CONSERVATION FARMING

Enhancing Productivity and Profitability of Rainfed Areas

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A New Paradigm in Watershed Management: A Must for Development of Rain-fed Areas for Inclusive Growth

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Two third of agriculture in India is rain-fed and is also the hot spot of poverty as is the case in Asia where large proportion of 852 million poor in the world reside. Rain-fed areas in developing countries and particularly so in India are at cross roads as looming water scarcity for achieving food security and reducing poverty rain-fed agriculture has come in the central stage. Large potential of rain-fed agriculture is untapped largely due to lack of enabling policy support and investments. In drought-prone rain-fed areas watershed management has shown the potential of doubling the agricultural productivity and increasing the rural family through increased water availability and diversifying the cropping and farming systems resulting in diversified sources of income. Impact of watershed programs can be substantially enhanced by developing new approaches and enabling policies, however, additional investments are must for meeting the millennium development goal. New paradigm based on the learnings over last thirty years for people-centric holistic watershed management involving convergence, collective action, consortium approach, capacity development to address equity, efficiency, environment, and economic concerns is urgently needed. Through new paradigm watershed management can be used as an entry point activity for improving livelihoods of rural poor in rain-fed areas to enable India to achieve inclusive and sustainable development for meeting the MDGs as well as achieving the food, water, and energy security. Concerted efforts by all the stakeholders and actors will make India a global leader in the area of inclusive and sustainable development in drought-prone challenging rain-fed areas to develop a watershed management as business model through public private partnerships harnessing the benefits of value chain and linking farmers to the market.

Why Rain-fed Areas Need Urgent Attention

Globally rain-fed agriculture is very important as 80 per cent of the world's agricultural land area is rain-fed and generates 58% of the world's staple foods (SIWI, 2001). Most food for poor communities in developing countries is produced in rain-fed areas for e.g. in sub-Saharan Africa (SSA) more than 95% of the farmed land is rain-fed, while the corresponding figure for Latin America is almost 90, for South Asia about 60 %, for East Asia 65 % and for Near East and North Africa 75%. In India, 66 per cent of 142 million ha arable land is rain-fed. In addition to vast areas covered by rain-fed agriculture these areas are also the hot spots of poverty, malnutrition, child mortality. Most of 852 million hungry and malnourished people in the world are in Asia, particularly in India (221 million) and in China (142 million). In Asia, 75% of the poor are in rural areas and they depend on agriculture for their livelihood. About half of the hungry live in smallholder farming households, while two-tenths are land-less. About 10% are pastoralists, fish folk and forest users (Sanchez et al, 2005). Within developing semi arid tropics (SAT) countries poverty is concentrated more in rain-fed areas (Ryan and Spencer, 2001). Rain-fed agriculture becomes important not only because of large areas but also from social and equity concerns for improving the livelihoods of large number of people to meet the millennium development goal (MDG) of reducing the number of poor by half by 2015.

Insights in Rain-fed Areas

An insight into the rain-fed regions shows a grim picture of water-scarcity, fragile environments, drought and land degradation due to soil erosion by wind and water, low rainwater use efficiency (35-45%), high population pressure, poverty, low investments in water use efficiency measures, poor infrastructure and inappropriate policies (Wani et al, 2003a, Rockstrom et al, 2007). Drought and land degradation are interlinked in a cause and effect relationship and both in turn are the causes of poverty. This unholy nexus between drought, poverty and land degradation has to be broken if we have to meet the MDG of halving the number of food insecure poor by 2015. Land degradation due to accelerated erosion resulting in loss of nutrient rich top fertile soil however, occurs nearly everywhere where agriculture is practiced and is irreversible. The torrential character of the seasonal rainfall creates high risk for the cultivated lands. For example, on 23rd June, 2007, Kurnool in Andhra Pradesh received 420 mm rainfall in a day against 77 mm monthly average. In India, alone some 150 million ha are affected by water erosion and 18 m ha by wind erosion. Thus, erosion leaves behind an impoverished soil on one hand, and siltation of reservoirs and tanks on the other. In addition imbalanced use of nutrients in agriculture by the farmers results in mining of soil nutrients. For example in India large number of farmers participatory watershed management trials in more than 300 villages demonstrated that in the SAT current subsistence

agricultural systems have depleted soils not only in macro-nutrients but also in micro-nutrients such as zinc and boron and secondary nutrients such as sulphur beyond the critical limits. Widespread (80 to 100%) deficiencies of micro and secondary nutrients were observed in farmers' fields in different states of India (Table 1).

