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Impact of Watershed Program and Conditions for Success

A Meta-Analysis Approach

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
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Abstract

Development of rain-fed areas in India is one of the prime concerns of the Government as 60 per cent of agriculture is rain-fed. Rain-fed areas are the hot-spots of poverty, water scarcity, malnutrition and are prone to severe land degradation. Watershed development program is considered and adopted as an effective tool to address problems of rain-fed areas in the country.

Under the Comprehensive Assessment of watersheds in India, macro-level evaluation of 636 micro watersheds was done through meta-analysis. The results of meta-analysis revealed that watershed program is providing multiple benefits in terms of augmenting income, generating rural employment (151 person days ha^{-1}), increasing crop yields, increasing cropping intensity (35.5%), reducing run-off (45%) and soil loss (1.1 t ha^{-1} y^{-1}), augmenting groundwater, building social capital and reducing poverty. In terms of economic efficiency, watersheds generated an average benefit-cost ratio (B:C) of 2 and 0.6 per cent of watersheds failed to commensurate with the investment (<1 B:C ratio).

The mean internal rate of return (IRR) from the watersheds investment was 27.4 per cent. Thirty two per cent of watersheds showed a mean BCR of >2 and 27 per cent of watersheds yielded an IRR >30 per cent which showed immense potential to upgrade watershed program in the country. Community watershed can become a growth engine for sustainable development of drylands, however, there is an urgent need to upgrade watersheds by adopting holistic, participatory and business mode approach. Drivers of success of watersheds are documented and discussed in detail.

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Contents

Background

Holistic development of the rain-fed areas is one of the prime concerns of the Government of India. About 60 per cent of total arable land (142 million ha) in the country is rain-fed, characterized by low productivity, low income, low employment with high incidence of poverty and a bulk of fragile and marginal land. These areas witness acute moisture stress during critical stages of crop production, which make agriculture production vulnerable to pre and post production risks. Development of watershed/catchment is one of the most trusted and eco-friendly approaches to manage rainwater and other natural resources, which has paid rich dividends in the rain-fed areas and is capable of addressing many natural, social and environmental intricacies (Samra 1998; Wani et al. 2002, 2003a,b; and Rockstorm et al. 2007). Management of natural resources at catchment/watershed scale produce multiple benefits in terms of increasing food production, improving livelihoods, protecting environment, addressing gender and equity issues along with biodiversity concerns (Sharma 2002; Wani et al. 2003a,b; Joshi et al. 2005; Ahluwalia 2005; and Rockstorm et al. 2007) and is also recommended as the best option to upgrade rain-fed agriculture to meet the growing food demand globally (Rockstorm et al. 2007).

Watershed development program is, therefore, considered as an effective tool for addressing many of these problems and recognized as a potential engine for agricultural growth and development in fragile and marginal rain-fed areas (Joshi et al. 2005; Ahluwalia 2005; and Wani et al. 2006). The Government of India has accorded high priority to the holistic and sustainable development of rain-fed areas through the integrated watershed development program since the 7th Five Year Plan (1985-90). A number of watershed programs have been specifically launched in the rain-fed areas with the sole objective to improve the livelihood of poor rural households in a sustainable manner.

A majority of watershed development projects in the country are being sponsored and implemented by the Government of India with the help of various state departments, non-governmental organizations (NGOs), self-help groups (SHGs), etc. Drought-Prone Area Program (DPAP), Desert Development Program (DDP), National Watershed Development Project for Rain-fed Area (NWDPRA), Watershed Development in Shifting Cultivation Areas (WDSCA) and Integrated Watershed Development Project (IWDP) are some of the important development programs that plan, fund and implement watershed development projects under the aegis of Ministries of Rural Development; Agriculture; and Environment & Forestry, Government of India. A total sum of Rs 286 billion has been invested on various watershed development projects since inception (mid 1980s) of watershed development program in the country. Some international organizations also sponsor and implement watershed projects but a significant proportion (about 70%) of the investment in watershed development program is being made by the Government of India under these five major programs.

During last three decades, watershed program has gone through a sea change. Numerous modifications are made in the watershed program based on experiences and learnings from the implementation of different generation watershed programs. The first generation watershed projects were mainly designed for soil conservation whereas the second generation watershed projects aimed at conserving degraded land area or more specifically soils (Joshi et al. 2005; and Ahluwalia 2005). The integrated watershed development approach was adopted during mid 1980s and in early 1990s, third generation watershed projects were introduced that emphasized on participatory approach. The new approach focuses on raising crop productivity and full livelihood improvement programs (Wani et al. 2006). These newly developed approaches like livelihood improvement and productivity enhancement are superior to the earlier approaches but still a large number of watershed projects are to be graduated as holistic/integrated programs.

During evolution of watershed development program (from compartmental to holistic) the processes and institutional arrangements also evolved. The Government of India revised the watershed guidelines and emphasized more on collective action and community participation, including participation of primary stakeholders through community-based organizations (CBOs), non-governmental organizations (NGOs) and *panchayati raj* institutions (GoI 1994, 2008; Hanumantha Rao et al. 2000; DOLR 2003; and GoI. 2008). The Government encouraged 'Public Private Partnership (PPP)' in the area of integrated watershed development and evidence indicates that PPP is emerging in this area (Wani et al. 2007a). Evidences show that watershed development programs have yielded considerable benefits in terms of equity, sustainability and efficiency (Kerr et al. 2002; Rao 2000; Farrington and Lobo 1997; Joshi et al. 2004, 2005; and Sreedevi et al. 2006).

This paper attempts to assess the benefits and conditions for success of watershed program in India. It also identifies conditions necessary for larger participation of the stakeholders in the watershed activities, which is a prerequisite for successful implementation of the watershed projects. More specifically, the objectives of the study are: (i) to document the benefits of watershed program in different regions of the country, (ii) identify conditions for successful implementation of watershed projects and assess the role of people's participation in the success of the watershed program; and (iii) to document conditions for greater people's participation in order to identify some of the drivers (bio-physical, social and economical) for successful watersheds.

Approach

This study is a part of the Comprehensive Assessment of Watershed Programs' impacts in India and it is a sequel of the earlier study "Meta-Analysis to Assess Impact of Watershed Program and People's Participation" by Joshi et al. 2005. The meta-analysis is a powerful methodology that collates research findings from previous studies, and distils them for broader conclusions. It is, therefore, termed as the "analysis of analyses". Meta-analysis can be helpful for policymakers, who may be confronted by mountains of conflicting conclusions (Alston et al. 2000). It has been diligently applied in a number of studies by a number of researchers. Earlier, the meta-analysis was applied to assess the returns to investment in education (Lockheed et al. 1980; and Phillips 1994) and understand the implications of certain medical treatments on offspring (Mann 1996). Alston et al. (2000) applied this method to measure the returns to research investment at the global level. It was meticulously applied to evaluate the impact of watershed program in India by Joshi et al. (2004, 2005). The study included 311 micro-level studies for evaluating the watershed program and people's participation in the country.

