COMPREHENSIVE Assessment of water management in agriculture

Research Report 8

Meta-Analysis to Assess Impact of Watershed Program and People's Participation

P. K. Joshi, A. K. Jha, S. P. Wani, Laxmi Joshi and R. L. Shiyani

ICRISAT

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Comprehensive Assessment of Water Management in Agriculture

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Cover photograph by Suhas P. Wani shows a rainwater harvesting structure in Adarsha Watershed, Kothapally, Andhra Pradesh, India.

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Contents

Summary

The study assessed the performance of watershed programs by employing meta analysis. Meta analysis is a statistical procedure that integrates and upscales numerous spatially and temporally distributed combinable micro-level studies to distil logical macro-level policy inferences. The inferences drawn, based on meta analysis, are often more objective and authentic. Based on an exhaustive review of 311 case studies on watershed programs in India, the study attempted to document efficiency, equity and sustainability benefits. It was noted that the mean benefit-cost ratio of a watershed program in the country was quite modest at 2.14. The internal rate of return was 22 percent, which is comparable with many rural developmental programs. The watershed programs generated enormous employment opportunities, augmented irrigated area and cropping intensity and conserved soil and water resources. The performance of the watershed program was at its best in areas that targeted the low and medium income groups, which was jointly implemented by the state and central government, and where there was effective people's participation and a rainfall ranging between 700–1,000 mm. The study concluded that the watershed program is silently rejuvenating and revolutionizing rain-fed areas. Lack of appropriate institutional support is impeding the tapping of potential benefits associated with these programs.

Meta-Analysis to Assess Impact of Watershed Program and People's Participation

P. K. Joshi, A. K. Jha, S. P. Wani, Laxmi Joshi and R. L. Shiyani

Background

Watershed programs are recognized as a potential engine for agricultural growth and development in fragile and marginally rain-fed areas. Since the Seventh Five-Year Plan, the Government of India accorded high priority to the rain-fed areas after realizing that the impacts of the green revolution in irrigated areas was gradually diminishing. The serious drought of 1987 that affected large parts of the Indian subcontinent, further justified investments in the development of sustainable production systems in rain-fed areas. Approximately 65 percent of all agricultural land in the country is rain-fed and it was anticipated that watershed-based programs could effectively meet the emerging and complex challenges of these areas, namely deplorably high poverty, unemployment and acute degradation of natural resources. It was thought that these programs would accelerate the development of a second green revolution in these rain-fed areas. Until 1987, several pilot projects on watershed development were implemented in different "agro-ecoregions." Approximately US$2.5 billion have already been allocated for watershed development programs for the period 2003-2004. Over time, the nature and scope of watershed program has undergone considerable modification and in this respect a participatory approach to watershed development has been adopted. The first generation watershed programs (1969-1974) focused on soil conservation. The second generation (1974-1979) watersheds focused more on water conservation. The recently launched, third generation watersheds (since early 1990s), however, revolved around the participatory approach by involving the beneficiaries in the planning, implementing, monitoring and sharing the benefits and costs.

Earlier, several studies had been conducted to assess the impact of watershed programs, and examine the people's participation (for seminal review refer Chopra et. al. 1990; Marothia 1997; Deshpande and Thimmaiah 1999; Hanumantha Rao 2000; Kerr et al. 2000; and Ratna Reddy 2000). Several watershed evaluation studies provided useful insight on the performance of numerous watershed projects but did not attempt to assess the patterns of multiple benefits of watershed programs in terms of differences in geographical regions, sizes, types, and the extent of people's participation. This study is an attempt to scan and dissect earlier micro-level studies to derive some logical conclusions on the linkage between the performance of watershed development programs and people's participation for their wider policy implications at the macro-level.

The report assesses the benefits of watershed programs and examines the role of people's participation in the overall performance of the program. In addition, it identifies conditions for larger participation of the stakeholders in the watershed activities. More specifically, the objectives of the study are: (i) to document the benefits of watershed programs in different regions of the country; (ii) to assess the role of people's participation in the success of the watershed programs; and (iii) to document conditions for greater people's participation in order to identify some of the influencing factors in (biophysical, social and economical) for successful watershed projects.

