89.8	49.4	57.4
Village-IV	86.2	42.0	67.8
Village-I	76.5	55.2	81.3
Village-II	114.3	50.0	77.8
Village-III	83.4	76.9	68.7
Village-IV	102.5	95.2	61.7

Level of Living

Farmers are positive about the benefits from the new institutional arrangements, though the benefits appear to be more in quality terms. On the other hand, the benefits are limited to improved water availability and diversification of agriculture and management of CPRs through plantations, fodder development and SHG dynamics. However, these benefits have direct or indirect impact on their level of living in some of the sample villages (see Table 4.12.). Though these positive benefits are an incentive for collective action, the magnitude of the benefit is too small to sustain the collective action in the long run. Except in States like Tamil Nadu, Gujarat and parts of West Bengal, in States like Jharkhand and parts of Gujarat also, the failure of the initiative to create and strengthen the social capital that would have helped in taking the initiative forward is mainly due to poor awareness, marginal commitment and low involvement of the primary stakeholders even after five years of the initiative, talks volumes and question the seriousness and commitment of the implementers.

The perceived consequences are observed in our 16 sample villages. The social status and cohesiveness, role and respect of traditional institutions are keenly observed in some of the sample villages and it is positive indication of their overall standard of living. Changes affected on small and marginal farmers through these initiatives in 16 sample villages across four States reveals that except in the State of Jharkhand, the economic and social condition has improved in Tamil Nadu, Gujarat and parts of West Bengal sample villages. However, on the changes affected on economic and social condition of the sample households the results were mixed in nature. The impact of land and water use practices have not influenced some of the sample households positively. The reasons are many. The positive impact assigned to strong collective mechanisms (sharing mechanisms, norms, rules, maintenance and contributions) are exercised by the beneficiaries and honest PIA. The data reveal from Table 4.12 that some of the sample households' economic conditions were not improved due to non-participation and lack of awareness. This was also reflected in income levels. This case was more in sample villages of Jharkhand where the study found weak leadership and lack of proper collective action mechanisms.

Table 4.12 : Perceived Consequences of Land and Water Use on Standard of Living

Villages	On the level of living (Positive)	On the social life style (Positive)	On the social cohesive-ness (Positive)	Role and respect for traditional Institutions (Positive)	Changes affected on small and marginal farmers	Economic and social condition improved Same/ Deteriorated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gujarat						
Village-I	8 (66.7)	9 (75.0)	5 (41.7)	7 (58.3)	8 (66.7)	4 (33.3)
Village-II	10 (83.3)	6 (50.0)	7 (58.3)	7 (58.3)	9 (75.0)	3 (25.0)
Village-III	7 (58.3)	6 (50.0)	3 (25.0)	5 (41.7)	9 (75.0)	3 (25.0)
Village-IV	9 (75.0)	4 (33.3)	6 (50.0)	8 (66.7)	10 (83.3)	2 (16.7)
Tamil Nadu						
Village-I	7 (58.3)	5 (41.7)	7 (58.3)	10 (83.3)	7 (58.3)	5 (41.7)
Village-II	6 (50.0)	7 (58.3)	3 (25.0)	7 (58.3)	7 (58.3)	5 (41.7)
Village-III	10 (83.3)	3 (25.0)	4 (33.3)	9 (75.0)	9 (75.0)	3 (25.0)
Village-IV	10 (83.3)	4 (33.3)	4 (33.3)	9 (75.0)	9 (75.0)	3 (25.0)

(Contd.)

Table 4.12 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jharkhand						
Village-I	3 (25.0)	3 (25.0)	2 (16.7)	6 (50.0)	4 (33.3)	8 (66.7)
Village-II	5 (41.7)	2 (16.7)	4 (33.3)	5 (41.7)	5 (41.7)	7 (58.3)
Village-III	5 (41.7)	3 (25.0)	5 (41.7)	7 (58.3)	6 (50.0)	6 (50.0)
Village-IV	2 (16.7)	4 (33.3)	3 (25.0)	4 (33.3)	3 (25.0)	9 (75.0)
West Bengal						
Village-I	4 (33.3)	4 (33.3)	3 (25.0)	5 (41.7)	7 (58.3)	5 (41.7)
Village-II	6 (50.0)	5 (41.7)	6 (50.0)	4 (33.3)	8 (66.7)	4 (33.3)
Village-III	5 (41.7)	4 (33.3)	4 (33.3)	3 (25.0)	8 (66.7)	4 (33.3)
Village-IV	7 (58.3)	3 (25.0)	2 (16.7)	3 (25.0)	8 (66.7)	4 (33.3)

Land and Water Use Practices : Role of Women

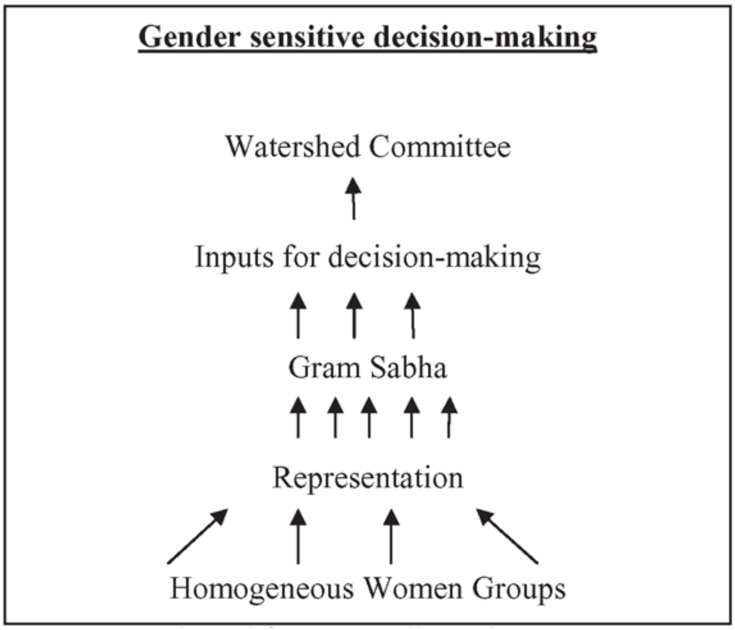
An important objective of land and water use practices/watershed development is to improve land productivity. Therefore, farmers are involved in decision-making process. However, women are also farmers. They are the prime food producers, contribute more hours of work and perform more tasks than men in agricultural production. Women farmers have independent views about farming practices and can contribute significantly to the improvement of agriculture. In our analysis of land and water use practices, an effective way of ensuring the interests of various groups of resource users, especially women, is to represent in decision-making. This is to understand different livelihood strategies upon which they are based. This should focus on access and control issues related to private and common resources (land, water, fuel, fodder) and on those resources which provide livelihood options to women.

These practices require decisions on the appropriate management of common pool resources upon which poor and marginal groups in the community often depend for their economic survival. Common pool resources play a key role in fulfilling fodder and fuel needs, the collection of which is primarily the responsibility of women. Moreover, these livelihood options are not easily visible because; the percentage of the population involved is small; income from these sources is regarded as secondary in terms of family income, even though it may be the primary source of income for the women.