Watersheds as Growth Engine for Development of Rain-fed Areas

Watersheds are not only hydrological units but provide life support to rural people making people and animals an integral part of watersheds. Activities of people/ animals affect the productive status of watersheds and *vice versa*. Currently there is a vicious cycle of 'poverty – poor management of land and crop – poor soils and crop productivity – poverty' is in operation in most of the watersheds. This results in a strong nexus between drought, land degradation and poverty. Appreciating this fact, the new generation of watershed development programmes is implemented with a larger aim to address issues of food security, equity, poverty, severe land degradation and water scarcity in dry land areas. Hence in the new approach, Watershed, a land unit to manage water resources has been adopted as a planning unit to manage natural resources of the area. Improving livelihoods of local communities is highlighted by realizing the fact that in the absence of them, sustainable NRM would be illusive. Due to these considerations watershed programmes have been looking beyond soil and water conservation into a range of activities from productivity enhancement through interventions in agriculture, horticulture, animal husbandry to community organization and gender equity. This holistic approach required optimal contribution from different disciplinary backgrounds creating a demand for multi-stakeholder situation in watershed development programmes.

During 1990's there has been a paradigm shift in the thinking of policy makers based on the learnings of earlier programmes. In India, watershed programmes are silently revolutionizing rainfed areas. (Wani et al; 2002a, 2006). Till 2006 up to 10th five year plan,

Table 1: Percentage of farmers' fields deficient in soil nutrients in different states of India

State	No. of farmers' fields	Organic Carbon	Available P	Available K	Available S	Available B	Available Zn
Andhra Pradesh	1927	84	39	12	87	88	81
Karnataka	1260	58	49	18	85	76	72
Madhya Pradesh	73	9	86	1	96	65	93
Rajasthan	179	22	40	9	64	43	24
Gujarat	82	12	60	10	46	100	82
Tamil Nadu	119	57	51	24	71	89	61
Kerala	28	11	21	7	96	100	18

about US $ 6 billions have been invested by Government of India and other donor agencies treating 38 million ha in the country (Table 2). During detailed evaluation of on-farm watershed programmes implemented in the country, ICRISAT team observed that once the project team withdrew from the villages the farmers reverted back to their earlier practices and very few components of the improved soil, water and nutrient management options were adopted and continued. Although, economic benefits of improved technologies were observed in on-farm experiments, adoption rates were quite low. Individual component technologies such as summer ploughing, improved crop varieties and intercropping were continued by the farmers. However, soil and water conservation technologies were not much favored. (Wani et. al., 2002b)

Detailed meta-analysis of 311 watershed case studies from different agro-eco regions in India revealed that watershed programmes benefited farmers through enhanced irrigated areas by 33.5%, increased cropping intensity by 63%, reducing soil loss to 0.8 t ha^{-1} and runoff to 13%, and improved groundwater availability. Economically the watershed programmes were beneficial and viable with a benefit – cost ratio of 1:2.14 and the internal rate of return of 22.0% (Joshi et al. 2005). However, about 65% of the case studies showed below average performance. (See Table 3 and Figure 1). Based on the learning from the meta-analysis and earlier on-farm watersheds ICRISAT in partnership with national agricultural research systems (NARSs) partners developed and evaluated an innovative farmers participatory integrated watershed consortium model for increasing agricultural productivity and later for improving rural livelihoods (Wani et al. 2003b).

Potential of Rain-fed Areas

In tropical regions, particularly in the sub-humid and humid zones, agricultural yields in commercial rainfed agriculture exceed 5-6 t ha^{-1} (Rockström and Falkenmark, 2000; Wani et al. 2003a, b). However, farmers' crop yields oscillate in the region of 0.5 – 2 t ha^{-1}, with an average of 1 t ha^{-1} in sub-Saharan Africa, and 1-1.5 t ha^{-1} in the SAT Asia and Central and West Asia and North Africa (CWANA) for rain-fed agriculture (Rockström and Falkenmark, 2000; Wani et al. 2003a, b). Evidence from long-term experiments at ICRISAT, Patancheru, India, since 1976, demonstrated the virtuous cycle of persistent yield increase through improved land, water, and nutrient management in rain-fed agriculture. Improved systems of sorghum/pigeonpea intercrops produced higher mean grain yields (5.1 t ha^{-1} per yr) compared to 1.1 t ha^{-1} per yr, average yield of sole sorghum in the traditional (farmers') post-rainy system where crops are grown on stored soil moisture (Fig. 1) with 5 t ha^{-1} farm yard manure once in two years. The annual gain in grain yield in the improved system was 82 kg ha^{-1} per year compared with 23 kg ha^{-1} per year in the traditional system. The large yield gap between attainable yield and farmers' practice as well as between the attainable yield of 5.1 t ha^{-1} and

Table 2: Degraded land developed under various watershed Development Programmes

(Area in lakhs ha and Expenditure in Rs. Crores)

