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FULL-LENGTH RESEARCH ARTICLE

Impact of Watershed Programmes in Bundelkhand Region of Madhya Pradesh, India: How Beneficiaries Perceive?

Biswajit Mondal[1] · Alka Singh[2] · G. A. K. Kumar[1] · M. K. Sinha[3] · Suresh Kumar[4]

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Abstract An ex- post study was conducted to assess the impact of watershed development programmes, and appraisal was made with perceptions of beneficiaries of respective watersheds. The water resources development activities were accorded the highest priority with the allocation of 42% of the total budget, followed by soil conservation activities with the allocation of 27% of the budget. The cumulative effect of land-based activities was observed in terms of an increase in cultivated area (34%), cropping intensity (44%), afforestation/plantation (34%), irrigation intensity (13%) as well as a decrease in current fallow (78%) and wasteland (35%). The value of crop diversification index and cultivated land utilization index were higher over pre-project situations, and higher value of crop yield index indicated the higher productivity levels for major crops in watershed villages. Positive and significant differences in various socio-economic attributes among watersheds and control areas like labour absorptions and income from crop enterprises also endorsed the positive effects of watershed-based interventions. However, yield enhancement, groundwater recharge, saving of resources and augmentation of income were the major benefits of various watershed-based interventions as perceived by the beneficiary households.

Keywords Bundelkhand region · Farmer's perceptions · Garrett ranking · Observed benefit · Watershed

Introduction

India is predominantly an agrarian economy having two-thirds of its people still deriving their livelihood from agriculture and allied activities. One of the major challenges is to accelerate and maintain agricultural growth and ensure food security without exhausting natural resources. Land degradation, loss of soil nutrients, groundwater depletion and diminishing biodiversity, remain as major impediments for the growth of agriculture, particularly in the rainfed regions, which shares about 58% of cultivated area in the country [30]. To overcome such challenges, integrated watershed management was conceived as a mitigating measure for achieving twin objectives of natural resource conservation and enhancing livelihoods in rural areas [23]. To ensure availability of drinking water, access to fuelwood and fodder, boost farm income, generate employment opportunities particularly for marginal categories of households and labourers through improvement in agricultural production and productivity, different soil and water conservation activities are taken up at watershed level [17]. Biophysical and socio-economic interventions are generally executed at a watershed scale through a multidisciplinary approach with the help of agencies such as departments of central and state government, non-

✉ Biswajit Mondal
bisumondal@rediffmail.com

[1] ICAR-National Rice Research Institute, Cuttack, Odisha 753 006, India

[2] ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110 012, India

[3] ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha 751 023, India

[4] ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Bellary, Karnataka 583104, India

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governmental organizations and research organizations with varying degrees of success.

A number of research/assessment studies carried out for watersheds located in different agroclimatic situations advocate that such measures were the key technological interventions for higher agricultural productivity and farm income as well as for conservation of natural resources [6, 24, 28]. An overwhelming majority of the studies have endorsed the programme in terms of economic indicators [1, 12, 27] and few highlighted the less quantifiable indirect/intangible benefits also [8, 14, 18]. Few researchers have attempted to analyse and understand the institutional arrangements as well as priority setting and choosing of watershed management alternatives [15, 29]. Under the comprehensive assessment of watersheds in India, macro-level evaluation of 636 micro-watersheds was done through meta-analysis [9] and the results revealed that watershed program is providing multiple benefits in terms of enhancing 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} $year^{-1}$), augmenting groundwater, building social capital and reducing poverty. These studies not only vindicated the economic viability of watershed programme but also endorsed development initiatives on a watershed basis as a doable approach for the holistic development of rainfed as well as dryland agriculture in India. Much of the semi-arid tract (SAT) lies in India, and the whole of SAT India is divided into watersheds for development purposes [31], as the marginal returns to investment on inputs are higher for dryland areas than for irrigated areas [4]. However, there is dearth of information on experiences and views of the prime stakeholders of watershed programmes while evaluating the impact. The inclusive opinion of the stakeholders in terms of visible benefits is very critical to find gaps between the kind and extent of benefits realized in comparison with what was intended from the watershed programme [32]. Therefore, we attempted to comprehend the gap by examining the impact of watershed-based interventions in the Bundelkhand region of Madhya Pradesh which would add newer information to the existing literature and facilitate for improving the process of planning for future watershed development programmes.