Methodology

Approach

The study is based on the meta-analysis approach, which is effectively an analysis of analyses. Meta-analysis is relatively a new methodology. The purpose is to collate research findings from previous studies, and distil them for broad conclusions. The approach is popularly known as "analysis of the analyses." Meta-analysis can be helpful for policymakers, who may be confronted by numerous conflicting conclusions (Alston et al. 2000). Previously meta-analysis was applied to assess the returns on investment in education (Lockheed et al. 1980; Phillips 1994), and understand the implications of certain medical treatments on offspring (Mann 1996). Recently, it was used to measure the returns to research investment at the global level (Alston et al. 2000). In the current study, an attempt has been made to amass available micro-level studies, which evaluated the watershed programs and assessed people's participation. These micro-level studies have been critically reviewed and analyzed for up-scaling the conclusions to stipulate the macro-level picture of the watershed benefits and people's participation (Hanumantha Rao 2000; Kerr et al. 2000).

Watershed programs were launched with three principal objectives, namely, improving production efficiency, equity and sustainability in the rain-fed areas. To document these benefits proxy indicators were chosen and analyzed. The benefit-cost ratio (BCR) and the internal rate of return (IRR) were used as proxies for efficiency gains from the watershed programs. Additional employment generation in agriculture as a consequence of watershed activities was assessed as an equity benefit. Four important indicators were identified to demonstrate sustainability benefits. These included (i) increased water storage capacity, which augmented irrigation; (ii) increased cropping intensity; (iii) reduced runoff, which enhanced groundwater recharge; and (iv) reduced soil loss.

Watershed programs are characterized by having the attribute of collective action that encompasses all the beneficiaries and the stakeholders. Therefore, people's participation becomes a critical determinant in the performance of watershed programs. In the individual cases studied, people's participation had been documented as high, medium and low based on ordinal scale keeping in view a comparative perspective with respect to various activities at different stages of the watershed programs. Here, the people's participations were directly drawn from the various studies. The degree of participation by communities was related to the multiple benefits derived from the watershed programs. This exercise also drew lessons for institutionalizing collective action.

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

The following model was used:

$$BCR = f (L, S, F, R, I, P, T, A, ST) \quad (1)$$

A linear equation was used in estimating BCR and was of the following form:

$$BCR = b_0 + X b + \varepsilon \quad (2)$$

Where, BCR is the benefit-cost ratio, b_0 is the intercept, X is the matrix of abovementioned explanatory variables included in the model, b is the vector of slope coefficients, and ε is the error term. More details of the methodology on "meta analysis" can be seen in Alston et al. (2000).

A summary of explanatory variables is given in table 1. All explanatory variables were dichotomous dummy variables coded as equal to one if the characteristic is present, and zero if it is absent. One characteristic of the variable was considered as the base, which was 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 in the analysis as clusters in each of the categories defined as explanatory variables.

TABLE 1.
Summary of explanatory variables used in the meta-analysis.

Characteristics	Detail of the explanatory variable
Geographical location	Gujarat Plain and Hill region*
	Trans-Gangetic Plain zone
	Western Himalayan zone
	Western Plateau and Hill zone
	Southern zone
Rainfall	Less than 500 mm*
	501–700 mm
	701–900 mm
	901–1,100 mm
	More than 1,100 mm
Size of watershed	Micro-watershed*
	Macro-watershed
Focus of watershed	Rehabilitation of degraded lands*
	Soil and water conservation
	Both
Implementing agency	Central government
	State government
	Central and state governments

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

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

Data

Numerous studies are conducted, which evaluated the performance of watershed programs. These watershed studies cover the entire country and, therefore, represent a wide range of environments according to their "agro-ecological" location, size, type, source of funding, rainfall, regional prosperity or backwardness, etc. The present study prepared an exhaustive bibliography on these evaluated watershed programs that comprised a total of 311 case studies,[1] given that the meta-analysis procedure requires a large number of studies in order to establish a high degree of confidence in the analysis results. These case studies include all type of watershed programs implemented with central government assistance; external assistance from the World Bank, European Economic Community (EEC), Swiss and German funding, and Danish International Development Agency (DANIDA) etc. These studies also cover watersheds constituted under watershed development programs of the state governments, Ministry of Rural Development (Union), Ministry of Environment and Forest etc. These studies, apart from several micro-watershed programs based on people's action and community participation, cover all sorts of Indian watershed development projects like, National Watershed Development Project for Rain-fed Areas (NWDPRA), River Valley Projects (RVP), Integrated Watershed Management in the catchments of Flood Prone Rivers (FPR), Watershed Development Project in Shifting Cultivation Area (WPSCA), World Bank aided Himalayan Watershed Management Project, Pilot Project for Watershed Management in Rain-fed Areas, Integrated Watershed Development Project for Hills (IWDP) and IWDP for Plains Project, Doon Valley Project (EEC) and many more macro-watershed projects. These studies were published either as research articles or research reports. The complete bibliography is available from the authors. There are, however, many more studies, which could not be traced.