S.No	Ministry / Scheme	Year of start	Progress up to X FYP (up to march 2006)		Projection for XI FYP	
			Area treated	Amount Expenditure	Area Target	Financial Requirement
A. Ministry of Agriculture (Department of Agriculture and Cooperation)						
1	NWDPRA	1990-91	85.59	2671.56	40.0	3000.0
2	RVP & FPR	1962 & 81	62.57	1908.43	20.0	2400.0
3	WDPSCA	1974-75	3.52	255.58	2.0	240.0
4	RAS	1985-86	6.87	105.94	5.0	287.0
5	WDF	1999-2000	0.39	2101.5	4.0	300.0
6	EAPs		28.0	4980.0	5.0	750.0
7	New schemes for problem soils				24.0	2950.0
	Sub - Total		186.94	12023.01	100.0	9927.0
B. Ministry of Rural Development (Department of land Resources)						
8	DPAP	1973-74	65.74	5060.5	40.0	3000.0
9	DDP	1977-78	35.31	1960.75	30.0	2250.0
10	IWDP	1988-89	84.54	2228.41	70.0	5250.0
11	EAPs		3.6	212.67		
	Sub - Total		**189.19**	**9462.33**	**140.0**	**10500.0**
C. Ministry of Environment and Forestry						
12	NAEP	1989-90	**8.77**	**852.89**		
D. Planning Commission						
13	HADP	From V plan		4908.26		
14	WGDP	From V plan		1426.65	10.0	750.0
	Sub - Total			**6334.91**	**10.0**	**750.0**
E. Public-Private- Partnership (PPP)					**30.0**	**2250.0**
	Total		**384.9**	**28673.14**	**280.0**	**23427.0**
				(=US$ 644.34)		**(=US$ 526.45)**

Note: Currency conversion @ 44.50 INR = 1 US$; one crore = ten million

Abbreviations: NWDPRA - National Watershed Development project for Rainfed Areas; RVP & FPR - River Valley Project & Flood Prone River; WDPSCA - Watershed Development Project for Shifting cultivation Areas; RAS - Reclamation of Alkali Soil; WDF - Watershed Development Fund; EAP - External Aided Projects; DPAP - Drought Prone Area Programme; DDP - Desert Development Programme; IWDP - Integrated Wasteland Development Project; NAEP - National Afforestation and Eco - Development project; HADP - Hill Area Development Programme; WGDP - Western Ghats Development Programme

Table 3: Benefits of watersheds – Summary of meta-analysis

Indicator	Particulars	Unit	No. of studies	Mean	Mode	Median	Min	Max	t- value
Efficiency	B/C ratio	Ratio	128	2.14	1.70	1.81	0.82	7.06	21.25
	IRR	Percent	40	22.04	19.00	16.90	1.68	94.00	6.54
Equity	Employment	Person days/ha/yr	39	181.50	75.00	127.00	11.00	900.00	6.74
Sustainability	Irrigated area	Percent	97	33.56	52.00	26.00	1.37	156.03	11.77
	Cropping intensity	Percent	115	63.51	80.00	41.00	10.00	200.00	12.65
	Rate of runoff	Percent	36	-13.00	-33.00	-11.00	-1.30	-50.00	6.78
	Soil loss	Tons/ha/yr	51	-0.82	-0.91	-0.88	-0.11	-0.99	39.29