The present study attempts to evaluate the impact of watershed program with the help of 636 micro-level studies including the 311 studies included in the previous study to get more authentic and realistic results. These micro-level studies have been critically reviewed and analysed for upscaling the conclusions to stipulate the macro-level picture of the watershed program as well as impact of people's participation on the performance of watersheds.

Management of watershed is a unique example of collective action (Chopra et al. 1990; and Joshi et al. 2004, 2005). People's active participation plays a decisive role in the performance and efficacy of watershed program. In the present study, performance of watersheds under different levels of people's participation has been examined. The people's participation has been documented as high, medium and low with respect to various activities at different stages of the watershed projects. Intensity of people's participation was related with the multiple benefits derived from the watershed projects. This importance of institutionalizing collective action in success of watersheds was highlighted.

Watershed projects in India are being implemented with objectives of improving production efficiency, equity and sustainability in the rain-fed areas. Sustainability of natural resources is, of course, a vital issue for the rain-fed areas. To document benefits of watershed program on sustainability of natural resources, a few proxy indicators were carefully chosen and analyzed. Five important indicators like (i) increased water storage capacity, (ii) increased irrigated area, (iii) increased cropping intensity, (iv) reduced run-off, which enhanced groundwater recharge, and (v) reduced soil loss, have been identified to demonstrate the sustainability benefits.

Ordinary least square (OLS) approach was employed to estimate the regression equation with benefit-cost ratio (BCR) of watershed program as dependent variable and geographical location of watershed (L), size of watershed (S), focus of watershed (F), rainfall in the watershed area (R), implementing agency of the watershed (I), people's participation (P), time gap between project implementation and evaluation (T), various activities performed in the watershed area (A) and the type of soil (L) in the watershed area as explanatory variables. Following model was estimated:

$$BCR = f\,(L, S, F, R, I, P, T, A, L)$$

A linear equation was estimated of following form:

$$BCR = b_0 + \times\, b + \varepsilon$$

Where, BCR is the benefit-cost ratio, b_0 is the intercept, $\times$ is the matrix of above mentioned explanatory variables included in the model, b is the vector of slope coefficients and ε is the error term.

All the explanatory variables in the study are dichotomous dummy variable, coded as equal to one if some characteristics are present and equal to zero if they are not. The dummy variable for one of the categories, the default category, is omitted from the regression in order to avoid the dummy variable trap, which occurs when too many dummy variables are included (Alston et al. 2000). Table 1 gives the specification of the variables included for the analysis.

Table 1. Summary of explanatory variables

Characteristics	Detail of the explanatory variable
Geographical location	Gujarat Plain & Hill region*
	Western Plateau & Hills zone
	Trans-Gangetic Plains
	Southern zone
	Western Himalyan zone
	Eastern Himalayan zone
	Central Plateau and Hills zone
Rainfall	Less than 500 mm*
	501-700 mm
	701-900 mm
	901-1000 mm
	More than 1000 mm
Size of watershed	Micro watershed*
	Macro watershed
Focus of watershed	Rehabilitation of degraded lands*
	Soil & water conservation
	Both

continued

continued.

Characteristics	Detail of the explanatory variable
Implementing agency	Central government
	State government
	Central & state governments
	Other agency in collaboration with Central & state governments
	Other organizations*
People's participation	Low participation*
	Medium participation
	High participation
Income stratum of target region	Low-income states*
	Medium-income states
	High-income states
Activities performed	Only agriculture
	Agriculture, livestock and forestry
	Agriculture and livestock
	Agriculture and forestry
Soil types in the watershed areas	Clay soils*
	Sandy loam soil
	Black cotton soils
	Red soils

* The variables were in default category
** People's participation was directly drawn from the studies

Data

A number of studies have evaluated the performance of various watershed projects in India. About 20000 micro watershed projects, distributed across the country, are being implemented under various watershed development projects. In addition, there are several macro watershed projects in the country. Obviously, these watershed studies cover the entire rain-fed regions of the country and represent a wide range of environment according to their agroecological location, size, type, source of funding, rainfall, regional prosperity or backwardness, etc. The present study prepared an exhaustive bibliography on studies that evaluated watershed program of which only 636 case studies could be scanned. These studies were published either as research articles or research reports. There are many more studies, which could not be traced. Complete bibliography is available with the authors.

Results and Discussions

Benefits of Watershed Program

Watershed projects, which have been specifically launched in the rain-fed areas with the sole objective to improve the livelihood of poor rural households in a sustainable manner, have paid rich dividends. It emanates that watershed projects have been successful in raising income levels and generating employment opportunities and augmenting natural resources, specifically soil and water in the rain-fed areas (Joshi et al. 2003, 2005; and Wani et al. 2005). By the adoption of different soil and water conservation measures and trapping of surface run-off water, watersheds have emerged as the growth engines in the fragile and rain-fed areas.

Table 2. Summary of benefits from the sample watersheds

	Particulars	Unit	No. of studies	Mean	Mode	Median	Minimum	Maximum	t-value
Efficiency	B:C ratio	Ratio	311	2.00	1.70	1.70	0.80	7.30	35.09
	IRR	Per cent	162	27.40	25.90	25.00	2.00	102.70	21.75
Equity	Employment	Person days ha^{-1} y^{-1}	99	154.50	286.70	56.50	5.00	900.00	8.13
Sustainability	Increase in irrigated area	Per cent	93	51.50	34.00	32.40	1.23	204.00	10.94
	Increase incropping intensity	Per cent	339	35.50	5.00	21.00	3.00	283.00	14.96
	Runoff reduced	Per cent	83	45.70	43.30	42.50	0.34	96.00	9.36
	Soil loss saved	t ha^{-1} y^{-1}	72	1.10	0.90	1.00	0.10	2.00	47.21

Summary of multiple benefits derived from watersheds, as indicated in numerous studies, is shown in Table 2. It is obvious that watershed projects in India have yielded multiple exemplary benefits. On the part of efficiency, watershed program performed well with a mean benefit-cost ratio of 2, which indicates that investment in watershed program is economically viable and substantially beneficial. However, the performance of watershed in accordance with their BCR was quite varied. About 32 per cent watersheds generated a mean BCR above 2, which is quite modest (Fig. 1). Merely 0.6 per cent watersheds failed to commensurate with cost of the project. The mean internal rate of return of 27.4 per cent on watershed investment shows marginal efficiency of the projects, however, seems to be significantly high and ascertains that investment in watershed program is comparable with any successful government programs. It is interesting to note that about 27 per cent watersheds yielded an IRR above 30 per cent. The watersheds with IRR <10 per cent were only 1.9 per cent (Fig. 2). These results reconfirm that watershed projects are able to meet their initial costs and generate substantial economic benefits and justify the investment in watershed program as income levels were raised within the target domains.