Results and Discussion

Benefits of watershed programs

Watershed programs have been specifically launched in the rain-fed areas with the primary objective of improving the livelihoods of poor rural households that are afflicted by a disproportionate degree of risk with respect to agrarian activities. Their net income levels are low and uncertain and their plight is further compounded by acute degradation of soil and water resources (Wani et al. 2003). The Government of India aggressively intensified watershed programs in fragile and high-risk ecosystems, where farm incomes drastically declined due to excessive soil erosion and moisture stress. It was anticipated that the watershed programs would augment farm income, raise agricultural production and conserve soil and water resources in rain-fed areas through the process of applying appropriate technical and financial support.

Watershed programs were initiated over a wide range of "agro-ecoregions" and were planned, developed and implemented by various government agencies. A review of available literature indicated that the past investment in watershed programs yielded positive results like raising the income levels,

[1]A complete bibliography on watershed studies is available with the authors.

generating employment opportunities and conserving soil and water resources. The advantage of “meta analysis” is that it helps in integrating and up-scaling the results of various spatially and temporally scattered independent micro-level studies (but lacking macro-policy implications) to draw some logical conclusions for taking decisions at the macro-level. A summary of the multiple benefits derived from these programs is presented in table 2. The mean benefit-cost ratio of watershed program was modest at 2.14 indicating that investment in watershed programs that are situated in fragile and uncertain rain-fed environments yielded more than double the initial investment. There were about 15 percent watersheds, which attained benefit-cost ratios of > 3 and similarly < 3 percent of the watersheds benefit-cost ratios of < 1 (figure 1). The mean internal rate of return on watershed investment was approximately 22 percent, with a maximum of 94 percent (table 2). The mean internal rate of return on watershed investments is comparable with successful government programs. It is interesting to note that 35 percent of the watersheds yielded > 30 percent internal rate of return (figure 2). In about 5 percent of the watersheds that performed poorly, the internal rate of return was < 10 percent (figure 2). These results suggest that watershed programs performed reasonably well under these fragile and uncertain environments and that the investments were justified as income levels were raised within the target domains.

TABLE 2.
Summary of benefits from the sample watershed studies.

Indicator	Particulars	Unit	No. of studies	Mean	Mode	Median	Minimum	Maximum	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/year	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/year	51	-0.82	-0.91	-0.88	-0.11	-0.99	39.29

Source: Derived from various studies (bibliography is available with the authors)

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

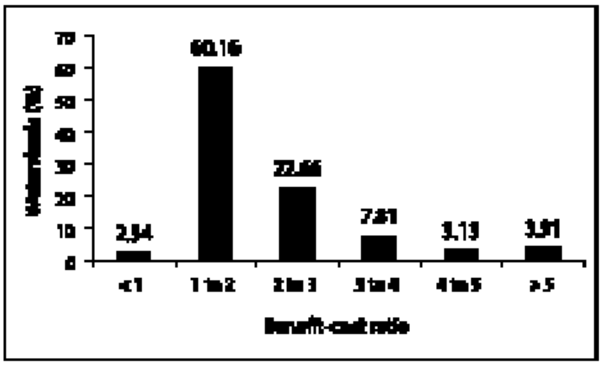
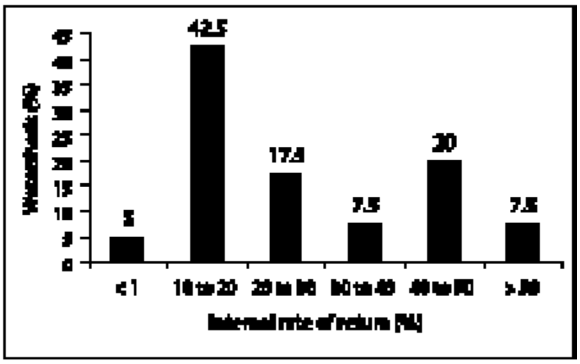


FIGURE 2.
Distribution (%) of watersheds according to internal rate of return (IRR).