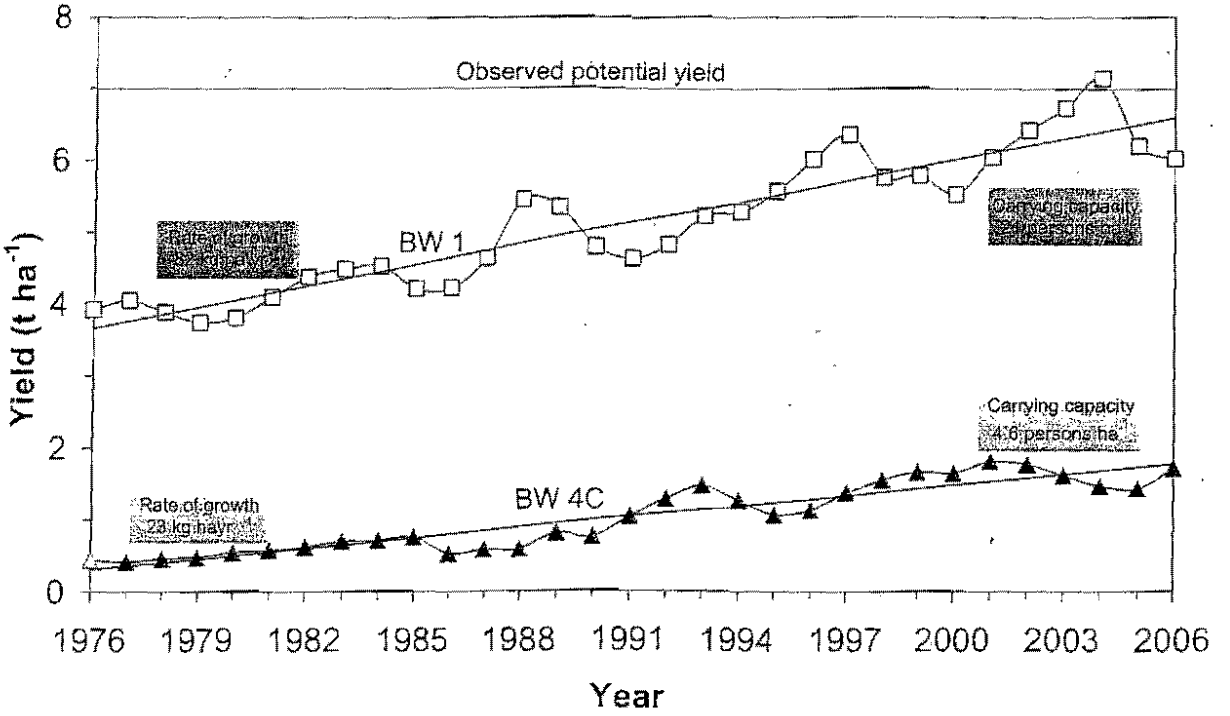

Fig. 1. Three-year moving average of crop yields in improved and traditional management systems during 1976-2006 at ICRISAT, Patancheru, India

potential yield of 7 t ha^{-1} shows that a large potential of rain-fed agriculture remains to be tapped. Moreover, the improved management system is still gaining in productivity as well as improved soil quality (physical, chemical, and biological parameters) along with increased carbon sequestration of 330 kg C ha^{-1} per year (Wani et al, 2003a).

Yield gap analyses, undertaken by the Comprehensive Assessment, for major rainfed crops in semi-arid regions in Asia and Africa, and rain-fed wheat in West Asia and North Africa (WANA), reveal large yield gaps, with farmers' yields being a factor 2 – 4 lower than achievable yields for major rainfed crops grown in Asia and Africa (Rockström et al. 2007). In India, large yield gaps for all the major rain-fed crops have been observed and with the available technologies crop yields can be doubled (Figure 2)

Why We Need a New Paradigm for Watershed Management in India

In the beginning, watershed development in rain-fed areas had become synonymous to soil and water conservation by putting up field bunds and structures to harvest runoff (Singh 1998, Wani et al., 2002a). In these activities techno-centric and target oriented approaches were followed by involving one or two departments of the Government without much coordination among each other. It was a top-down approach with hardly any involvement of the stakeholders in planning, implementation, and maintenance (Figure 3).