Participation of Women in Decision-making

Most of the decisions in the watershed committees are restricted to PIA or farming community. Most women are unaware of the role they can play in watershed development projects. The efforts hitherto in the watershed decision-making process often are limited to awareness. The decision often in the meetings is to enforce the ban on free grazing and open access to common pool resources on which women depend more. Hence, women have to travel distant places in search of fuelwood and fodder due to restrictions on village commons and forest lands where women's stake is far less in the decision-making of those restrictions. Due to fewer stakes of women in the major decision–making aspects of these land and water use practices, the ultimate losers are the poor women who depend more on common pool resources for livelihood security.

Separate meetings of women with similar interests to identify their priorities prior to the gram sabha can help to facilitate more effective expression of women's needs and priorities (see below Box).



Source : Adapted from Vasudha Lokur Pangare, 1998.

Women's organisations serve to empower women socially and economically. Such groups can be strengthened by PIAs, as one way of encouraging women to participate in community activities.

Supporting Women's Participation in Community Activities

Facilitating women's participation begins with understanding the community in which the watershed or natural resource development activity is to be undertaken. Gender roles, responsibilities and gender-based division of tasks in the household and community need to be analysed before planning any development activity. This aspect has been observed in Tamil Nadu and some sample villages in Gujarat and West Bengal. Positive role of women's participation is observed in these sample villages of the three States. Whereas in the sample villages of Jharkhand State this aspect is weak due to lack of effective leadership of PIA and low level of community participation and inefficient use of resources. Some villages performed in a better way and other villagers did not due to their low stake in decision–making process. It reflected in their livelihood security.

Triple work burden of women

Domestic work
+
Work in own fields/work with livestock/daily wage labour
+ +
Community Action
Shramdan (voluntary labour)/meetings/gram sabha/ watershed development activities
=
Triple work burden of women

Source : Adapted from Vasudha Lokur Pangare, 1998.

Although certain socio-economic generalisations can be made, each community is unique in terms of specific norms and relationships. Land and water use practices depend on community action and it is important, therefore, to understand each individual community before any attempts can be made to overcome social and cultural barriers. It is the responsibility of the PIA to recognise women as leaders and appropriate the value of their contribution. The same was observed in our sample States also. However, successful implementation and maintenance of these practices mostly depends upon the PIA. Wherever the PIA is more efficient, the success rate is more.

The data presented in Table 4.13 are based on total sample responses on position of women, involvement, knowledge and sharing of benefits. Most of the data were collected through focus group discussions. Our analysis of 16 sample villages in four States reveal very mixed responses. The position of women, involvement, knowledge and sharing of benefits observed are more in Tamil Nadu and West Bengal (Table 4.13). It ranges 50 from to 83.3 per cent in Tamil Nadu, while in West Bengal it is 25 to 66.7 per cent. The reasons are obvious. Women are involved in these two States in all planning and implementation activities such as resource identification, decision-making process and implementation of interventions. Whereas in

Table 4.13 : Opinion on Relation to Position of Women, Involvement, Knowledge, and Sharing of Benefits (No. of Respondents)

Villages	Knowledge and adaption level of management of natural resources		Women involvement : Traditional Vs. Modern Practices		Influence of different practices and position of women		Sharing of Benefits	
	Yes	No	Traditional	Modern	Improved	Deteriorated	Yes	No
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gujarat								
Village-I	4	8	7	5	8	4	9	3
	(33.3)	(66.7)	(58.3)	(41.7)	(66.7)	(33.3)	(75.0)	(25.0)
Village-II	3	9	6	6	10	2	2	10
	(25.0)	(75.0)	(50.0)	(50.0)	(83.3)	(16.7)	(16.7)	(83.3)
Village-III	2	10	3	9	3	9	6	6
	(16.7)	(83.3)	(25.0)	(75.0)	(25.0)	(75.0)	(50.0)	(50.0)
Village-IV	7	5	4	8	7	5	4	8
	(58.3)	(41.7)	(33.3)	(66.7)	(58.3)	(41.7)	(33.3)	(66.7)

(Contd.)

Table 4.13 : (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tamil Nadu								
Village-I	9 (75.0)	3 (25.0)	4 (33.3)	8 (66.7)	7 (58.3)	5 (41.7)	4 (33.3)	8 (66.7)
Village-II	7 (58.3)	5 (41.7)	6 (50.0)	6 (50.0)	10 (83.3)	2 (16.7)	6 (50.0)	6 (50.0)
Village-III	10 (83.3)	2 (16.7)	10 (83.3)	2 (16.7)	5 (41.7)	7 (58.3)	3 (25.0)	9 (75.0)
Village-IV	6 (50.0)	6 (50.0)	1 (8.30)	11 (91.7)	2 (16.7)	10 (83.3)	7 (58.3)	5 (41.7)
Jharkhand								
Village-I	3 (25.0)	9 (75.0)	2 (16.7)	10 (83.3)	6 (50.0)	6 (50.0)	3 (25.0)	9 (75.0)
Village-II	2 (16.7)	10 (83.3)	1 (8.30)	11 (91.7)	7 (58.3)	5 (41.7)	6 (50.0)	6 (50.0)
Village-III	1 (8.30)	11 (91.7)	3 (25.0)	9 (75.0)	4 (33.3)	8 (66.7)	2 (16.7)	10 (83.3)

(Contd.)

Table 4.13 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Village-IV	2	10	4	8	2	10	4	8
	(16.7)	(83.3)	(33.3)	(66.7)	(16.7)	(83.3)	(33.3)	(66.7)
West Bengal								
Village-I	7	5	4	8	10	2	8	4
	(58.3)	(41.7)	(33.3)	(66.7)	(83.3)	(16.7)	(66.7)	(33.3)
Village-II	3	9	7	5	5	7	4	8
	(25.0)	(75.0)	(58.3)	(41.7)	(41.7)	(58.3)	(33.3)	(66.7)
Village-III	9	3	6	6	1	11	2	10
	(75.0)	(25.0)	(50.0)	(50.0)	(8.30)	(91.7)	(16.7)	(83.3)
Village-IV	8	4	3	9	2	10	3	9
	(66.7)	(33.3)	(25.0)	(75.0)	(16.7)	(83.3)	(25.0)	(75.0)

other two States, Jharkhand and Gujarat, it is slightly low participation when compared to Tamil Nadu and West Bengal. It ranges from 16.7 to 58.3 per cent in Gujarat and 8.3 to 25.0 per cent in Jharkhand.

The influence of technology and involvement of women in the practises of land and water use reveals mixed results across four sample States. The States of Gujarat, Tamil Nadu and West Bengal are ahead when compared to Jharkhand. Even in the State of Jharkhand some villages performed better (Table 4.13). On sharing benefits among men and women under these initiatives, our sample data in four sample States reveal that, it is more in Gujarat, West Bengal, Tamil Nadu and Jharkhand, respectively. Mostly, these aspects influenced in different states and within the state in different villages in particular by local level initiations and group dynamics as well as size and homogeneous groups. The nature and use of resource varies from state to state and from village to village by women's participation and their livelihoods security (Table 4.14). As observed, it varies from men to women across states. Mostly, the access and control over resources is more in favour to women's preview in Gujarat, Tamil Nadu and West Bengal. But overall these are more prone to men.