A further important function of watershed programs was to generate employment opportunities. This would have the positive impact of alleviating rural poverty and reducing income disparities among households. The mean additional annual employment generation in the watershed area on various activities and operations was 181 person days/ha/year (table 2). In those watershed projects that included multiple activities, employment generation increased to 900 person days/ha/year. The generation of employment opportunities within these rural communities will invariably increase their purchasing power with a corresponding decline in rural poverty. Based on these observations, the watershed investments may be viewed as a poverty alleviation program in the fragile areas.

Rain-fed areas are confronted with acute problems of land degradation through soil erosion, and high levels of risk associated with agriculture due to variable rainfall. Technological interventions through soil and water conservation can greatly reduce the risk in rain-fed degraded systems. The watershed programs are largely aimed to conserve soil and water as a means of raising farm productivity. The available evidences revealed that both these objectives were accomplished in the watershed programs. Soil loss of about 0.82 tons per ha per year was saved due to interventions in the watershed framework (table 2). Similarly, there was an average reduction of 13 percent in surface runoff that was used to augment both surface and groundwater reserves. These have direct impacts on expanding the irrigated area and increasing cropping intensity. On average the irrigated area increased by 34 percent, while the cropping intensity increased by 64 percent (table 2). 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 programs are a viable strategy to overcome several externalities arising from the degradation of soil and water resources. The above evidence suggests that watershed programs successfully met three basic objectives of raising income, generating employment and conserving soil and water resources. These benefits have far reaching implications for rural populations in the rain-fed environments. However, the benefits often vary depending upon the location, size, type, rainfall, implementing agency, and people' s participation, among others.

Results of meta-analysis

The results of the meta-analysis are presented in table 3. The coefficient of multiple determination (R^2) indicates that more than 54 percent of the variation in the BCR was associated with the variables included in the model. A positive and highly significant intercept clearly indicates the positive role of watersheds in augmenting income (table 3). It reveals that carefully planned and executed watershed activities yielded returns at least 2.1 times more than the initial investment. There are other factors that determine the efficiency of watershed programs. These include geographical location, rainfall pattern, focus of the watershed program, implementing agency, status of target population, people's participation, activities performed under the program and the soil types in the area. The influence of time between implementation and evaluation could not be captured, as the variable was statistically non-significant. However, a positive sign of the variable indicates a larger benefit associated with the intervention with time. Therefore, performance of the watershed programs should not be evaluated immediately after implementation. The impact of these variables on the watershed efficiency is discussed below:

Geographical location of the watershed

Watershed programs have been established over a diverse range of rain-fed "agro-ecoregions" in India. All watersheds were broadly grouped into five agro-climatic zones: (i) Trans-Gangetic Plain zone; (ii) Western Himalayan zone;

TABLE 3.

Variables determining the performance of watershed: regression coefficient based on meta analysis.

Particulars	Default category	Variables	Estimated coefficients	t-statistics
		Intercept	2.1139	4.288*
Geographical location	Gujarat plains and hills zone	Western plateau and hill zone	-0.3760	-1.813***
	All other observations	Trans-Gangatic plains zone	-0.5292	-1.562@
	All other observations	Southern zone	0.2137	0.985
	All other observations	Western Himalayan zone	0.6925	0.557**
Rainfall	Rainfall less than 500 mm	Rainfall above 1,100 mm	-0.7172	-2.864*
	All other observations	Rainfall between 501 and 700 mm	-0.2429	-0.923
	All other observations	Rainfall between 701 to 900 mm	0.0013	2.324**
	All other observations	Rainfall between 901 to 1,100 mm	0.5718	2.477**
Size of watershed	Micro-watersheds	Macro-watersheds	0.5637	2.600*
Focus of watershed	Degraded land	Degraded land along with soil and water conservation	-0.6169	-1.369@
	All other observations	Soil and water conservation	-0.3753	-0.848
Implementing agency	Other implementing agencies	Implemented by the Central Government only	-0.4547	-1.484@
	All other observations	Implemented by others in collaboration with centre and state	0.2171	0.824
	All other observations	Implemented by the centre and state	0.3918	2.009**
Peoples' participation	Low peoples' participation	Medium peoples' participation	-0.1860	-1.772***
	All other observations	High peoples' participation	0.1866	1.779***
Per capita income in the region	Location in low income group states	Location in high income- group states	-0.3016	-1.181@
	All other observations	Location in medium income-group states	0.2398	0.9660
Activities performed under watershed	Only agriculture	Agriculture, livestock and forestry	-0.2236	-1.084
	All other observations	Agriculture and forestry	-0.1702	-0.809
	All other observations	Agriculture and livestock	0.3946	2.292**
Soil types	Clay soils	Sandy loam soils	-0.0002	0.2810
	All other observations	Black cotton soils	-0.4360	-0.199
	All other observations	Alluvium soils	0.8330	3.315*
	All other observations	Red soils	0.4404	1.618***
	R^2		0.5400	
	Number of observations		128	

@, ***, **, and * are significant at 20, 10, 5 and 1 percent of probabilities, respectively.