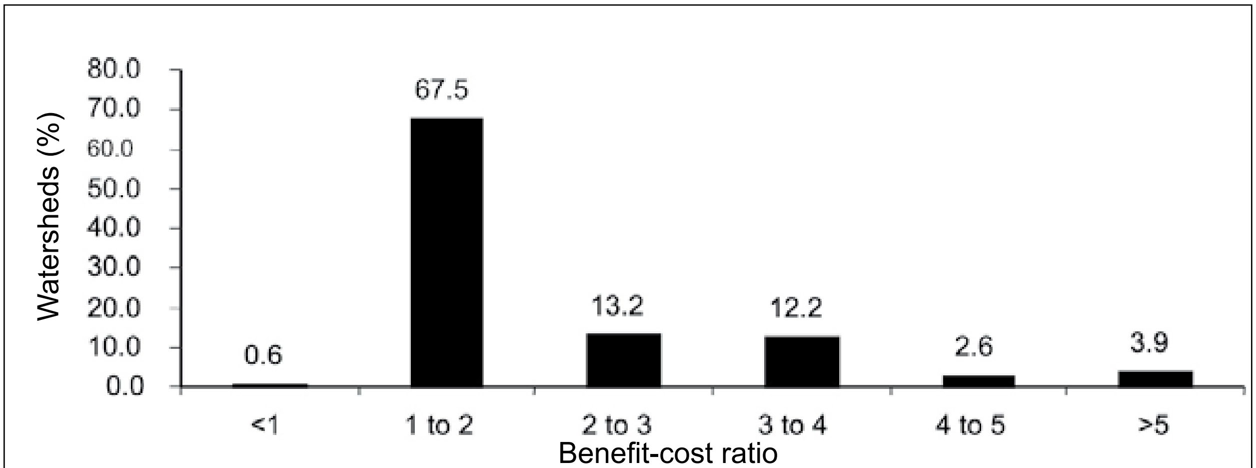

Figure 1. Distribution (%) of watersheds according to benefit-cost ratio (BCR).

Another important purpose of the watershed program was to generate employment opportunities and through that alleviate rural poverty and reduce disparities among rural households. The mean additional annual employment generation in the watershed area on various activities and operations was about 154 person days. It was as high as 900 person days per ha in those watersheds, which included multiple activities. Generating employment opportunities for the rural poor means raising their purchasing power and inturn alleviating rural poverty. Based on these observations, the watershed investment may be characterized as a poverty alleviation program in the fragile areas.

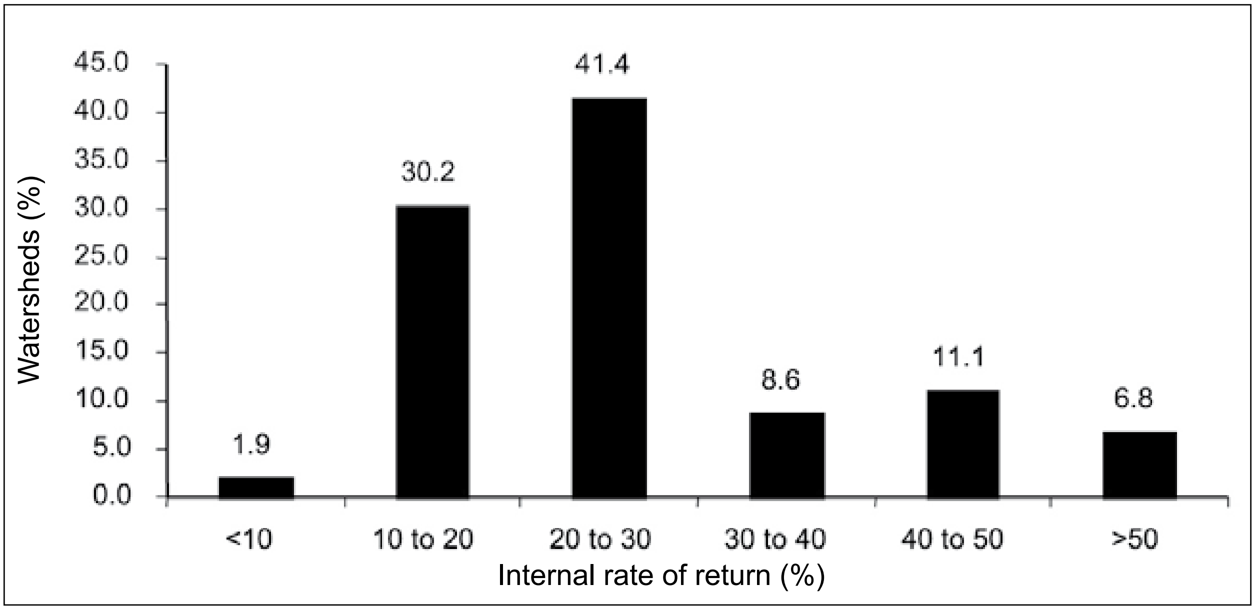

Figure 2. Distribution (%) of watersheds according to internal rate of return.

Watershed projects have been specifically launched in the rain-fed areas with the sole objective to improve the livelihood of poor rural households, who encounter disproportionate uncertainties in agriculture (Joshi et al. 2005). Their income levels are meager and uncertain. Their plight is further compounded by acute degradation of soil and water resources. The Government of India aggressively intensified watershed program in fragile and high-risk ecosystems, where the farm incomes had markedly descended due to excessive soil erosion and moisture stress. It was viewed that the watershed program would augment farm income, raise agricultural production and conserve soil and water resources in rain-fed areas by providing appropriate technical and financial support.