Our study has identified some favourable relief from overburden of women both in domestic as well outside. Management of natural resources and sustained livelihoods and participation in the decision making through some drudgery-reducing alternatives are being taken up by the PIA in some of the sample villages especially in Tamil Nadu and Gujarat.

CHAPTER V
CONCLUSIONS

The foregoing discussion of different land and water use practices in our four sample States is to bring together the various dimensions of natural resources development under an overarching perspective of equitable, productive and sustainable development. The interventions and group dynamics approach is feasible and needs continuous follow-up and active involvement of different stakes at all levels. These local level practices in tune with climate change and local level available resource base is desirable, where micro-environment element interventions are more suitable to meet climate change effects at local level. Watershed is an excellent venue of micro-environment for putting together all elements (different practices) of area development of improved biomass, efficient water use and internalised production systems. This aspect is keenly observed in our four sample States.

The study has focused on four main interventions : these are,

- First intervention is through SHGs-land augmenting technologies-fodder cultivation (Tamil Nadu and Gujarat)
- Second intervention is through agri-horticultural model (Tamil Nadu, Gujarat and West Bengal)
- Third intervention is soil and water conservation activities by User Groups
- Fourth intervention is Water Harvesting Structures by User Groups (Jharkhand, Gujarat, Tamil Nadu and West Bengal)

Major Findings

In the light of common property theory, and to promote collective action of different stakeholders in the realm of natural resource management, our study findings reveal diverse results regarding the land and water use practices in 16 sample villages across four States in India.

1. Functioning and effectiveness of institutions in the villages and dealing with the practices of land and water (including biomass) by these institutions mostly depend on the process of their evolution.

Both pre and post-implementation processes play an important role in this regard. Very few farmers are involved in the pre-planning phase of the watershed related activities, though a majority of them expressed that the formation of village level institutions (informal as well as formal committees like watershed committees, user groups and SHGs, etc.) is appropriate to solve the problems of irrigation, drinking water and mitigate drought conditions and thereby ensuring livelihood security. The involvement of local community was much less in the down reaches especially Jharkhand and in some parts of Gujarat sample villages. In the absence of local community participation, the main lacuna observed in the pre-planning process was: limited devolution of powers to these institutions in almost all States (16 sample villages) and in the selection of good leaders.

2. The low cost and time as well as risk saving structures like farm ponds are feasible in drought-prone areas where rainfall is scanty in nature. The relevance of farm ponds in some of the sample villages explores the potential of water harvesting and possibility of convergence with other programmes such as RKVY and National Agricultural Innovative Project (NAIP – Component-3 Livelihoods). The works carried out in these sample villages are mostly through village organisations and some farmers on their own with the help of PIA.

3. Awareness regarding the land and water conservation practices is quite high among the communities especially in Tamil Nadu, Gujarat and parts of West Bengal. Greater awareness in the communities

could be due to the smaller coverage, often pertaining to one village and PIA closeness to these communities.

The effectiveness of institutions in these sample villages is observed. It is higher in sample villages of Tamil Nadu and Gujarat and some villages in West Bengal, while it is very low profile in the State of Jharkhand sample villages. Most of the suggestions pertained to devolution of powers and proper repair of works. It is also observed that work done together with village institutions and panchayats induce better results in some of the sample villages.

4. Democratic decision-making is more in Tamil Nadu, Gujarat and West Bengal. But it is more or less absent in the State of Jharkhand.

5. Our field data show that except in sample villages of Jharkhand and some villages of Gujarat and West Bengal, watershed beneficiaries contributed both in cash as well as in kind.

6. In our sample villages of Tamil Nadu, Gujarat and parts of West Bengal due to stringent efforts made by the PIAs as well as multi-disciplinary team, the confidence and capacity building measures were established among women and marginal sections of the people. This helped them to spend more time on watching the development of watershed activity whenever it is necessary. But in our sample villages in Jharkhand and some parts of West Bengal, due to lack of institutional strength (collective action) looking/watching after the watershed development activities/structures/plantations/fodder/ fuel in common property resources by the panchayat/ watershed committee is lacking.

7. It is observed that proportion of area under different crops has increased tremendously, across sample households in all the sample villages, especially in Gujarat, Tamil Nadu, West Bengal and even in the State of Jharkhand also after initiation of these practices of land and water and more so the advent of watershed development activities in these sample villages. Despite the increase in area,

substantial shifts in cropping pattern in terms of new crops have taken place, though there were changes in the area allocations towards different crops. Maize, wheat, paddy, vegetables, *chana*, cotton, sugarcane, blackgram and horticulture crops are the major crops grown in the sample villages, which continue to dominate even after the advent of watershed.

8. Taking the before and after scenarios, as sources of drinking water for beneficiary sample households within the watershed area improved, use of drinking water increased in all villages after the advent of watershed. Along with the increase in the quality of water consumed, the time spent in fetching water has gone down in seven sample villages. This indicates substantial improvement in the drinking water situation.

As data show, in almost all states, especially the States like Gujarat and Tamil Nadu, the impact is positive. Effectiveness of land and water use practices has shown through the trends that it has positive impact on drinking as well as groundwater availability and recharge. The overall impact of the initiation of participatory land and water use conservation and different practices regarding land, water and biomass through watershed approach has led to positive indication on groundwater table in sample villages. Improvement in groundwater table situation has reduced the time spent in fetching drinking water in some of the sample village watersheds.

9. The practices of land and water use in 16 sample villages across four States reveal the impact of drudgery on poverty as positive. The data show that number of households below poverty line has come down.

10. The effects of these practices influenced positively and the number of people below poverty line reduced significantly. The evidences reveal a tremendous impact in Tamil Nadu, Gujarat and West Bengal and even in some of the sample villages in Jharkhand. This in turn affected on their asset generation like increase of pacca houses and houses got electrified significantly.

11. In almost all the sample villages across four States, the data reveal that new occupation of livelihoods increased ranging between 58 and 75 per cent in Gujarat while it is between 75 and above 90 per cent in Tamil Nadu and 75 and 83 per cent in West Bengal. There is a considerable change in sample villages of Jharkhand, it ranges from 42 to 68 per cent. The poor performance in Jharkhand when compared to other States is mainly due to low profile of collective action and PIA role is nominal.

12. Increase of income from different sources including agriculture, livestock, horticulture and labour is achieved significantly in almost all the sample villages. The study has worked out poverty and income levels social class-wise both in numbers as well as their average income per family per annum. The relative shares of income have positively changed after the introduction of different practices not only from agriculture, livestock, and horticulture, but also from labour in different locations of farmers. However, one should not attribute this positive trend solely to these practices, as other factors also contribute in this regard.

13. The perceived consequences of land and water use practices are observed in our 16 sample villages. The social status and cohesiveness, role and respect of traditional institutions are keenly observed in some of the sample villages and it is positive indication of their overall standard of living. Changes affected on small and marginal farmers through these initiations in 16 sample villages across four States reveal that except in the State of Jharkhand, the economic and social condition has improved in Tamil Nadu, Gujarat and parts of West Bengal sample villages.