(iii) Western Plateau and Hill zone;
(iv) Gujarat Plains and Hill zone; and
(v) Southern zone. Due to the inherent heterogeneity of agro-climatic characteristics over different regions, they have divergent potentials and opportunities. The analysis suggests that economic benefits over initial investment in watershed programs were highest in the Western Himalayan regions, followed by the Southern zone, Gujarat Plain and the Hill zone. The Western Himalayan regions attained 45 percent higher BCR than the base level of Gujarat Plain and Hill zone. Performance of watersheds located in Trans-Gangetic Plain zone and Western Plateau and Hill zone was poor in comparison to the watersheds located in other agro-climatic zones mentioned earlier. The findings have important implications for investment priorities for watershed programs. To maximize returns on investment in watershed programs, the highest priority should be accorded to the Western Himalayan zones followed by the Southern zone, Gujarat Plain and the Hill zone. However, decisions on investment are much more complex and should be taken up more cautiously. Due to the lack of available data from sufficient studies of the north-eastern hill regions, the analysis could not capture the efficiency of watershed programs in that region. Like Western Himalayan region, the north-eastern hill region is endowed with similar natural resources. The region is expected to yield high returns on investments in watershed programs.

Rainfall

The rainfall in the region largely influences the performance of watersheds. To examine the effect of rainfall, watersheds were grouped into five rainfall zones: (i) less than 500 mm; (ii) 501–700 mm; (iii) 701–900 mm; (iv) 901–1,100 mm; and (v) > 1,100 mm. The results indicate that the performance of watersheds with respect to BCR was best in rainfall regimes ranging from 901 to 1,100 mm followed by 701–900 mm (table 3). It was noted that the BCR was 25 percent higher in the rainfall ranging between 901–1,100 mm in comparison to the base level of less than 500 mm. Rainfall regimes lower than 700 mm and higher than 1,101 mm were poor performers due to the limited availability of water on the one hand and excessive water availability on the other. The results suggest that higher investment priority should be given to watershed programs in the areas where rainfall ranges from 700 to 1,100 mm. The other rainfall regions may require a high degree of research and development (R&D) allocation in watershed programs to design innovative strategies to enhance the efficiency of watershed programs.

Size of the watershed

Depending upon the size of the watersheds, these are broadly divided into micro- and macro-watersheds. Watersheds with areas up to 1,250 hectares were classified as micro-watersheds, whereas the macro-watersheds were those which had areas greater than this value. This classification was adopted since most of the reviewed articles for this study classified watersheds on this basis. The results show the superiority of macro-watersheds over micro-watersheds in terms of returns to investment. The performance of macro-watersheds was 42 percent better than the micro-watersheds. This is contrary to the general belief that micro-watersheds perform better (Ratna Reddy 2000). The result, however, may be due to economies of scale and more externalities through diverse activities associated with large watersheds.

Focus of the watershed

Watershed focus was classified into three broad categories: (i) rehabilitation of degraded lands, (ii) soil and water conservation, and (iii) both rehabilitation of degraded lands as well as soil and water conservation. No significant difference was noted based on the focus of the watershed program. However, there is an indication that investments that focus on rehabilitation of degraded lands in the watershed framework are more beneficial than other focus areas. Obviously rehabilitation of degraded lands yield immediate returns and generates greater benefits.

Implementing agency

Several organizations are involved in financing and implementing watershed programs. The results suggest that watershed programs jointly financed, planned and implemented by the central and state agencies gave higher returns. The returns from such watersheds were 43 percent higher than the watersheds controlled by other agencies. Since agriculture is a state responsibility, support flowing from the central government has a synergistic effect on the performance of watersheds. The independent programs of the central government obtained lowest returns to investment. This is mainly due to lack of effective monitoring. The clear role of NGOs could not be established as they received funds either from the state or the central government. Only conclusion drawn from the analysis is that the central government should play a catalytic role with state governments in implementing and managing the watershed programs.