The watershed projects are largely aimed to conserve soil and water to raise farm productivity. The available evidences revealed that both these objectives were accomplished in the watershed areas. Soil loss of about 1.1 t ha^{-1} y^{-1} was saved due to interventions in the watershed framework. Conserving soil means raising farm productivity and transferring good soils to the next generation. On water conservation, it was noted that on an average about 38 ha m additional water storage capacity was created in a 500 ha watershed as a result of watershed program. Augmenting water storage capacity contributed in (i) reducing rate of run-off and (ii) increasing groundwater recharge. These have direct impact in expanding the irrigated area and increasing cropping intensity. On an average, the irrigated area increased by about 52 per cent, while the cropping intensity increased by 35.5 per cent. Such an impressive increase in the cropping intensity was not realized in many surface irrigated areas in the country. These benefits confirm that the watershed program performed as a viable strategy to overcome several externalities arising due to soil and water degradation and therefore, it can be reiterated that watershed could be a safe and effective strategy for augmentation of water resources in the rain-fed areas.

Rain-fed areas are confronted with intrinsic problem of degradation of land and water. Soil erosion, which is often induced by high wind velocity and intense precipitation, not only degrades the land masses but also leads to the problem of sedimentation and siltation of water-bodies/reservoirs and reduces their storage capacity. Consequently, a sizable volume of water that could be stored in these water-bodies/reservoirs get lost and leads to floods in low-lying rain-fed areas. Another water related problem that adds to the agony of rain-fed areas is loss of water due to heavy run-off of surface water. In general, rain-fed areas experience many contrasting agro-climatic conditions. A vast portion of rain-fed areas face arid and semi-arid type situations and receive scanty rains for nearly 50-55 days during monsoons, which is grossly insufficient to meet the year-round requirements of water. In contrary, there are regions (entire eastern region) that experience humid and per humid climate with a long spell of intense and profuse rains. Technological interventions through soil and water conservation can greatly overcome these eventualities.

The above evidences suggest that the watershed program successfully met initial three principal objectives of raising income, generating employment and conserving soil and water resources. These benefits have far reaching implications for rural masses in the rain-fed environment. The results of meta-analysis further showed that the benefits vary depending upon the location, size, type, rainfall, implementing agency and people's participation, among others.

Results of Meta-Analysis

The results of meta-analysis are presented in Table 3. The coefficient of multiple determination (R^2) shows that the variables included in the model were able to explain more than 56% variation in the BCR. The positive value of intercept also signifies a positive impact of watershed program on augmentation of income. However, efficiency of watersheds is determined by a number of factors. Joshi et al. (2005) found that geographical location, rainfall pattern, focus of watershed program, implementing agency, status of target population and people's participation are some of the critical factors that play a deterministic role in the performance and efficiency of watersheds. Consideration of time gap between implementation and evaluation of the program is also important. However, the effect of time gap between implementation and evaluation could not be captured, as the variable was statistically non-significant. However, a positive sign of the variable indicated that latter the evaluation, larger the benefit. Therefore, the performance of the watershed program should not be judged immediately after implementation. The impact of other variables on the watershed efficiency is discussed below:

(a) Geographical location of the watershed

The present study groups all watersheds into seven agro-climatic zones viz. (i) Trans-Gangetic Plain zone, (ii) Western Himalayan zone, (iii) Western Plateau & Hill zone, (iv) Gujarat Plains & Hill zone, (v) Southern zone (vi) Central Plateau and Hill zone and (vii) North Eastern zone. These zones have heterogeneous agroclimatic conditions, divergent potentials, unique opportunities and very distinct socio-economic characteristics. The analysis indicated that economic benefits over investment on watershed projects were positive and significant in all the zones, which establishes the efficacy and utility of watershed program for enhancing the income in the rain-fed areas across the country. However, the results indicated that economic benefits on initial investment were the highest in Western Himalayan regions, Southern zone, Trans-Gangetic Plains, Western Plateau and Hill zone, Eastern Himalayan zone and Gujarat Plain & Hill zone. The Western Himalayan regions attained 12 per cent higher BCR than the base level of Gujarat Plain & Hill zone. The positive and significant coefficients obtained for all the zones have important implications for investment priorities in watershed program. To maximize returns to investment on watershed projects with current available technologies, highest priority may be accorded to the Western Himalayan zones, followed by Southern zone, Trans-Gangetic zone, Western Plateau and Hill zone, Central Plateau and Hill zone and Eastern Himalayan zone. In earlier study, efficiency of watersheds in the eastern Himalayan zone and Central Plateau zone could not be captured due to non-availability of sufficient studies. However, most important finding of this study is that for different agroecoregions (geographical regions with varying climate and socioeconomic situations) different watershed management interventions are needed to maximize the benefits. These results are in conformity with the earlier findings reported by Joshi et al. 2005.

(b) Rainfall

The results of present meta-analysis also confirm that the rainfall in the region largely influenced performance of watersheds. This study classified rainfall into five zones: (i) less than 500 mm, (ii) 501-700 mm, (iii) 701-900 mm, (iv) 901-1000 mm and (v) more than 1001 mm, to capture the effect of rainfall on the efficiency of watersheds. The results indicate that the performance of watershed was best in the rainfall ranging between 901 and1000 mm, followed by 701-900 mm. It was noted that the BCR was 30 per cent higher in the rainfall ranging between 901 and1000 mm in comparison to a base level of less than 500 mm. Rainfall lower than 700 mm and higher than 1001 mm were poor performers due to scanty and excessive water availability, which need different soil and water management interventions. The current approach "one size fits all" adopted for watershed management is not benefiting lower (<700 mm) and higher (>1000 mm) rainfall regions. The results clearly infer that higher investment priority should be accorded to the watershed program in the areas where rainfall is ranging between 700 and 1000 mm with the available technologies. The other rainfall (lower and higher) regions call for increased R&D allocation in watershed program to design innovative strategies to enhance the efficiency of watershed projects. This need must be addressed urgently as results of rainfall as well as geographical regions have shown remarkable benefits due to watershed program. However, with the current available technologies, the issues of soil and water conservation must be addressed in all rain-fed areas in the country. New strategic research findings emerging for low (<700 mm) and high (>1000 mm) rainfall regions can be used for refining the interventions.