14. On the access, control and management of natural resources by women, our analysis of four States in 16 villages reveals very mixed responses. The knowledge and adaption level of management of natural resources by women, are observed more in Tamil Nadu and West Bengal. It ranges from 50 to 83.3 per cent in Tamil Nadu while in West Bengal it is from 25 to 66.7 per cent. Whereas in other two

States, Jharkhand and Gujarat it is slightly low participation when compared to Tamil Nadu and West Bengal. It ranges from 16.7 to 58.3 per cent in Gujarat and from 8.3 to 25.0 per cent in Jharkhand.

Success or failure of the different practices in the sample states :

	Positive Factors	Negative Factors
1.	Skilled Staff-PIA, WDT	High turnout of staff, less women staff
2.	Effective community approaches Collective action and nested platforms	Limited infrastructure
3.	Considerable convergence	Delayed funds
4.	Professional approach and clean image of PIA and commitment of different stakeholders	Dry years followed by excessive rains
5.	location-specific-easy to facilitation by PIAs	

As observed from the above contributing factors in some of the sample state villages, the success of sustainable maintenance of natural resources practices especially land, water use practices and improvement of biomass basically influences the positive factors. However, there have been some negative factors which have disabled the programmes in varying capacities. Low dependability and erratic nature of rainfall make it difficult to assess the actual, progressive impact of different land and water use practices.

Contributing Factors for Effectiveness of Different Practices in sample States:

1. Exposure Visits and Awareness Building Measures

Exposure visits and training are the key ingredients to bring about a change and building confidence among heterogeneous as well as homogeneous people in the villages. The perception of community and the capacity to initiate the different practices in the villages are evident. This was observed and shared by sample households in Tamil Nadu, Gujarat and West Bengal. This aspect is not vibrant in the sample State of Jharkhand. The reasons are obvious. The project implementing agency has not strengthened to build capacities among different stakeholders in the project area and more so in some of the sample villages. The political dominance is much prevalent. Our findings also revealed that the success of these land and water use practices can be attributed to exposure and subsequent dissemination of information and awareness among the participants.

2. Market Linkage through Federation

Our sample data and focus group discussions revealed that people have gained confidence while working as group and feel that the activity of buying and selling of seeds for crops, fodder, dairy activities and crop residue which has been taken up by the federation is quite useful to different sections of people who work as group based on activity and to the farmers. They are assured of good quality of inputs at a reasonable price. This observation was quite visible in Tamil Nadu, Gujarat and West Bengal. But in Jharkhand this was not so due to weak institutional as well as exposure and training aspects.

3. Income Generation Through Pasture Land, Agri-Horticulture Model

Increase in cultivable land through more area brought under waste and fallow lands and check on soil degradation and resilience capacity of soil organic matter are important interventions for better crop production as well as gainful income generation. Data from our sample states especially Tamil Nadu, Gujarat and West Bengal and even some of the villages in Jharkhand State revealed that pasture land development, agri-horticulture interventions, vegetable cultivation and even paddy cultivation in West Bengal are of such activities which are beneficial to all the stakeholders. Sustained income to the beneficiaries as well as to the fund for further development of resources and also help to conserve the ecological balance through reduced soil and water degradation is evident from our data analysis across four sample States.

4. Ridge to Valley Approach and Other Processes in Practice

Based on natural resource technology and on our logical framework, the ridge to valley approach was applied in the villages after careful consideration of topography, geo hydrology, land use pattern and climate conditions. Initially, when there were difficulties in mobilising people and deciding upon the land to be treated, exposure visits and training on different conservation practices helped in making people understand the very objective of the different practices. This has been observed in almost all the sample villages across four States.

5. Selection of Beneficiaries in a Practical Manner

Selection of beneficiaries and identification of groups for different activities in a rigid manner does not always work. As the natural resource development practices designed in a logical framework, it is not always possible to have involvement of most of the poor and landless. The impact of these practices initiated under different schemes can be seen only when land is treated in patches. Selection of beneficiaries in flexible framework has helped to attain maximum benefits to the different initiations/practices. Except Jharkhand and West Bengal, the selection of beneficiaries in Tamil Nadu and Gujarat is more flexible and vibrant.

6. Synergy in Various Programmes

It is observed that there is no coordination between two or more government schemes in the villages. Most of the times, it is possible to plan and integrate various schemes to get maximum benefits in the village. Sometimes, it also helps to deliver benefits in an equitable manner and solve conflicts among the villages. The study observed that synergy of different schemes coordinated in Tamil Nadu and Gujarat.

7. Let Communities Resolve Their Own Disputes

There was a conflict between some of the villages of Jharkhand, Tamil Nadu and Gujarat over the location of major activities. Different interest groups have different opinions to construct or initiate activity on different locations to avail of maximum benefits. The project implementing agency, along with villagers, gave their opinion on the location, explaining reasons for it, and also made clear that final decisions have to be taken in consensus. Different village institutions including formal as well as informal institutions in the villages played a crucial role in negotiating with the villagers and different stakeholders on both sides of different groups and made different groups come to amicable solutions.

Suggestions and Policy Implications

John Kerr (2007) observed that collective action is more likely in small, village-level catchment area development initiatives/watersheds. Our field data analysis also supports the same where micro-level environment activities of land and water use practices and biomass coupled with collective action of different stakeholders sustained the livelihoods of small and marginal farmers. Through collective action, the best practices of land and water use and biomass by the small and marginal farmers have maintained several resilience capacity mechanisms as well as cope up mechanism in some of the 16 sample villages across four States in India.

* The first issue that warrants attention is the assets created while implementing the project. These include the soil conservation measures, water harvesting structures and the vegetative measures in CPRs.

* Adequate awareness had to be created on the importance of maintaining the assets so created during the training and capacity building programmes. If the assets were created through the participatory approach more than half of the job is achieved. While the conservation measures in farmers' fields essentially were mechanical, their sustenance would be feasible only by properly vegetating such structures using multiple plantation trees (MPT), shrubs and grasses/fodder legumes.

* The community assets like water bodies and vegetated CPRs should be handed over to the UGs for their maintenance providing some

seed money towards expenses. The other way would be to impose user charges for maintenance. However, the former could be a more feasible choice. The water bodies may be utilised for inland fish production, nursery or vegetable growing and/or for drinking purposes for livestock.

* The second issue is focus on production systems (crops, livestock). As discussed in the report, the benefits of soil and water conservation works and even the water harvesting structures would be more pronounced with time, say after 3 to 5 years of their completion. Even the enhanced biomass generation, increased livestock activities would be having a telling effect on the production systems with time.

* So there is a need for a hand-holding approach by the PIA/WDT or line departments for 2-3 years after completion of the project to provide the needed technological assistance to the stakeholders in the project area.

* Once the production becomes sustainable and also diversified, the perishable commodities so produced need immediate processing and marketing (both natural and "house shopping"). It is here that producers need all assistance. It is best done through common interest groups (CIG) – approach avoiding middlemen.