Target population

Target populations play a key role in executing watershed programs. In this respect watersheds were grouped according to the average state income level of the targeted population. Three groups were identified: (i) high income group states; (ii) medium income states; and (iii) low income states. High income group states had a per capita agricultural gross domestic product (AgGDP) greater that Rs 4,000 during 1996–1997. Medium and low income group states were those, which had a per capita AgGDP from Rs 2,000 to Rs 4,000 and below Rs. 2,000 per annum, respectively. The regression coefficients were not found to be statistically significant. However, there are indications that the returns from watershed programs were higher in medium and low income states. States having a high income did not appear to show attractive returns on investments in watershed programs. The BCR of watersheds in low and medium income states were 2.46 and 2.21, respectively. The medium income groups of states have a comparative advantage since beneficiaries supplement private investment in public resources allocated for watershed activities. In low income states, beneficiaries offer their labor to supplement investment through a range of activities. Such an interfacing of government resources and people's participation has a multiplier effect on returns to investment. These results have a strong bearing on investment priorities for watershed programs. States in the higher income range should receive least priority with regard to watershed development programs. Medium and low income states should be accorded higher investment priority for watershed programs.

People's participation

People's participation is critical in the success of watershed programs. The results of the study showed that the benefits were highest from the watersheds where people's participation was high. The average benefit-cost ratio of the watersheds having high people's participation was 2.37, whereas in watersheds where the people' s participation was low the average benefit-cost ratio was approximately 2.

Activities performed

Benefits are the outcome of activities performed in the watersheds. Different activities pertaining to agriculture, livestock and forestry were performed in various watershed areas. It is interesting to note that the contribution through integrated agriculture and livestock activities was significantly better than that of agriculture alone (table 3). Perhaps the complementarity between these two enterprises helped the beneficiaries in diversifying their activities more favorably. It is plausible that the negative coefficient obtained for the activities that encompassed agriculture and forestry simultaneously was due to the effect of practicing "jhoom" (shifting) cultivation in most of the hilly tracts of the eastern region. Shifting cultivation affects the forest as well as the watersheds in the area. Besides, most of the forest areas fall in the regions where the rainfall is above 1,100 mm. As discussed previously the best-suited areas for high BCR associated with watershed programs lie within the rainfall range of 701 to 1,100 mm.

Soil type

Soil types, structure and properties are critical in recuperating agricultural performance in the watershed. The best way to capture the effect of soil would have been to include their intrinsic physical and chemical properties. In the absence of such information, a broad classification of soil type, namely clay, sandy loam, black cotton, alluvium and red soils was used in the model. The results indicated that the most ideal soils for the watersheds were alluvial and red soils. It was noted that the areas having alluvial or red soils with the other favorable attributes (discussed above) would reap more benefits from the watershed programs in comparison to others. About 24 and 18 percent higher benefits were recorded in the watersheds having alluvial and red soils, respectively, than the clay soils.

People's Participation and Benefits from Watersheds

People's participation in planning, developing and executing watershed activities is a critical factor that determines the success of the program. It calls for community participation and collective action. It is necessary because individual choices have collective consequences in the watershed framework. Action of one group of farmers in one location affects adversely (or favorably) on other groups of farmers and stakeholders in a different location. Often these 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 these conflicting objectives. It is often thought that better organized and effective people's participation will yield higher benefits. A summary of the results of people's participation and benefits from watersheds is given in table 4. The available evidence confirms that there existed a positive relationship between people's participation and benefits accrued from watershed programs. The benefit-cost ratio was much more (2.4) in watersheds where people's participation was high in comparison to the watersheds with low people' s participation (1.24). The other impact indicators were also far ahead in watersheds having greater people's participation.

It is interesting to note that benefits from watershed programs were conspicuously higher in the low-income regions when compared to the high-income regions (table 5). The benefit-cost ratio was 2.46 in low-income regions as compared to 1.98 in high-income regions. The corresponding figures for annual employment generation were 175 and 132 person-days/ha/year. This suggests that watershed programs in medium- and low-income regions should receive higher priority by the governments in watershed activities. Such investments will not only raise income and employment opportunities in these regions but also contribute in conserving soil and water resources. In a recent study Fan and Hazell (1997) demonstrated that the returns on investment in inputs as well as research at the margin were higher for dry land areas than for irrigated areas. Farmers in these regions could not invest due to low income and limited opportunities. Government intervention through

TABLE 4.
Summary of benefits from the sampled watershed studies associated with people's participation.