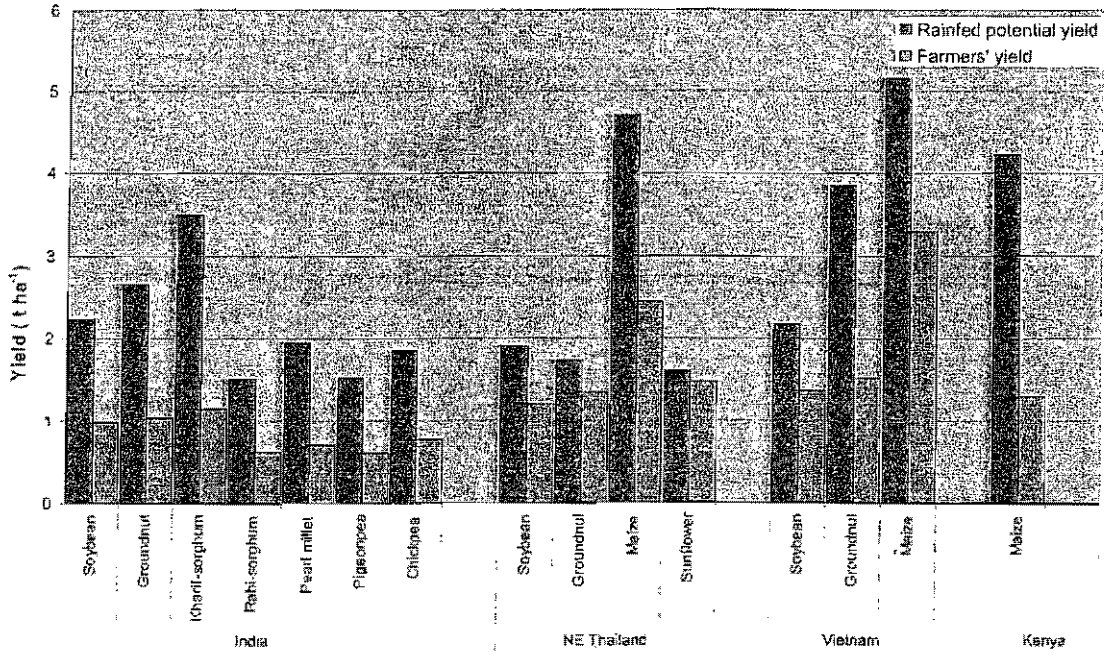

Fig. 2. Yield gap analysis of important rainfed crops in different countries

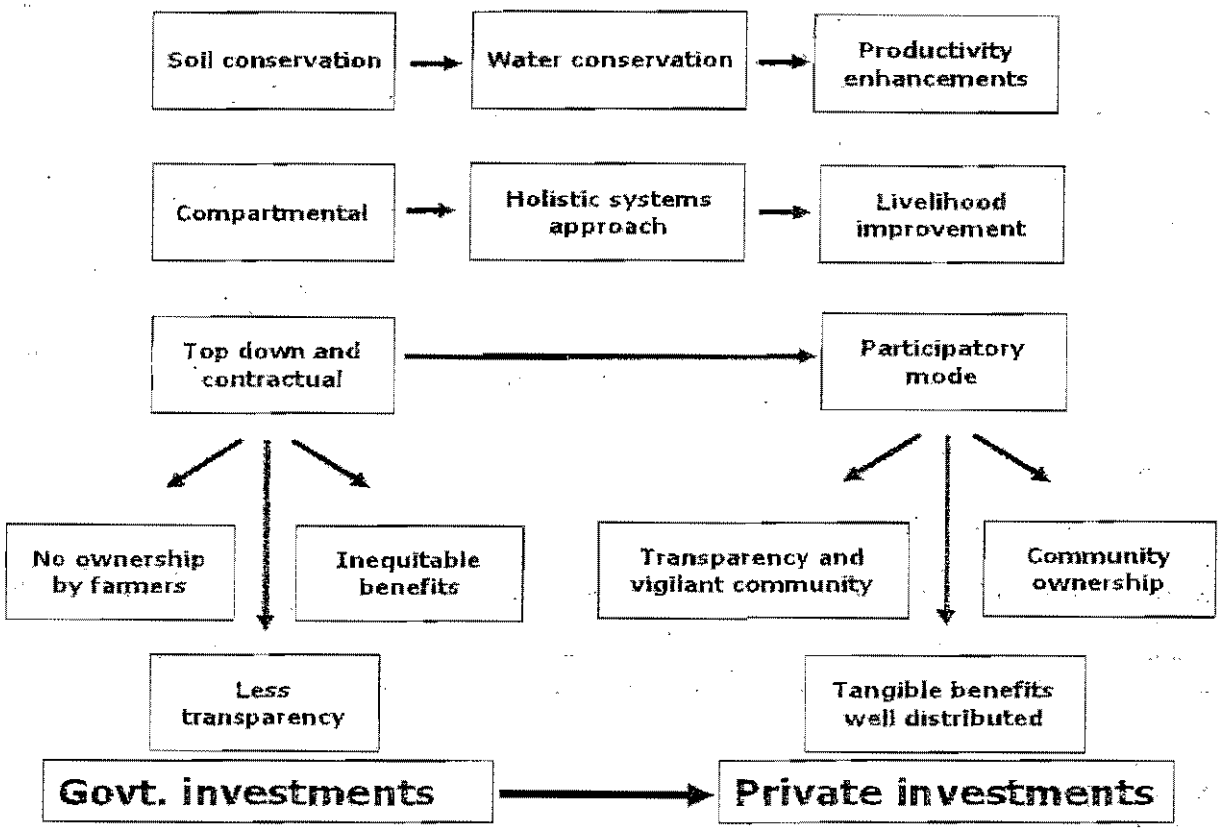

Fig. 3. Journey through watershed approach in India

Hence, such efforts did not make headway in impacting livelihoods of the rural poor in the rainfed areas (Farrington and Lobo 1997, Joshi et al. 2000, Wani 2002a). Learning from such experiences, in the later stages watershed management in rain-fed areas has been attempted by various watershed development programmes implemented through different agencies such as Government departments, non-governmental organizations (NGOs) and Research institutes.

For enhancing rainwater use efficiency in rain-fed agriculture management of water alone can not result in enhanced water productivity as in these areas crop yields are limited by more factors than water limitation also. ICRISAT's experience in rainfed areas has clearly demonstrated that more than water quantity *per se* management of water resources is the limitation in the SAT (Wani et al., 2003a; Rego et al., 2005).

Based on the Policy on water resource management for agriculture remains focused on irrigation, and the framework for integrated water resource management (IWRM) at catchment and basin scales are primarily concentrated on allocation and management of blue water (irrigation water) in rivers, groundwater and lakes. The evidence from the comprehensive assessment indicated water for agriculture is larger than irrigation, and there is an urgent need for a widening of the policy scope to include explicit strategies for water management in rain-fed agriculture including grazing and forest systems. However, what is needed is effective integration so as to have a focus on the investments options on water management across the continuum (range) from rain-fed to irrigated agriculture. This is the time to abandon the obsolete sectoral divide between irrigated and rain-fed agriculture, which would place water resource management and planning more centrally in the policy domain of agriculture at large, and not as today, as a part of water resource policy (Molden, 2007). Furthermore, the current focus on water resource planning at the river basin scale is not appropriate for water management in rainfed agriculture, which overwhelmingly occurs on farms of < 5 ha at the scale of small catchments, below the river basin scale. Therefore, focus should be to manage water at the catchment scale (or small tributary scale of a river basin), opening for much needed investments in water resource management also in rain-fed agriculture.