* The third issue is the sustenance of CBOs created by the PIA in the project area. In several studies it was found that many CBOs so created were dysfunctional or partly functional. If the WHSs are handed over to UGs for their use and maintenance and if production systems are put in place, the sustenance of CBOs would be a lesser problem. But with the changing paradigms in the implementation of MGNREGS it should be possible to still provide incentives in enhancing the productivity of the farm lands. Such an approach would be providing the necessary cushion for the SHGs to be more active. As a consequence of the above the LGs and the CIGs could continue to be functional.

* The fourth issue is training and capacity building. We must realise that training and capacity building are continuous processes. Thus there is a felt need to provide infrastructure along with some seed money to clusters of completed watersheds (say 10 contiguous watersheds of 500ha each which equals to 5000ha in the present context of New Guidelines as well). Such a facility should be launched independent of PR bodies, but through cluster of village organisations facilitated by the district/block/mandal administration. In that event the created facility is to be operated (by rotation) with the help of the CBOs of the watershed clusters. They might be empowered to identify the training needs and also the trainers.

* As was observed in some of the sample villages, the fifth issue is to evolve mechanisms for maintaining and sharing the usufructs in the CPRs spread over the cluster of watersheds. It is to be realised that vegetation in any form is useful in protecting the land and water resources. The vegetation has to be considered for the macro hydrological unit encompassing several of the watershed areas. So the stakeholders in these projects even have to come together and plan for the maintenance of the vegetation avoiding 'free-riding' problem. The sharing of usufructs is done with a pro-poor bias and with a tacit understanding that the poor in these areas must be put in place for sustenance of such an approach.

* The sixth issue is development and maintenance of revolving fund (RF) and WDF. Together the funds must be put to proper use. Good examples are available. One is to provide these funds on soft loan for enhancing productivity of crops and livestock, but loaning only to those who contributed to WDF. Second is to provide for specific community assets like threshing floor or a collection centre for perishable commodities for processing and selling through CIGs.

* The seventh issue is equity. More often the upstream land owners remain as donors benefiting the downstream persons. Such an externality must be compensated to the 'donors' either by the beneficiaries or through project funds.

* The eighth issue is gender. In the present study participation of women in the project was fairly visible. To ensure their interests even after the completion of the project, it should be the endeavours of the CBOs to involve women in the post-project activities to ensure better availability of water, fuel and fodder. Livestock care and production activities (eg. dairying) should be the domain of the women.

* The last issue is the livelihood options and micro-enterprises. In the scheme of things these were not specified in the watershed guidelines till 01/04/2008. With some civil societies and in the internationally funded projects there were attempts to cover these two endeavours.

References

1. Agcaoili, M., Perez, N. & Rosegrant, M. (1995), Impact of Resource Degradation On Global Food Balances, Paper Prepared For The International Food Policy Research Institute Workshop On Land Degradation In The Developing World : Implications For Food, Agriculture, And Environment To The Year 2020, Annapolis, Maryland, 4-6 April.

2. Ahuja, A. (1998), Land Degradation, Agricultural Productivity and Common Property : Evidence from Cote d'Ivore, Environment and Development, 3, 7–34.

3. AKRSP-I (2004), Impact of AKRSP (I)'s Intervention on Drought Coping by People, Aga Khan Rural Support Programme, Ahmedabad.

4. Baidu-Forson, J. (1999), Factors Affecting Adoption of Land-Enhancing Technology in the Sahel : Lessons from a Case Study in Niger, *Agricultural Economics,* 20, 231–239.

5. Barbier, E. (2000), The Economic Linkages Between Rural Poverty and Land Degradation : Some Evidence from Africa, Agriculture, Ecosystem and Environment, 82, 355–370.

6. Barrett, C. B., Lynam, J., Place, F., Reardon, T., & Aboud, A. A. (2002). Towards Improved Natural Resource Management in African Agriculture. In C. Barrett, F. Place, & A. Aboud (Eds.), Natural Resource Management in African Agriculture, Undersigning and Improving Current Practices (pp. 287–296), CAB Publishing.

7. Batchelor, C.a. K. Singh, C.h. Rama Mohan Rao, And C. Butterworth. (2003), "Watershed Development; A Solution To Water Shortages Or Part Of The Problem?", Land Use And Water Resources Research # : 1-10.

8. Biot, Y., Blakie, P., Jackson, P., & Palmer-jones, R. (1995), Re-thinking Research On Land Degdaration In Developing Countries, World Bank Discussion Paper 289, Washington, DC, The World Bank.

9. Birthal, P.s., A.k. Jha, M.m. Tiongco And C. Narrod (2008), "Improving Farm To Market Linkages Through Contract Farming : A Case Study Of

Small Holder Dairying In India", PRI Discussion Paper 00814, Washington, D.C.

10. Birthal, P.s., Pk Joshi And Av Narayanan (2011), "Agricultural Diversification In India: Trends, Contribution To Growth And Small Farmer Participation", ICRISAT, Mimeo.

11. Boserup, E. (1965), The Conditions of Agricultural Growth, The Economics of Agrarian Change Under Population Pressure, Earthscan Publications Ltd., London.

12. Bunch, R. (1989), Encouraging Farmer's Experiments, In R. Chambers, A. Pacey, & L. Thrupp (Eds.), Farmer First (Pp. 55–59), International Technology Publications.

13. Business Standard (2005), "India Dwarfs USA As FDI Hotspot", December 10-11.

14. Calder, I., A. Gosain, M.S. Rama Mohan Rao, C. Batchelor, M. Snehylatha, and E. Bishop. 2006, "Planning Rainwater Harvesting In India - 1) Biophysical And Societal Impacts" In National Workshop On Priorities For Watershed Management In India", Bangalore, 22-23 May 2006, Government Of Karnataka And The World Bank.

15. Chand, R., PA Lakshmi Prasanna and Aruna Singh (2011), "Farm Size and Productivity : Understanding the Strengths of Smallholders and Improving their Livelihoods", *Economic and Political Weekly,* Vol.46, Nos. 26 and 27.

16. Chaturvedi, V. (2005), Maintenance of Physical Assets in Watershed, Research Report (WSD), Development Support Centre (DSC), Ahmedabad.

17. Cleaver, K. M., & Schreiber, G. A. (1994), Reversing the Spiral, The Population, Agriculture and Environmental Nexus in Sub-Saharan Africa, Washington, DC, The World Bank.

18. Cramb, R. A., Garcia, J. N. M., Gerrits, R. V., & Saguiguit, G. C. (1999), Smallholder Adoption of Soil Conservation Technologies : Evidence from

Upland Project from the Philippines, Land Degradation and Development, 10, 405–423.

19. Chambers, R., Pacey A., & Thrupp L. (Eds.) (1989), Farmer First : Farmer Innovation and Agricultural Research, Intermediate Technology Publications, 218 pp.

20. Chambers, R. (1987), Sustainable Livelihoods, Environment and Development : Putting Poor People First, Discussion Paper 240, Institute of Development Studies, UK.

21. Critchley, W., Reij, C., & Seznec, A. (1992), Water Harvesting for Plant Production, Volume II : Case Studies and Conclusions for Sub-Saharan Africa, World Bank Technical Paper No. 157, 133p.