Table 3. Determinants of the performance of watershed: regression coefficients on meta-analysis

Variable	Default category	Variable name	Estimated coefficients	t-ratio
		Intercept	0.0721	0.1097
Geographical location	Gujarat Plains & Hills	Western Himalayan zone	0.7525	2.5553**
	All other observations	Southern zone	0.5950	2.3521**
	All other observations	Trans-Gangetic Plains	0.4345	1.8584*
	All other observations	Western Plateau & Hills zone	0.4215	1.4052@
	All other observations	Central Plateau and Hills zone	0.3514	1.1743
	All other observations	Eastern zone	0.3408	1.0536
Rainfall	Rainfall < 500 mm	Rainfall between 901 to 1100 mm	0.9252	5.1494***
	All other observations	Rainfall between 701 to 900 mm	0.3891	2.5887**
	All other observations	Rainfall between 501 to 700 mm	0.1024	0.6494
		Rainfall >1100 mm	-0.0010	-0.0051
Size of watershed	Micro-watersheds	Macro-watersheds	0.2282	2.4297**
Focus of watershed	Land degradation	Degraded land with soil and water conservation	0.1195	1.4414@
	All other observations	Soil & water conservation	-0.0938	-1.0359
Implementing agency	Other implementing agencies	Implemented by centre and state	0.8376	4.1621***
	All other observations	Implemented by the centre only	0.2051	1.4239
	All other observations	Implemented by centre, states and others	0.0639	0.3131

Continued

Continued.

Variable	Default category	Variable name	Estimated coefficients	t-ratio
People's participation	Low people's participation	High people's participation	0.7777	5.9220***
	All other observations	Medium people's participation	0.1510	1.3168@
Per capita income in the region	Location in low-income group states	Location in medium-income group states	0.0906	0.5743
	All other observations	Location in high-income group states	0.0733	0.4289
Activities performed under watershed	Only Agriculture	Agriculture and livestock	0.3574	2.6192***
	All other observations	Agriculture and forestry	-0.2817	-1.4428@
	All other observations	Agriculture, livestock and forestry	-0.1743	-1.1481
Soil type	Clay soils	Red soils	0.3688	1.8918*
	All other observations	Alluvial soils	0.0744	0.4308
	All other observations	Black cotton soils	-0.0720	-0.3782
	All other observations	Sandy loam soils	-0.0462	-0.2673
R2				0.5629
Number of observations				636

@, *, **, and *** are significant at 20, 10, 5 and 1 per cent of probabilities, respectively

(c) Size of watershed

Size of watersheds does play a critical role. Small size (<250 ha) watersheds were less effective than large size (>1200 ha) watersheds, based on the economic efficiency parameters (Joshi et al. 2005). Depending upon the size of the watersheds, these are broadly divided into micro and macro watersheds (500-1000 ha and more than 1000 ha respectively). The results show superiority of macro watersheds over micro watersheds with respect to the returns to investment. The performance of macro watersheds was 34 per cent better than the micro watersheds. This is contrary to general belief that micro watersheds perform better. It may be due to economies of scale and more externalities through diverse activities in large watersheds. This brings up the need to reconsider the standard 500 ha watersheds and it is proposed that to address the issues of suitable watershed size and social problems associated with administrative institutions (villages) cluster of micro-watersheds of 500-1000 ha need to be developed simultaneously instead of developing micro watersheds in scattered manner (Wani et al. 2006).

(d) Focus of watershed

The watersheds mainly focused in three broad areas: (i) rehabilitation of degraded lands, (ii) soil and water conservation and (iii) both rehabilitation of degraded lands as well as soil and water conservation. Results indicate that investment to rehabilitate degraded lands along with soil and water conservation were more rewarding than only rehabilitation or focusing on soil and water conservation.

(e) Implementing agency

Watershed program involve several organizations in implementing watershed projects. The implementing agencies play a critical role in the watershed program and often influence the performance of watersheds mainly due to their strengths and weaknesses for implementation as well as technological and social interventions. The results indicate that the watershed projects jointly planned and implemented by the central and state agencies gave higher returns. The returns from such watersheds were 34 per cent higher than the watersheds controlled by other agencies. Since the agriculture is a state subject, support flowing from the Central Government has a synergetic effect in the performance of watersheds. The independent programs of the Central Government obtained least returns to investment. It is mainly due to lack of effective monitoring and coordination. This implies that the Central Government should play a catalytic role with the state governments in implementing and managing the watershed program.

(f) Target population

One of the key elements in the watershed program is target population. Target population plays a key role in executing the watershed program. The study attempts to estimate the effect of target population on the performance of watershed. For this, the watersheds were grouped according to the average income level of the targeted population. Three groups were formed: (i) high-income group states, (ii) medium-income states and (iii) low-income states. Though the estimated regression coefficients were statistically insignificant, these indicate that the returns from watershed program were comparatively higher in medium-and low-income states. States having high income were not showing attractive returns for investment on watershed program. The BCR of watersheds in low, medium and high income states were 2.26 and 2.1 and 1.78, respectively. In low-income states, beneficiaries offer their labor to supplement the investment made in various activities. Such an interfacing of public-private partnership has a multiplier effect on returns to investment. These results have strong bearing on investment priorities for watershed program. The medium-income groups of states have comparative advantage because beneficiaries supplement private investment to the public resources allocated for watershed activities. States falling in higher income range should receive least priority for watershed development program. Medium-and low-income states should be accorded higher investment priority for watershed program as communities from these group of states come together for meeting their need for improving livelihoods. Earlier studies have also demonstrated that in a watershed, small and medium size farmers participated better for collective action if tangible benefits were flowing to them than large size farmers (Sreedevi et al. 2004).

(g) Activities performed

Benefits always depend on the nature of activities performed in the watersheds. Watersheds often include different activities pertaining to agriculture, livestock, forestry, etc., as the livelihood options. It is interesting to note that the contribution through integrated agriculture and livestock activities was significantly better than that of agriculture alone (Table 2). Perhaps the complementarity between these two enterprises helped the beneficiaries in diversifying their activities more favourably. It is plausible that negative coefficient that encompassed agriculture and forestry simultaneously was due to the effect of practicing *jhoom* (shifting) cultivation in most of the hilly tracts of eastern region. Shifting cultivation affects the forest as well as the watersheds in the area. Besides, most of the forests fall in the areas where rainfall is above 1100 mm and the best regions that yield higher benefit-cost ratios fall within the rainfall range of 701 to 1100 mm with the current technologies adopted.

(h) Soil type

Soil types, structure and other properties are critical in determining the performance of watersheds. The best way to capture the effect of soil should be to include their intrinsic physical and chemical properties. In the absence of such information, a broad classification of soil type viz. clay, sandy loam, black cotton, alluvium and red soils was fitted in the model. The results indicated that under present circumstances the most ideal soils for the watersheds were alluvial and red soils. Since the same soil behave differently in different rainfall zones, this aspect needs to be considered judiciously and further detail investigations are recommended.