Detailed scrutiny of meta analysis revealed very valuable learnings such as that current technologies used in watershed programs are effective in annual rainfall of 700 to 1100 mm region, higher benefits were observed in low and medium GDP regions than in high GDP areas, more success was observed where community participation was better (Table 4), watershed size was >1200 ha, where NGOs were having technical support and also central and state government institutions worked together. However, 65% of the watersheds were performing below average performance as they lacked community participation, equity and sustainability issues were eluding, technical support was lacking (Figure 4), programs were

Table 4: Returns were higher in medium (2000-4000 Rs. Ag GDP) and low (<2000 Rs. Ag GDP) income states

Indicator	Particular	Unit	Per capita income of the region		
			High	Medium	Low
Efficiency	B:C ratio	*Ratio*	1.98 (16.86)	2.21 (12.28)	2.46 (7.73)
Equity	Employment	Person days/ ha/year	132.01(4.14)	161.44 (5.29)	175.00 (4.66)
Sustainability	Irrigated area	Percent	40.34 (9.73)	23.01 (6.24)	36.88 (4.19)
	Cropping intensity	Percent	77.91 (8.67)	36.92 (11.99)	86.11 (7.64)
	Rate of runoff reduced	Percent	12.38 (5.31)	15.82 (3.39)	15.43 (6.01)
	Soil loss reduced	Tons/ha/year	0.82 (40.32)	0.88 (37.55)	0.69 (4.60)
Extent of people's participation			High	High	Low

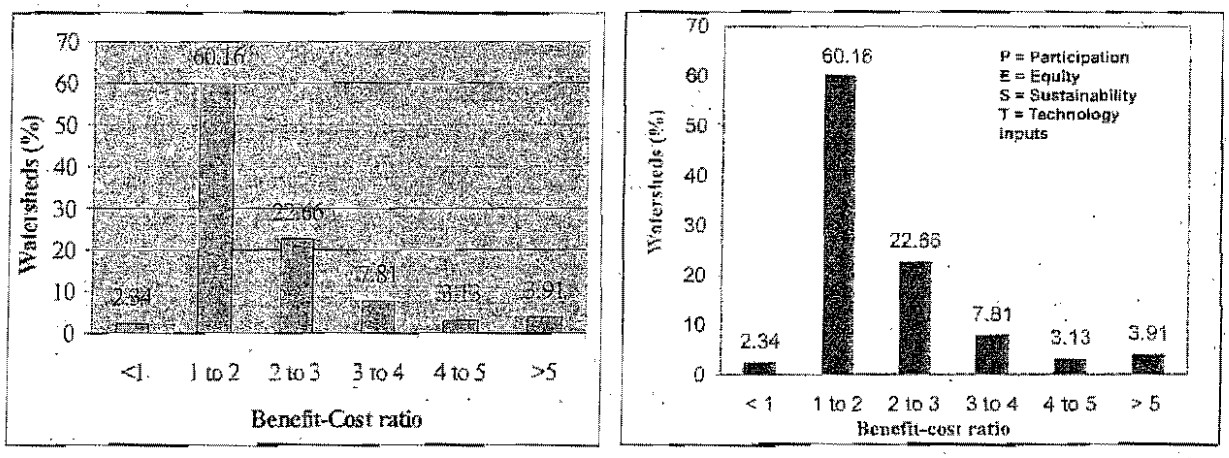

Fig. 4. Performance of different watersheds analyzed during meta analysis, with regards to BC ratio

supply driven, and compartmental approach was adopted (Joshi et al., 2005, Wani et al., 2005).

Government of India has established a National Authority for Development of Rain-fed Area (NADORA) with the objective of improving rain-fed agricultural productivity and improving livelihoods of small and marginal farmers.

Considering all these learnings and urgency to address the issues of food security, improving livelihoods, protecting environment, building coping strategies to face water scarcity and increased vulnerability associated with climate change there is an urgent need to develop and adopt a new paradigm for development of rain-fed areas. Watershed management can be the growth engines for sustainable development of rain-fed drought-prone areas to meet the MDG while protecting the environment. However, we need to evolve our watershed

management approaches based on the experiences and changing scenarios to address the issues of equity, sustainability and inclusive growth through development of new paradigm for integrated watershed management to meet the desired goals.