Indicator	Particular	Unit	People's participation* High	Medium	Low
Efficiency	B/C ratio	Ratio	2.37 (12.41)	1.79 (24.10)	1.24 (14.93)
	IRR	Percent	30.80 (7.72)	38.43 (2.07)	32.43 (4.87)
Equity	Employment	Person days/ha/year	201.75 (3.13)	183.26 (2.42)	176.72 (6.39)
Sustainability	Irrigated area	Percent	28.87 (6.52)	41.08 (5.58)	34.03 (8.32)
	Cropping intensity	Percent	90.84 (6.53)	63.88 (8.00)	53.39 (10.45)
	Rate of runoff reduced	Percent	12.98 (4.02)	8.51 (2.56)	15.62 (4.84)
	Soil loss reduced	Tons/ha/year	0.85 (50.60)	0.80 (15.24)	0.81 (17.53)

Source: Derived from various studies (bibliography is available with the authors)

Note: Figures in parentheses are the t-values * People's participation was directly drawn from the studies.

TABLE 5.
Summary of benefits from the sample watershed studies according to economic status of the region.

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

Source: Derived from various studies (bibliography is available with the authors)

Note: Figures in parentheses are the t-values.

*, **, and ***include the states having per capita AgGDP greater that Rs 4,000, between Rs 2,000 to Rs 4,000 and below Rs 2,000 per annum, respectively during 1996–1997.

watershed programs 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 labor in various activities launched in the watershed. In fact, for the small farmers and landless laborers 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 investments in watershed-related activities.

Above evidence reveals that people's participation was the key determinant in the success of the watershed development programs. People's participation is critical not only during the implementation phase of watersheds but also beyond the actual investment phase. In the absence of active involvement of all stakeholders, watershed programs may not be sustained.

Enabling conditions for people's participation

Traditionally, watershed programs in the country were supply-driven. Central and state governments were responsible for the allocation of resources for watershed development and officials within responsible departments identify locations and decide on the various activities that would be implemented in the program. Often such approaches did not match the needs of stakeholders in the watershed. In the absence of people's participation, the potential benefits that could flow from watershed programs were not realized. Recognizing this, the concept of Participatory Integrated Development of Watershed (PIDOW) was adopted in the 1980s. This approach had qualified success. Overtime people institutions (i.e., Zilla Parishad), self-help groups, and watershed implementing committees gradually became involved in the project management. With increasing funds allocated to watershed development, several nongovernment organizations aggressively participated in implementing this program, and demonstrated the importance of people's involvement in the success of watershed development. Most of these arrangements were informal and varied across the watersheds and implementing agencies. In order to formalize these arrangements, watershed development guidelines for 1994 specifically included people's involvement as one of the conditions to implement the program. In this respect the voluntary participation of people in the program effectively ensured the success and sustainability of watershed programs. It is, therefore, important to identify conditions under which the beneficiaries of watershed development will become involved in order to ensure participation in the implementation phase and sustain maintenance of structures after the project is formally over. The following section is based on the review of earlier results and not drawn from meta analysis.

Demand driven watershed approach

Demand-driven watershed activities have the advantage in that they inherently attract a high percentage of people's participation. Once the watershed is identified, the needs of the stakeholders must be jointly assessed by the implementing agency and stakeholders. Since there are diverse groups of beneficiaries within a watershed, the requirements of each of these groups should be looked into. It is often reported that only influential and large farmers are involved in this process and, hence, they are the major benefactors of the development. In addition, there is evidence to suggest that most watershed programs were not sensitive to the needs of women and the landless. Most often the women and landless laborers were silently left out of watershed-related decision-making processes. Efforts to integrate small and marginal farmers, women and the landless into the process require conscious efforts at the initiation of the planning phase. It is, therefore, imperative that a needs assessment of stakeholders be a precondition in designing and developing the watershed activities.

Self-help groups

The second stage of people's participation is the implementation of interventions. At this stage regular monitoring is required. The success of the watershed development is contingent upon how effectively the stakeholders monitor progress. There are reports from some of the successful watersheds that informal groups were constituted to regularly monitor the watersheds' activities. These were of different forms. For example, in some watersheds the formal water users associations were formed. The users associations were found to be economically viable, and significantly contributed to the management of common pooled resources in the watershed. A new concept of "Mitra Kisan" or "Gopal" based on the concept of self-help group (SHG), that encouraged farmer-led technology transfer, has shown mixed results across different watersheds in different states (Deshpande and Thimmaiah 1999). Similarly, the participating farmers in a few of the watersheds formed "Thrift Groups."