22. Critchley, W., Sombatpanit, S., & Madina, P. (2001), Uncertain Steps? Terraces in the Tropics. In : E. Bridges, I. Hannam, I. Oldeman, L. Penning de Vries, F Scherr, & S. Sombatpanit (Eds.), Response to Land Degradation, Enfield, Science Publishers Inc.

23. CWC (2002), Water and Related Statistics, Central Water Commission, New Delhi, Government of India.

24. Datt, Gaurav and Martin Ravallion (2002), "Is India's Growth Leaving the Poor Behind?", *Journal of Economic Perspectives,* 16(3) : 89-108.

25. de Janvry, A., Fafchamps, M., & Sadoulet, E. (1991), Peasant Household Behaviour with Missing Markets : Some Paradoxes Explained, *Economic Journal,* 101, 1400–1417.

26. De Vries, F.P., Acquay, H., Molden, D., Scherr, S., Valentin, C. & Cofie, O. (2008), Learning from Bright Spots to Enhance Food Security and to Combat Degradation of Water and Land Resources, In : D. Bossio and K. Geheb (eds), Conserving Land, Protecting Water, CABI.

27. Dev, Mahendra, S. Inclusive Growth in India : Agriculture, Poverty and Human Development, Oxford University Press, 2008.

28. Dhawan, B.D. (1989), Studies in Irrigation and Water Management, New Delhi, Commonwealth Publishers.

29. Dhruvanarayana (1993), Soil and Water Conservation Research in India, New Delhi, Indian Council of Agricultural Research.

30. EPWRF (2003), Domestic Product of States of India, 1960-61 to 2000-01, *Economic and Political Weekly,* Research Foundation, Mumbai.

31. EPWRF (2004), National Accounts Statistics of India from 1950-51 to 2002-03, *Economic and Political Weekly,* Research Foundation, Mumbai.

32. FAO (2003), An International Action Programme on Water and Sustainable Agricultural Development, Rome : FAO.

33. FAO, (2011), "The State of the World Land and Water Resources for Food and Agriculture : Managing Systems at Risk", FAO of UN, Rome.

34. Farrington, J., C., Turton. and A. J. James (1999), Participatory Watershed Development : Challenges for the 21st Century. New Delhi and Oxford, OUP.

35. Fetter, C.W. (1988), Applied Hydrogeology, London, Merrill.

36. Fujisaka, S. (1994), Learning from Six Reasons Why Farmers Do Not Adopt Innovations Intended to Improve Sustainability of Upland Agriculture, Agricultural Systems, 46, 409–425.

37. Gebremedhin, B., Pender, J., & Tesfay, G. (2003), Community Natural Resource Management : The Case Of Community Woodlots In Northern Ethiopia, Environment and Development Economics, 8, 129–148.

38. GEC (1984), Groundwater Estimation Methodology : Report of the Groundwater Estimation Committee, Ministry of Irrigation, Government of India, New Delhi.

39. Ghosh, Jayati (2005), "The Political Economy of Farmers' Suicides in India", Sixth Freedom from Hunger Lecture, New Delhi, Centre for Environment and Food Security.

40. Gazette of India (2005), The National Rural Employment Guarantee Act, 2005, No.42 of 2005, New Delhi.

41. Gulati, Ashok (2009), "Emerging Trends in Indian Agriculture : What can we learn from these?" 2nd Prof. Dayanath Jha Memorial Lecture, National Centre for Agricultural Economics and Policy Research, New Delhi

42. Hanumantha Rao Committee (1995), Report of the Technical Committee on DPAP and DDP, New Delhi, Government of India.

43. Hazell, Peter (2011), "Five Big Questions About Five Hundred Million Small Farms", Paper Presented at the Conference on New Directions for Smallholder Agriculture, 24-25 January 2011, Rome, IFAD.

44. Heath, J., & Binswanger, H. P. (1996), Natural Resource Degradation Effects of Poverty and Population Growth are Largely Policy Induced : The Case of Colombia, *Environment and Development Economics,* 1, 64–84.

45. Hemantha Kumar, U. et al (2007), "Stakeholders Participation and Equity Aspects of Watershed Development : A Study in Rajasthan and Andhra Pradesh", Research Report, NIRD, Hyderabad.

46. Higgins, G.M. and A.H. Kassam (1981), "The FAO Agro-ecological Zone Approach to Determination of Land Potential", Pedologie, 31(2) : 147-168.

47. HLC (2001), Report of the High Level Committee on Long Term Grain Policy, Ministry of Consumer Affairs, Food and Public Distribution, New Delhi, Government of India.

48. Hoff, K., Braverman, A. & Stiglitz, J. E. (Eds.) (1993), The Economics of Rural Organisation, Oxford University Press.

49. Holden, S., Shiferaw, B., & Pender, J. (2004), Non-farm Income, Household Welfare and Sustainable Land Management in the Less Favored Area in the Ethiopian Highlands, *Food Policy,* 29, 369–392.

50. Holden, S., & Shiferaw, B. (2004), Land Degradation, Drought and Food Security in the Less-favored Areas of Ethiopian Highlands : A Bio-economic Model with Market Imperfections, *Agricultural Economics,* 30, 31–49.

51. Holden, S. T., Shiferaw, B., & Wik, M. (1998), Poverty, Credit Constraints, and Time Preferences : Of Relevance for Environmental Policy? *Environment and Development Economics,* 3, 105–130.

52. Hurni, H. (2000), Assessing Sustainable Land Management (SLM), Agriculture, Ecosystems and Environment, 81, 83–92.

53. IFAD (2001), Rural Poverty Report, The Challenge of Ending Rural Poverty, Oxford University Press and the International Fund for Agricultural Development (IFAD), Rome.

54. ILO-ARTEP (1993), India : Employment, Poverty and Economic Policies, New Delhi, International Labour Organisation, Asian Regional Team for Employment Promotion.

55. Jodha, N. S. (1986), "Common Property Resources and the Rural Poor in Dry Regions of India", *Economic and Political Weekly,* 54, pp. 1169-82.

56. Joshi, P. K., Jha, A. K., Wani, S. P., Joshi, L., & Shiyani, R. L. (2005), Meta-Analysis to Assess Impact of Watershed Programme and People's Participation, Research Report No. 8. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

57. Joshi, P.K., Pangare, V., Shiferaw, B., Wani, S.P.,Bouma, J., and Scoot, C., (2004), "Watershed Development in India : Synthesis of Past Experiences and Needs for Future Research" *Indian Journal of Agricultural Economics,* Vol. 59, No. 3, July-Sept.

58. Joshi P K and A. Gulati (2003), 'From Plate to Plough: Agricultural Diversification in India', Paper Presented at the Dragon and Elephant : A Comparative Study of Economic and Agricultural Reforms in China and India', New Delhi, India, March 25-26

59. Kerr, John and Kimberly Chung (2001), "Evaluating Watershed Management Projects", *Water Policy,* August 3(6) : 537-554.

60. Kerr, J., & Sanghi, N. (1992), Indigenous Soil and Water Conservation in India's Semi-Arid Tropics, Gatekeeper Series, No 34, London, International Institute for Environment and Development, 1993.