New Paradigm; What It Involves

We need to change the strategy and use water management as an entry point only to improve livelihoods using science-led development adopting holistic system's approach and not an end in it self as was the case with the conventional approach. Guidelines need to be evolved and harmonized to suit the needs and interventions (farm-based vs community- based), investments, institutional arrangements, holistic approach, emphasis on productivity enhancement and value addition, targeted activities for women and vulnerable groups, empowerment and knowledge, innovative extension methods, multiple benefits expected from the programmes, diversification with high-value crops, rehabilitation of degraded lands, promoting partnerships and private investments in watersheds

The new paradigm for watershed management needs to be evolved to address the issues faced and the learnings from the past studies. It has to be evolutionary and a tool box approach highlighting the principles rather than prescribing the technologies, it can not be either or for example we can not say only bottom-up or top down approach, it will depend on the context and existing situation, it should be science-led at the same time indigenous knowledge also need to be put together, etc. Following few examples will elaborate the details.

- Need to select watersheds using new science tools such as satellite imageries and geographical information system (GIS) along with social and economic parameters without sacrificing the watershed boundaries to harness the best possible benefits from the programs implemented. Develop micro-watersheds in clusters to harness the maximum benefits.

- Bottom-up approach for rainwater conservation should start with the individual farm-based interventions to undertake *in-situ* conservation and not directly with *ex-situ* run-off harvesting structures. Once farm-based interventions are implemented the excess run-off water need to be taken out safely from the fields minimizing soil erosion. Emphasis on individual farm-based intervention has ensured tangible economic benefits to the farmers which served as the trigger for their participation in community rainwater harvesting and more so principle of enhancing water use efficiency results in increasing the incomes. This concept addresses the basic issue of equity and tangible economic benefits for small and marginal farmers who were bypassed in traditional watershed approach (Wani et al., 2002a, Sreedevi et al., 2004, Joshi et al., 2005).

- Knowledge-based entry point activity (EPA) to build rapport with the community rather than money-based EPA which resulted in contractual mode of participation rather than cooperative and collegiate mode of participation. Enough evidence exists to show that money-based EPA were not effective in building the rapport (FAO 2000) and knowledge-based EPA proved more effective although slow in the beginning these were sustainable and promoted collective action as community did not receive the wrong message that project will provide everything for the interventions (Wani et al., 2002a, 2003a; Sreedevi et al., 2004).

- Low-cost structures for harvesting rainwater through out the topo-sequence using scientific information to benefit large number of small and marginal farmers. For example secondary and tertiary drains can be effectively converted into water recharging structures by constructing low-cost structures to benefit farmers from middle and top topo-sequence positions (Wani et al., 2003b, Pathak et al., 2005, Sreedevi et al., 2006). Dried and open wells can also be used as water storage structures and revived with careful recharging using suitable silt traps to avoid blocking natural water recharging channels (Wani et al 2006)

- Emphasize efficient use of water resources to manage the water demand rather than only augmenting the water resources through shifting non-productive evaporation to productive evapo-transpiration. Rainwater use efficiency in arid and SAT is 35 to 50% and up to 50 % of the rainwater falling on crop or pasture fields is lost as non-productive evaporation. This is a key window for improvement of green water productivity, as it entails shifting non-productive evaporation to productive transpiration, with no downstream water trade-off. This *vapour shift* (or transfer), where management of soil physical conditions, soil fertility, crop varieties and agronomy are combined to shift the evaporative loss into useful transpiration by plants, is a particular opportunity in arid, semi-arid and dry-subhumid regions (Rockstrom et al. 2007).

- ***Increasing crop productivity*** is common in all the watersheds and evident in so short period from the inception of watershed interventions. To cite few cases, in benchmark watersheds of Andhra Pradesh, improved crop management technologies increased maize yield by 2.5 times and sorghum by 3 times. Over-all, in 65 community watersheds (each measuring approximately 500 ha), implementing best-bet practices resulted in significant yield advantages in sorghum (35–270%), maize (30–174%), pearl millet (72–242%), groundnut (28–179%), sole pigeonpea (97–204%) and as an intercrop (40–110%). In Thanh Ha watershed of Vietnam, yields of soybean, groundnut and mungbean increased by three to four folds (2.8–3.5 t ha^{-1}) as compared with baseline yields (0.5 to 1.0 t ha^{-1}) reducing the yield gaps between potential farmers' yields. A reduction in N fertilizer (90–120 kg urea ha^{-1}) by 38% increased maize yield by18%. In Tad Fa watershed

of northeastern Thailand, maize yield increased by 27–34% with improved crop management (Wani et al, 2003b, 2006).