(i) People's participation

Watershed development is a community approach. Active people's participation is, therefore, highly critical in the success of the watershed program (Kerr et al. 2002, Sreedevi et al. 2004; and Joshi et al. 2005). The results of this study showed that the benefits were the highest from the watersheds where people's participation was high (Table 4). More about people's participation is discussed in the following section.

People's Participation and Benefits from Watersheds

People's participation in planning, developing and executing the watershed activities is indispensable (Wani et al. 2003; and Joshi et al. 2005). Active and voluntary participation of all stakeholders guarantees the successful implementation of watershed program. Therefore, watershed program always call for community participation and collective action. It is necessary because individual choices have collective consequences in the watershed framework as lot of externalities are involved. Action of one group of farmers in one location affects adversely or favorably other group of farmers in different location (off-site impacts). Often the different groups and locations have conflicting objectives with respect to their investment priorities and enterprise choices. These need to be converted into opportunities. The action of all the farmers in the watershed should converge in such a way that the positive externalities are maximized, and negative ones are minimized. To achieve this, the community or stakeholders have to develop their own rules, which resolve their conflicting objectives. It is believed and observed that better organized and effective people's participation would yield higher benefits. A summary of results of people's participation and benefits from watersheds is given in Table 4. The available evidences confirm that there existed a positive relationship between pe ople's participation and benefits from watershed program. The benefit-cost ratio was greater (2.63) in watersheds where people's participation was higher in comparison to the watersheds with lower participation (1.42). The other impact indicators were also far ahead in watersheds having greater people's participation.

It is interesting to note that benefits from watershed program were conspicuously more in the low-income regions as compared to the high-income regions (Table 5). The benefit-cost ratio was 2.25 in low-income regions as compared to 1.75 in high-income regions. The corresponding figures for annual employment generation were 164 and 91 person-days per ha. The low-income regions call for such investments to enhance income levels of rural poor. This suggests that watershed program should receive higher priority by the government in medium and low-income regions. Such investments will not only raise income and employment opportunities in the backward regions but also contribute in conserving soil and water resources. Fan and Hazell (1997) demonstrated that the returns to investment in inputs as well as research at the margin were higher for dryland areas than for irrigated areas. Farmers in these regions could not invest due to low income and limited opportunities. Government intervention through watershed program would benefit the rural poor in the low-income regions. Ironically, the participation of beneficiaries in planning and execution of the watershed in the low-income regions was observed to be less than the higher income regions. This implies that poor rural households were less involved in planning and decision making processes in the watersheds. However, the rural poor in the low-income regions were offering their labour in various activities launched in the watershed. In fact, for the smaller farmers and the landless labourers in the watershed, there is often little prospect for development beyond the employment generated from the watershed works over the project period (Farrington et al. 1999). Perhaps greater involvement of the beneficiaries would yield higher dividends from the investment in watershed related activities.

Table 4. Summary of benefits from the sample watersheds according to people's participation					
Indicator	Particulars	Unit	People's participation		
			High	Medium	Low
Efficiency	B: C ratio	Ratio	2.63	1.60	1.42
			(16.01)	(29.72)	(16.36)
	IRR	Per cent	38.28	22.26	17.30
			(10.21)	(4.74)	(8.21)
Equity	Employment	Person days ha^{-1} y^{-1}	165.17	118.73	105.42
			(5.29)	(4.31)	(9.97)
Sustainability	Increase in irrigated area	Per cent	77.43	56.17	29.43
			(8.23)	(8.07)	(10.32)
	Increase in cropping intensity	Per cent	44.60	24.96	32.03
			(9.37)	(10.21)	(14.21)
	Runoff reduced	Per cent	43.24	40.41	69.00
			(6.03)	(4.22)	(7.19)
	Soil loss reduced	t ha^{-1} y^{-1}	1.18	1.10	0.87
			(43.21)	(18.21)	(22.33)

Figures in parentheses indicate t-values

Above evidences reveal that people's participation was the key determinant in the success of the watershed development program. People's participation is not only critical during the implementation phase of watersheds but beyond the actual investment phase. In the absence of active involvement of the stakeholders, the watershed program cannot be sustained.

Table 5. Summary of benefits from the sample watersheds according to income status of the region					
Indicator	Particulars	Unit	Per capita income of the region*		
			High*	Medium**	Low**
Efficiency	B:C ratio	Ratio	1.75	1.96	2.25
			(15.34)	(28.21)	(9.36)
	IRR	Per cent	24.55	27.90	30.64
			(7.23)	(6.89)	(6.02)
Equity	Employment	Person days ha^{-1} y^{-1}	91.05	159.70	164.30
			(7.27)	(9.16)	(6.76)
Sustainability	Increase in irrigated area	Per cent	48.48	45.83	76.02
			(12.50)	(8.09)	(6.71)
	Increase in cropping intensity	Per cent	31.40	34.09	43.75
			(10.82)	(14.41)	(10.27)
	Runoff reduced	Per cent	43.21	43.27	49.32
			(9.32)	(6.81)	(5.28)
	Soil loss reduced	t ha^{-1} y^{-1}	1.18	1.10	0.87
			(36.23)	(41.11)	(12.26)

Figures in parentheses indicate t-values. *, **, and *** include the states having per capita AgGDP greater than Rs. 4000, between Rs. 2000 to Rs. 4000, and below Rs. 2000 per annum, as in Joshi et al. 2005.

Drivers of Collective Action and Success

People's Participation

As highlighted above, active people's participation is a pre-requisite for the success of watershed development programs. Involvement of local stake-holders in planning, development and execution of the watershed activities is crucial. Watershed is a community development approach and hence, it calls for community participation and collective action (Sreedevi et al. 2007). It is believed that better organized and effective people's participation would yield higher benefits and community participation does not happen automatically. However, it needs to be nurtured through a process of trust building, harnessing synergies between the project of objectives and needs of communities and most importantly, ensuring tangible economic benefits equitably for the community (Wani et al. 2003a, 2007).

The first generation watershed projects in the country were supply-driven. The government officials used to identify locations and decide various activities for implementation of watershed projects, which were funded by Central and state governments. This top-down approach did not match the needs of stakeholders in the watershed. In the absence of people's participation, the potential benefits of the watershed program could not be realized. To overcome this problem, the concept of Participatory Integrated Development of Watershed (PIDOW) was initiated in 1980s. However, only a partial success could be achieved and some radical steps were taken to involve the local stakeholders/people in planning, formulation and implementation of watershed program in the country. Overtime, people's institutions, like *zilla parishad*, SHGs, and watershed implementing committees were gradually involved into the project management systems. With more funds allocated for watershed development, several non-governmental organizations (NGOs) aggressively participated in implementing this program, and demonstrated the importance of people's involvement in the success of the watersheds. Most of the arrangements were informal and vary across watersheds and implementing agencies. To make it formal, the 1994 watershed guidelines specifically included people's involvement as one of the conditions in the watershed development. It is more important to see that how people's participation comes forward voluntarily. Only voluntary participation (not forced one) would sustain the watershed program. It is, therefore, important to identify conditions under which the watershed beneficiaries would involve themselves in implementation during the project tenure and maintenance of structures after the project is formally over.