61. Kerr, J., Pangare, G., Pangare, V.L., and George, P.J. (2000), An Evaluation of Dryland Watershed Development Projects in India : EPTD Production Technology Division, International Food Policy Research Institute (IFPRI).

62. Kerr, J. and K. Chung (2001), "Evaluating Watershed Management Projects" : CAPRI Working Paper, No. 17, International Food Policy Research Institute.

63. Kerr, J. (2002), "Watershed Development, Environmental Services, and Poverty Alleviation in India", *World Development,* 30.

64. Kerr. J. (2002), Sharing the Benefits of Watershed Management in Sukhomajri, India, In Selling Forest Environmental Services : Market-Based Mechanisms for Conservation and Development, eds. Pagiola. S., J. Bishop. And N. Landell-Mills, 327-343, London : Earthscan.

65. Kerr. J. (2007), "Watershed Management : Lessons from Common Property Theory", *International Journal of the Commons,* Vol. I, No. I, October, 2007 PP 89-109.

66. Kerr, J., Milne, G., Chhotray, V., Baumann, P., & James, A. J. (2007), Managing Watershed Externalities in India, Theory and Practice, Environment, Development and Sustainability, 9, 263–268.

67. Knox, A. and R., Meinzen-Dick (2001), "Collective Action, Property Rights in Natural Resource Management : Exchange of Knowledge and Implications for Policy", A Workshop Summary Paper, CAPRi Working Paper No.11.

68. Lee, D. R. (2005), Agricultural Sustainability and Technology Adoption in Developing Countries : Issues and Policies for Developing Countries, *American Journal of Agricultural Economics,* 87, 1325–1334.

69. Lipton, M. (2006), "Can Small Farmers Survive, Prosper, or be the Key Channel to Cut Mass Poverty", *Journal of Agricultural and Development Economics,* Vol 3, No.1, 2006, pp58-85.

70. Lobo, C. (1996), Institutional Arrangements and Impact of Participatory Natural Resources Management, WOTR, Ahmednagar.

71. Madhur, Gautam (2011), "India : Accelerating Agricultural Productivity Growth - Policy and Investment Options", Mimeo, World Bank, Washington, D.C.

72. Mahendra Dev, S. (2012), "Small Farmers in India : Challenges and Opportunities", Working Paper - 14, Indira Gandhi Institute of Development Research, Mumbai.

73. Mazzucato, V., Niemeijer, D., Stroosnijder, L., & Rolling, N. (2001), Social Networks and the Dynamics of Soil Water Conservation in Sahel, Gatekeeper Series SA101, London, International Institute for Environment and Development.

74. Narasimhan, T.N. (1990), 'Groundwater in the Indian Peninsular Shield: A Framework for Rational Assessment', *Journal of the Geological Society of India,* 36 : 353-363.

75. NBSS-LUP (1992), Agro-Ecological Regions of India, Technical Bulletin No. 24, Nagpur, National Bureau of Soil Survey and Land Use Planning.

76. North, D.C. (1990), Institutions, Institutional Change and Economic Performance, Cambridge University Press.

77. NSSO (2000), Employment and Unemployment in India, Key Results of NSS 55th Round (1999-2000), National Sample Survey Organisation, Ministry of Statistics and Programme Implementation, New Delhi, Government of India.

78. NCEUS (2008), "A Special Programme for Marginal and Small Farmers", A Report Prepared by the National Commission for Enterprises in the Unorganised Sector, NCEUS, New Delhi.

79. Pandey, S. (2001), Adoption of Soil Conservation Practices in Developing Countries : Policy and Institutional Factors, In : E. Bridges, I. Hannam, I. Oldeman, L. Penning de Vries, F Scherr, & S. Sombatpanit (eds.) Response to Land Degradation, Enfield, Science Publishers Inc.

80. Parthasarathy Committee Report, (2006), "From Hariyali to Neeranchal Report of the Technical Committee on Watershed Programmes in India", DoLR, MoRD, Government of India.

81. Patnaik, Utsa (2005), 'It is Time for Kumbhakarna to Wake up', The Hindu, August 5.

82. Pattanayak, S., & Mercer, D. E. (1997), Valuing Soil Conservation Benefits of Agroforestry : Contour Hedgerows in Eastern Visayas, Philippines, *Agricultural Economics,* 18, 31–46.

83. Pender, J. L., & Kerr, J. M. (1998), Determinants of Farmers' Indigenous Soil and Water Conservation Investments in Semi-Arid India, *Agricultural Economics,* 19, 113–125.

84. Pender, J. L., Nkonya, E., Jager, P., Sserunkuuma, D., & Ssali, H. (2004). Strategies to Increase Agricultural Productivity and Reduce Land Degradation, *Agricultural Economics,* 31, 181–195.

85. Pender, J., & Hazell, P. (2000), Promoting Sustainable Development in Less-favored Lands : Overview, In Pender, J. & Hazell, P. (Eds.) Promoting Sustainable Development in Less-Favored Lands, Focus 4, Washington, DC, IFPRI.

86. Planning Commission (2001), Report of the Working Group on Watershed Development, Rainfed Farming and Natural Resource Management for the Tenth Five-Year Plan, New Delhi, Government of India.

87. Planning Commission (2002), Report of the Steering Committee on Irrigation for the 10th Five Year Plan, 2002-07, New Delhi, Government of India.

88. Planning Commission (2004), Report of the Inter-Ministry Task Force on Integrating Ongoing Schemes, New Delhi, Government of India.

89. Planning Commission, 2005, Report of the Inter-Ministry Task Group on Redressing Growing Regional Imbalances, New Delhi, Government of India.

90. Poulton, C., Kydd, J., & Doward, A. (2006), Overcoming Market Constraints on Pro-poor Agricultural Growth in Sub-Saharan Africa, *Development Policy Review,* 24, 243–277.

91. Rajamani, V. (2005), "Interlinking Rivers : Is it the Solution?", The Hindu, August 29.

92. Rakshit Mihir (2004), "Comments on "Fiscal Developments and Outlook in India" by Indira Rajaraman and "Macroeconomic Implications of the Fiscal Imbalances" by Kalpana Kochhar, At the IMF/NIPFP Conference on Fiscal Policy in India, New Delhi, India, January 16-17, 2004.

93. Rao, Hanumantha (2000), "Watershed Development in India : Recent Experience and Emerging Issues", *Economic and Political Weekly,* 35(45), November 4, Mumbai.

94. Rao, CH, Hanumatha (2005), Agriculture, Food Security, Poverty and Environment, Oxford University Press, New Delhi.

95. Rao, NC and Dev, S.Mahendra (2010), Biotechnology in Indian Agriculture: Potential, Performance and Concerns, Academic Foundation, New Delhi.

96. Reardon, T., & Vosti, S. A. (1997), Poverty Environment Links in Rural Areas of Developing Countries. In T. Reardon & S. A. Vosti (Eds.), Sustainable Growth and Poverty Alleviation, The John Hopkins University Press.

97. Reardon, T., & Vosti, S. A. (1995), Links Between Rural Poverty and Environment in Developing Countries : Asset Categories and Investment Poverty, *World Development,* 23, 1495–1503.