- Adopt integrated water resource management approach in the watersheds by discarding the artificial divide between rain-fed and irrigated agriculture. There is an urgent need to have sustainable water (rain-, ground- and surface-water) use policies to ensure sustainable development. As described earlier in the absence of suitable policies and mechanisms for sustainable use of groundwater resources benefits of watershed programs can easily be undone in short period with over exploitation of the augmented water resources. Cultivation of water inefficient crops like rice, sugarcane need to be controlled using groundwater in watersheds through suitable incentive mechanisms for rain-fed irrigated crops and policy to stop cultivation of high water requiring crops.
- Innovative institutional mechanisms such as Consortium approach for technical backstopping (Wani et al, 2003a), empowerment of community-based organizations (Wani et al; 2003a, 2006), strengthening of area groups as is the case in Sujala Watershed program, strengthening of SHGs in APRLP, women's village organization (VO) in APRLP or Village organization like in Sujala watershed program in Karnataka as PIAs, including Gram Panchayat representatives in Watershed Committee (governing body), concurrent monitoring and evaluation by an independent body as evaluated in Sujala Watershed program, participatory M&E involving community and other stakeholders, transparency at village level, farm-based planning (net planning) (Indo German Program), trained farmers as master trainers are found effective institutional mechanisms. There is an urgent need to identify such effective institutional mechanisms for enhancing the impact and sustainability of watershed programs.
- Convergence of actors and their actions at watershed level to harness the synergies and to maximize the benefits through efficient and sustainable use of natural resources to benefit small and marginal farmers through increased productivity per unit of resource. We have missed out large benefits of watershed programs due to compartmental approach and there is an urgent need to bring in convergence as the benefits are many folds and its win-win for all the stakeholders including number of line departments involved in improving rural livelihoods.
- New institutional mechanisms are also needed at district, state, and national level to converge various watershed programs implemented by number of ministries and development agencies to enhance the impact and efficiency by overcoming duplicity and confusion. In 2005, the National Commission on Farmers adopted a holistic integrated watershed management approach, with focus on rainwater harvesting and improving soil health for sustainable development of drought prone rainfed areas (Government of India, 2005). Recently, Government of India has established National Authority for

Sustainable Development of Rainfed Areas (NASDORA), with the mandate to converge various programmes for integrated development of rainfed agriculture in the country. These are welcome developments, however, it is just a beginning and lot more still need to be done to provide institutional and policy support for development of rainfed areas. Thus, it has become increasingly clear that water management for rainfed agriculture requires a landscape perspective, and involves cross-scale interactions from farm household scale to watershed/catchment scale.

- Knowledge management and sharing is an important aspect in management of NRs for sustainable development. Use of new information and communication technologies (ICTs) to cover the last mile to reach the un-reached is must as existing extension mechanisms are not able to meet the ever growing demand as well as to share the new and vast body of knowledge with large number of small and marginal farmers. Innovative methods and new local community members need to be empowered as extension agents by linking them with knowledge resource centers.
- Align M&E processes as per the objectives and use quantitative and qualitative indicators judiciously for assessing the effectiveness of the programs as well as for doing the mid-course corrections in the strategy. Select suitable impact assessment methods at different levels and use new science (social as well as biophysical) tools to assess the impact collecting quality data selectively rather than collecting voluminous reports out of the mill approach.
- Watersheds to be developed as business model through public private partnership (PPP) using principles of market-led diversification using high-value crops, value chain approach and livelihood approach rather than only soil and water conservation approach. Strengths of rain-fed areas using available water resources efficiently through involvement of private entrepreneurs and value addition can be harnessed by linking small and marginal farmers to markets through PPP business model for watershed management.

Caution: Watersheds are only management units for sustainable development of NRs and agriculture is the backbone of rural development. Watersheds need to be used as planning units for developing area plans by adopting bottom-up approach for sustainable inclusive growth using water management as an entry point activity. Watershed management is just a beginning for holistic area development and improving livelihoods and not an end in itself. The watershed plans can be converged to make district and state plans for development of rain-fed and drought-prone districts to reduce poverty. These plans can be used for implementing various programs such as NREGS, food for work, watersheds, various crop missions (e.g. pulses mission, oil seeds mission etc.), rural knowledge centers etc. It calls for convergence of actors and actions at village, district, state and country level but it should not result in a race for defending operational territories.

India to be a Global Leader in Integrated Watershed Management for Inclusive Growth

With its long experience, investments, development of technical human power and access to new technologies such as remote sensing India has a potential to be a global leader in the area of development of rain-fed agriculture through integrated watershed management. There is an urgent need to make quick adjustments in our approaches by adopting new paradigm for development of rain-fed areas and necessary investments must be made to ensure inclusive growth. It will be a role model not only for India it self but also for all the developing countries in Asia and Africa. These countries are plagued with the same dilemma of achieving inclusive sustainable growth including small and marginal farmers from rain-fed areas, to achieve food security and overcome the looming water scarcity. The challenge faced in the country can be converted in to an opportunity and harnessed through urgent steps and increased investments in development of rain-fed agriculture.

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