Bottom-up Approach

The watershed that involves activities, which are able to cater the specific needs of local people, certainly attracts larger level of people's participation. It is therefore, essential to ensure that once the watershed is identified, the needs of the stakeholders must be assessed together by the implementing agency and the stakeholders. Since a watershed has diverse groups of beneficiaries, all genuine and valid needs of each and every group should be appropriately addressed in the watershed. There are reports, which state that in many watersheds only influential and large farmers were involved and the small and marginal farmers were not involved. Besides, there were evidences that most of the watershed programs were not sensitive to the needs of women and landless laborers. Most often, women and landless laborers were silently left out of watershed related decision-making processes (Meinzen-Dick et al. 2004; Sreedevi and Wani 2007). Efforts to integrate small and marginal farmers, women and landless laborers into the process require conscious efforts right from the beginning.

Tangible Economic Benefits to Individuals

In spite of bottom-up participatory approach for planning and implementation of watershed development, community participation was not forthcoming in most of the watershed programs. Main reason for low or contractual mode of participation was large number of small and marginal farmers were not getting tangible economic benefits as productivity enhancement initiatives were missing to a large extent. Improved groundwater availability benefited few well-to-do farmers who could invest and extract the groundwater. Such well to do farmers had no time to participate. On the other hand, a large number of small and marginal farmers who had time to participate were not getting any tangible benefit. One of the important drivers of success in a consortium approach was tangible economic benefits to large number of farmers through increased crop productivity on individual farms through *in-situ* rainwater conservation and its efficient use with improved crops/cultivars, nutrient, water and pest management options (Wani et al. 2002; and Sreedevi et al. 2004). Through this approach more number of farmers started participating in watershed development program as they derived tangible economic benefits from the productivity enhancement activities from the first season itself.

Knowledge-Based Entry Point Activity

In most watershed projects, entry point activity (EPA) as identified by the community is undertaken under the project to build rapport with the community activities such as construction of meeting room, school, class room, bore well pump, drinking water tank, etc. However, it was observed that such cash-based EPA passed a wrong signal to the community that all activities can be undertaken through project funds and they need not contribute their share. Such a subsidy dependency approach never got community ownership, resulting in neglect of the resources invested. ICRISAT-led consortium has developed knowledge-based EPA to build rapport with the community, using soil analysis or introduction of disease-tolerant cultivars, etc., which provided free knowledge but farmers had to pay for materials (Wani et al. 2006; and Dixit et al. 2007).

The knowledge-based EPA ensured that demand-driven technologies were evaluated by the farmers rather than supply-driven provided by the project staff, which resulted in cooperative and consultative mode of community participation as against the contractual mode in case of direct cash-based EPA. Knowledge-based EPA was one of the important drivers of collective action in the community watersheds, developed through consortium approach for technical backstopping (Sreedevi et al. 2004; and Shiferaw et al. 2006).

Agroecoregion Specific Technologies

Meta analysis of watershed case studies revealed that the current technologies and interventions showed better impact in terms of B:C ratio and IRR in the 700-1100 mm rainfall agroecoregion and not in <700 mm and >1100 mm rainfall zones (Joshi et al. 2005). This study highlights the need to identify and adopt specific watershed development technologies for <700 and >1100 mm rainfall zones (Wani et al. 2007b). Current practice of allocating greater proportion of resources for RWH structures that too of big size needs close scrutiny. Wani et al. (2003a) have demonstrated the benefits of low-cost water harvesting structures throughout the toposequence that benefited more number of farmers than construction of masonary check dams only at lower reaches in a watershed.

Targeted Activities for Women and Vulnerable Groups

In order to enlist active participation of women and vulnerable groups targeted activities benefiting these groups economically are suggested by Sreedevi and Wani (2007). Based on specific case studies, these authors reported that more income-generating commercial scale activities for women resulted in better participation as well as improved decision-making power and social status in their families and societies. Mere presence of women members on the watershed committee had no real impact as they were not effective in decision-making process in the committee (Seeley et al. 2000). Harnessing gender power by balancing activities for men and women, farmers and landless people was found effective to enhance the impact of community watershed programs (Sreedevi and Wani 2007; Sreedevi et al. 2007).

Watershed Institutions/Self-Help Groups

The next stage of people's participation is even more critical. It connotes the phase of implementation, while various interventions are being made. This stage requires regular monitoring because success of a watershed program depends upon how effectively the stakeholders are monitoring the progress. Evidences show that some successful watersheds constituted informal groups for regular monitoring of watershed activities. However, there were considerable differences between these groups. For instance, some watersheds constituted formal users' associations. The users' groups (UGs) were found active during the implementation phase only. They had to meet regularly, once the construction activity was completed unlike the SHGs, which met regularly for financial transactions. In a recent study of institutional arrangements in different watershed programs. Sreedevi et al. (2007) observed that area groups (AGs) approach adopted in Sujala Watershed program in Karnataka was found far superior over UGs approach in terms of functional efficiency, sustainability and regularity as the membership was voluntary for undertaking project activities in their area and had a role in decision-making process in the watershed.

In the same study, membership criteria and actor linkages in the APRLP, Sujala, Indo-German Watershed Development Program (IGWDP) and Hariyali guidelines-based watershed program were studied. It was concluded that representation in watershed committee for women SHGs in Sujala and APRLP programs were effective for women's participation and decision-making where as community was not effective/functional in Hariyali program watersheds. The *gram panchayat* had a major role in Hariyali watersheds but it was not the same in other programs. Similarly, the apparent convergence of line department in Hariyali watersheds was evident on paper only and effective and close working relationship between WDTs, WC and AGs were found in Sujala program (Sreedevi et al. 2007). The concepts like *'Mitra Kisan'* or *'Gopal Mitra'* have shown mixed results across different watersheds in different states (Deshpande and Thimmaiah 1999).