The success of watershed programs is not only dependent on the presence of watershed institutions, but will depend on how effective the credit delivery system, input delivery system, output markets, and technology transfer mechanisms are. A strong linkage of watershed program with various institutions has resulted in the desired outputs.

Decentralize decision-making process

Decentralization of decision-making processes also contributed in the success of the watershed program. This is possible if there is flexibility in the decision-making process. Often it is noted that the rigid norms did not allow decentralization of decision-making to be made. To some extent, involvement of local elected representatives of the people and Panchayati Raj Institutions (PRI) members (Sarpanch, Zilla Parishad Chairman and elected members) in the development process may ease the process. There are reports that in Madhya Pradesh a conscious effort has been made since 1995 to involve elected representatives of people. Greater involvement of local elected representatives and Panchayati Raj Institutions may assume significant roles in project planning and execution. This is because they are the elected representatives, who can accrue political mileage as a result of developmental programs, such as watersheds. In this process, they become accountable to the watershed and can be voted-out in the event of inadequate progress. Furthermore, involvement of PRIs in the watershed activities would contribute towards sustaining the watershed management initiatives.

Target poor regions

As indicated previously poorer regions should receive higher priority with respect to developing watershed programs. Furthermore, poor villages within these watersheds should be given higher priority within the development program. In general, prioritization of stakeholders in poor regions was not routinely sought. This can be overcome by ensuring all stakeholders are involved during planning and execution of the watershed program. An observation made in some watershed programs implemented in low-income regions was that the households generously participated in making the program successful in order to raise the farm productivity and augment their income levels. The landless laborers would have incentives to get more jobs in the rural areas, whereas the women folk would be benefited by way of easy access to fetch water and fuelwood from the watershed area. There are reports that a well-knitted participatory approach reduced migration by rural youth (Deshpandey and Narayana Murthy 1999; Rao 2000). In general, it can be concluded that people who are in need of help come forward effectively for participation, while those who are better off do not actively participate in the development program as they are of the opinion that the Government will undertake these activities regardless of their non-involvement and that they will be able to harvest the benefits.

Commensurate benefits and costs

As stated earlier individual actions have collective consequences. There are many conflicting objectives among stakeholders within a watershed. In a watershed framework the benefits to all the beneficiaries may not commensurate the cost incurred and the labor utilized by them on the watershed activities. Hence, a mechanism for sharing of benefits in accordance with the cost share is one of the prerequisites for the success and sustainability of the watershed program. For example, in the watershed framework, farmers located in the upper reaches of the catchment have a higher investment, but the gains due to these actions are predominantly attributable to farmers in the middle or lower reaches (Joshi et al. 1996).

Training of stakeholders

Training programs for beneficiaries is another key element for the success of the watershed activities. Stakeholders must be aware of the importance of various activities in the watersheds, their benefits in terms of economics, social and environmental aspects. Many actions by the stakeholders in the watershed are being undertaken in ignorance, which adversely affects the income and environment of other stakeholders and locations. Educating all the stakeholders would minimize such actions 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, and adopted in a spirit to make the program more participatory and successful.

Conclusions

The report 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 programs were 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 700-1,000 mm. 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 programs were greater 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 water users’ involvement, watershed programs failed to sustain themselves. The important conditions of people’s participation are related to (i) demand-driven watershed programs rather than supply-driven ones; (ii) involvement of all stakeholders (including women and landless laborers) in program implementation and monitoring; (iii) decentralization of the decision making process; (iv) involvement of elected representatives and Panchayat Raj Institutions; (v) commensurate benefits of all stakeholders with their cost; and (vi) establishing effective linkages of watershed institutions with other institutions, like credit sector, input delivery system, and technology transfer mechanism.

Watershed programs are one of the most important strategies to bring socioeconomic change in the rain-fed system. In some of the regions, it has silently revolutionized agriculture and allied sectors through various technological interventions, particularly soil and water conservation, and crop diversification. For watershed programs, location-specific technologies are available. There is overwhelming policy and political support for these activities; however, there is a lack of appropriate institutional arrangement, suitable technical backstopping and capacity building initiatives for all the stakeholders. This is a major obstacle in attaining the potential benefits of a watershed program. Earnest efforts to enthuse stakeholders for their voluntary participation would sustain watershed development and bring prosperity in the rain-fed areas for which novel methods, policies and suitable forward and backward linkages need to be delivered.

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