98. Reardon , T and B. Minten (2011) , "The Quiet Revolution in India's Food Supply Chains", IFPRI Discussion Paper 01115, August 2011.

99. Reardon, T and B. Minten (2011 a), "Surprised by Supermarkets : Diffusion of Modern Food Retail in India", *Journal of Agribusiness in Developing and Emerging Economies,* 1 (2).

100. Reddy, V. R., (2005), Costs of Resource Depletion Externalities : A Study of Groundwater Overexploitation in Andhra Pradesh, India, *Environment and Development Economics,* 10, 533–556.

101. Reddy, C.B. and A. Ravindra (2004), Watershed Development Programme: Understanding Investments and Impacts, Report of the Study of the Impact of Five Watersheds in Andhra Pradesh, WASSAN, Hyderabad.

102. Reij, C. (1991), Indigenous Soil and Water Conservation in Africa, Gatekeeper Series 27, London, International Institute for Environment and Development.

103. Robbins, M., & Williams, T. O. (2005), Land Management and Its Benefits: The Challenge, and the Rationale, for Sustainable Management of Drylands, A Paper Presented at a STAP Workshop on Sustainable Land Management, Washington DC.

104. Sarthak, Gaurav and Srijit Mishra (2011), "Size Class and Returns to Cultivation in India : A Cold Case Reopened", IGIDR Working Paper No. WP 2011-27, Mumbai.

105. Shah, Amita (2000), "Who Benefits from Watershed Development: Evidence from Gujarat", Working Paper No. 118, Gujarat Institute for Development Research, Ahmedabad.

106. Shah, Anil (2000), Eloquent Silent Revolution (WSD 1), Actions & Reflections Series, Development Support Centre (DSC), Ahmedabad.

107. Shah, Anil (2002), Advantage Watershed in Second Year of Drought (WSD 2), Actions & Reflections Series, Development Support Centre (DSC), Ahmedabad.

108. Shah, Anil (2004), Advantage Declined : Part III of Longitudinal Study of Sixteen Drought Prone Villages of Gujarat (WSD 3), Research Report, Development Support Centre (DSC), Ahmedabad.

109. Shah, Mihir., D. Banerji, P.S. Vijayshankar and Pramathesh Ambasta (1998), India's Drylands : Tribal Societies and Development Through Environmental Regeneration, Oxford University Press, New Delhi.

110. Shah, Tushaar et al (2000), Global Groundwater Situation : Overview of Opportunities and Challenges, International Water Management Institute, Colombo.

111. Shah, Tushaar, Ashok Gulati, Hemant P, Ganga Shreedhar, R C Jain (2009), "Secret of Gujarat Agrarian Miracle After 2000", *Economic and Political Weekly,* Vol. 44, No.52.

112. Shah, Tushaar (2005), Groundwater and Human Development : Challenges and Opportunities in Livelihoods and Environment, IWMI-TATA Water Policy Program, Water Policy Research Highlights, http://www.iwmi.org/iwmitata.

113. Sharda, V.N., J.S. Samra and Pradeep Dogra (2005), "Participatory Watershed Management Programmes for Sustainable Development : Experiences from IWDP", mimeo.

114. Scherr, S. (2000), A Downward Spiral? Research Evidence on the Relationship Between Poverty and Natural Resource Degradation, *Food Policy,* 25, 479–498.

115. Shiferaw, B., & Holden, S. T. (1998), Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands : A Case Study in Andit Tid, North Shewa, *Agricultural Economics,* 18(3), 233–248.

116. Shiferaw, B., & Holden, S. (2000), Policy Instruments for Sustainable Land Management : The Case of Highland Smallholders in Ethiopia, *Agricultural Economics,* 22, 217–232.

117. Shiferaw, B., & Holden, S. (2001), Farm-level Benefits to Investment for Mitigating Land Degradation, Environment and Development Economics, 6, 355–358.

118. Shiferaw, B., & Bantilan, C. (2004), Rural Poverty and Natural Resource Management in Less-favored Areas : Revisiting Challenges and Conceptual Issues, *Journal of Food, Agriculture and Environment,* 2(1), 328– 339.

119. Singh, R.B., P.Kumar and T.Headwood (2002), "Smallholder Farmers in India : Food Security and Agricultural Policy", FAO, Regional Office for Asia and the Pacific, Bangkok.

120. Singh, C. (Editor), (1992), Water Law in India, New Delhi, Indian Water Law Institute Stine, S., (1994), Extreme and Persistent Drought in California and Patagonia During Medieval Time, *Nature,* 369, 546-549.

121. SSP, Sharma. et al (2008), "Effectiveness of Watershed Development and Environment Conservation in Jharkhand and Madhya Pradesh", Research Report, NIRD, Hyderabad.

122. Sundaram, K. (2001), "Employment and Poverty in 1990s, Further Results from NSS 55th Round, Employment-unemployment Survey, 1999-00", *Economic and Political Weekly,* 11 August, pp.3039-49

123. Sundaram, K. (2007), "Employment and Poverty in India, 2000-2005", *Economic and Political Weekly,* July 28, pp.3121-3131

124. Swinton, S. M., & Quiroz, R. (2003), Is Poverty to Blame for Soil, Pasture, and Forest Degradation in Peru Altiplano? *World Development,* 31, 1903–1919.

125. TARU (2001), The Rajiv Gandhi Watershed Mission in Madhya Pradesh: An Assessment, TARU, New Delhi.

126. TERI (2004), Impact Assessment of the Watershed Development Programme : A Compendium, The Energy and Resources Institute (for Department of Land Resources, MoRD, GoI), New Delhi.

127. Templeton, S. R., & Scherr, S. R. (1999), Effects of Demographic and Related Microeconomic Change on Land Quality in Hills and Mountains of Developing Countries, *World Development,* 27, 903–918.

128. Thapa, G. and R. Gaiha (2011), "Smallholder Farming in Asia and the Pacific : Challenges and Opportunities", Paper Presented at the Conference on New Directions for Small Holder Agriculture, 24-25 January 2011, Rome, IFAD.

129. Tiffen, M., Martimore, M., & Gichuki, F. (1994), More People Less Erosion: Environmental Recovery in Kenya, John Wiley and Sons Publishers, London.

130. UNDP (2005), Human Development Report 2005, New Delhi: OUP.

131. Vaidyanathan, A. (1994), Food, Agriculture and Water (Second India Series Revisited), Madras, Madras Institute of Development Studies.

132. Vaidynathan, A. (2010), "Agricultural Growth in India : Role of Technology, Incentives and Institutions", Oxford Collected Essays.

133. K N Vajpai and Ms. Bhawna Maheshwari, (200), International Conference on Innovative Technologies for Rural Water Supply and Environmental Sanitation RUWATSS-2000, Centre for Continuing Education, Indian Institute of Technology-IIT, Roorkee, India.

134. Vasudha Lokur Pangare (1998), "Gender Issues in Watershed Development and Management in India", AgREN, Network Paper No. 88.

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Research Reports Series - 96

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Dr. SSP SHARMA

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Authors

CONTENTS