The success of watershed program would not only rely on the watershed institutions, but depend more on how effective are the credit delivery system, input delivery system, output markets, and technology transfer mechanisms. It is, therefore, imperative to ensure that watershed projects/ institutions should also have a strong linkage with various institutions like markets, banks, etc.

Decentralize Decision-Making Process

Decision-making is the key component of watershed program. The success or failure of watershed program very much depends on who and how decisions are made? Hence, decentralization of decision-making process is of great importance. A number of watershed evaluation reports show that watersheds performed reasonably well where decision-making process was decentralized. Decentralization of decision-making processes, however, requires flexibility. Often it is noted that the rigid norms did not allow decentralization of decision-making. To some extent, involvement of elected representatives of the people (MLAs and MPs) in the development process may ease the process (Joshi et al. 2004). There are reports that in Madhya Pradesh, conscious effort have been made since 1995 to involve elected representatives of people. Greater involvement of local MLA, MP and *panchayati raj* institutions may assume significant role in project planning and execution. Since they are the elected representatives, who like to take political mileage as a result of developmental programs like watershed, they become accountable to the watershed and can be voted-out in the event of tardy progress.

Commensurate Benefits and Costs

Watershed is a community-based approach but individual actions are also important. As stated earlier, the individual actions have collective consequences. There are many conflicting objectives among the stakeholders. Benefit-sharing is perhaps the most complex challenge in management of watershed. In a watershed framework often benefits do not commensurate the cost incurred and the labor put on the watershed activities. Sharing of benefits in accordance with the cost and contributions of the participants will go a long way in sustaining the watershed program. For example, in the watershed framework, the farmers located at the upper reaches have to invest more but gains of their actions are more to farmers at middle or lower reaches (Joshi et al. 1996).

Capacity Building

Management of watershed is a complex process. Many of the watershed-related activities that aim to conserve, restore and augment soil and water resources call for specialized skills. Most important weak links in watershed programs are training and capacity building of all the stakeholders from farmers to policy makers. Most stakeholders conceive watershed development program as construction of RWH structures and never go beyond to include productivity enhancement, income-generating activities, livestock-based activities, institutions, monitoring and evaluation mechanisms, wasteland development, market linkages, etc. Most stakeholders emphasize the area of their expertise, for example NGOs emphasize social mobilization and RWH and WDTs and technocrats emphasize technologies and overlook holistic integration. Technical backstopping through consortium approach provides on-ground opportunities for training and capacity development of all the actors involved. Thus, training of beneficiaries is another key element for the success of the watershed activities. Unawareness and ignorance of the stakeholders about the objectives, approach and activities is one of the reasons that affect the performance of watersheds. For example, in most watersheds not only the farmers but most stakeholders are not aware of the major constraints for increasing productivity or actual potential of the watershed (Wani et al. 2003a,b). The stakeholders must be aware about the importance of various activities in the watersheds, their benefits in terms of economics, social and environmental factors. Many actions by the stakeholders in the watershed are being taken in ignorance, which adversely affect the income and environment of other stakeholders and locations. Educating all the stakeholders would minimize such actions, conflicts and maximize benefits from the watershed. Prof. Hanumantha Rao Committee and Sri Eshwaran Committee have strongly recommended the need for training of all stakeholders in the watershed. These recommendations must be adhered to make the program more participatory and successful.

Demand Driven Watershed Approach

Demand-driven watershed activities will attract higher people's participation. Once the watershed is identified, the needs of the stakeholders must be assessed together by the implementing agency and the stakeholders. Since there are diverse groups of beneficiaries in the watershed, their needs should not be overlooked. There are often reports that only the influencial and large farmers were involved, while invariably, the small and marginal farmers were omitted. Besides, there were evidences that most of the watershed programs were not sensitive to the needs of women and landless laborers. Most often the women and landless labourers were silently left out of watershed related decision-making processes. Efforts to integrate small and marginal farmers, women and landless labourers into the process require conscious efforts right from the beginning. It is therefore, necessary that need assessment of the stakeholders should be the precondition in designing and developing the watershed activities.

Target Poor Regions

Poorer regions should receive higher priority to get watershed program. In poor regions the relatively backward villages should be given greater attention for the watershed program. Overall, the prioritization of stakeholders in poor regions was not sought effectively. It should be ensured that the stakeholders must be involved during planning and execution of the watershed. The observation from a few watersheds in low-income regions was that the households generously participated in making the program successful to raise the farm productivity and augment income levels. The landless labourers would have incentives to get more jobs in the rural areas, and women folk for fetching water and fuel wood from the watershed area. There are reports that a well-knitted participatory approach checked migration of rural youth.

Summary and Conclusions

The paper documented the benefits from the watershed program by collating information from micro-level studies to give a macro dimension. The benefits were assessed in terms of efficiency, employment and sustainability. It was noted that the watershed program was contributing in raising income, generating employment and conserving soil and water resources. The analysis showed that the benefits of the watershed program were more in the poor income regions as compared to higher income regions. Benefits were more in the rainfall regions ranging between 700 mm and 1000 mm with the available technologies. It also highlighted to undertake research to develop and identify suitable technological interventions for low (<700 mm) and high (> 1000 mm) rainfall regions. It suggested that the watershed program would be a vehicle of development to alleviate poverty by raising farm productivity and generating employment opportunities in marginal and fragile environments.

The benefits of watershed projects were more where people's participation was higher. It was noted that people's participation is not only important during the phase of implementation of watershed development activities but beyond the actual investment phase. In the absence of users' involvement, the watershed program would fail to sustain. The important conditions of people's participation are related to (i) demand-driven watershed projects rather than supply-driven, (ii) involvement of all stakeholders (including women and landless labourers) in program implementation and monitoring, (iii) decentralization of decision-making process, (iv) involvement of elected representatives and *panchayati raj* institutions, (v) tangible economic benefit to large number of community members (vi) commensurating benefits of all stakeholders with their cost (vii) establishing effective linkages of watershed institutions with other institutions, like credit sector, input delivery system, and technology transfer mechanism, (viii) predisposition of the community for collective action, and ix) good local leadership.

Watershed program is the one of the most important strategies to bring socio-economic change in the rain-fed areas. In dryland regions, it has silently revolutionized the agriculture and allied sector through various technological interventions, particularly soil and water conservation and land use diversification. There is an overwhelming policy and political support. Only problem is lack of appropriate institutional arrangement. This is a major obstacle in attaining the potential benefits of watershed program. Earnest efforts to enthuse stakeholders for their voluntary participation would sustain watershed development and bring prosperity in the rain-fed areas.

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About ICRISAT

ICRISAT
Science with a human face

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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