Materials and Methods

Background of Study Area

Bundelkhand region of Madhya Pradesh state was purposively chosen to carry out the study due to its largely rainfed agriculture and backwardness relative to other regions [7]. The Bundelkhand region per se spread over the southern part of Uttar Pradesh state (seven districts) and the northern part of Madhya Pradesh state (six districts), between 23° 10′ and 26° 30′ north latitude and 78° 20′ and 81° 40′ east longitude. Located in a hot and semi-humid region between the Yamuna and Narmada, the Bundelkhand region has a distinctive physical environment that has had important impacts on its development. Compared to many other backward regions of India, Bundelkhand receives fairly good rainfall (991 mm per annum), but the topography and geology of the terrain, soil types and the nature of precipitation are such that runoff and erosion are very high. As a result, both drought and floods are common in this region. A substantial part of forest area, especially upper catchments, much of which have suffered severe degradation, checking soil and water erosion is imperative for enhancing and sustaining productivity. Further, agriculture in the region is marked by low use of fertilizers, high yielding variety seeds and the low percentage of irrigated land, which results in a low agricultural productivity, inducing a large-scale migration. The Madhya Pradesh Government has undertaken a major initiative through setting up of Rajiv Gandhi Mission for Watershed Management (RGMWM), which has emerged as an implementer of the largest number of micro-watershed projects in the entire country. The Ministry of Rural Development (MoRD) and Ministry of Agriculture (MoA) are sponsoring financially for implementation of watershed development programmes in the state and contributed about 58% and 39% shares (in terms of total area treated) [21]. The RGMWM is the nodal agency that implements watershed programmes sponsored by MoRD through *zilla panchayat* and various other departments of state government as well as non-governmental organizations as project implementing agencies, while watersheds sponsored by MoA are implemented by agriculture and other related departments at the district level.

Sampling and Data Collection

The Bundelkhand region of Madhya Pradesh comprises of six districts, among which four districts representing different topography and demographic conditions were chosen for this study. Eight micro-watersheds, two from each selected district, were selected randomly for detailed investigation. A brief description of selected watersheds indicating their locations and physiographic characteristics is given in Table 1. To make a comparative study, one control village from the contiguous area where no such interventions have been carried out, was also selected (name indicated against the respective watershed). List of households in both the watersheds as well as control villages was collected from *patwari* (village accountant), and

Table 1 Brief description of the selected watersheds. *Source*: Detailed project report of selected watersheds

Watersheds	Location (District)	Scheme under which watershed programmes implemented	Project duration	Project cost (INR in millions)	Treated area[a] (hectare)	Average rainfall (mm)	Rainfed area (% of treated area)	Waste land (% of geographical area)	Control village
Manjhgawa	Chhatarpur	IWDP	2002–06	5.05	1000	984.8	84.70	25.75	Samnapur
Manpura	Chhatarpur	NWDPRA	2003–07	1.92	488	984.8	59.55	3.07	Bokna
Khakriya	Sagar	EAS	1997–01	1.52	440	1086.7	36.36	10.53	Bhatiya
Kevlari	Sagar	NWDPRA	2003–07	1.63	474	1086.7	78.48	0	Jamuniya
B. Udesha	Damoh	DPAP	2002–06	3.00	500	1065.4	70.00	48.30	Kumhari
Rusolli	Damoh	DPAP	2002–06	2.70	500	1065.4	76.03	19.74	Rihuta
Simrakala	Panna	DPAP	2001–05	2.54	500	1069.6	80.60	9.20	Khairi
Simrakhurd	Panna	DPAP	2001–05	2.35	500	1069.6	83.26	24.67	Kunwarpura

IWDP Integrated Wasteland Development Programme, *NWDPRA* National Watershed Development Project for Rainfed Areas, *EAS* Employment Assurance Scheme, *DPAP* Drought Prone Areas Programme, *INR* Indian rupee

[a]Area in which land and water development activities were taken up

a list of beneficiaries of the respective watershed was collected from the watershed committee. Fifteen households from each watershed and control villages were selected randomly as the respondent of the study and surveys were conducted during 2010–2011. A semi-structured checklist and a structured interview schedule were prepared for the primary survey, and the data collected by personal face-to-face interviews of the respondents on demography, resource inventory, farming details, etc. Secondary information related to the project details covering various watershed management alternatives, expenditure, pre- and post-project changes in land use, water resources, cropping pattern, etc., was gathered from the documents and records maintained by implementing agencies and watershed committees.

Data Analysis

A descriptive analysis was carried out for characterizing resources and socio-economic profile of sample farmers residing at the selected villages. A number of bio-physical and socio-economic indicators were used to measure the observed impact of watershed development programmes as adopted in earlier studies [3, 22, 26]. The indicators used are (1) change in cultivated area, wasteland area, irrigated area, cropping and irrigation intensity. (2) Crop diversification index (CDI) pertains to pre- and post-project situation to assess the changes in cropping patterns due to introduction of better variety and/or improved package of practices [25] and is calculated as: $\text{CDI} = \sum_{i=1}^{n} Pi \log(1/Pi)$, where P_i is the proportion of ith crop in comparison with total cropped area and n is the total number of crops. (3) Cultivated land utilization index (CLUI) pertains to pre- and post-project situation to indicate the impact of various interventions carried out under watershed programmes through changes in cultivated land area and duration of crop, which indicates how efficiently the available land area has been used [2], and is measured as: $\text{CLUI} = \sum_{i=1}^{n} a_i d_i / A \times 365$, where n is the total number of crops, a_i is the area occupied by ith crop, d_i are the days for which ith crop occupied in a_i area, and A is the cultivated land area.; (4) difference in productivity level of major crops at watershed villages over the period before initiation of the programmes as well as over control villages and measured through a crop yield index (CYI) [33]. The index was defined as $\text{CYI} = 1/n \sum_{i=1}^{n} (y_i/Y_i)$, where n is the total number of crops, y_i is the average yield of ith crop cultivated in the watershed or during post-project period, and Y_i is the yield of ith crop during pre-project period or yield level at control villages; (5) watershed eco index (WEI), which was measured as the proportion of additional area brought under vegetation during the project to the total area of the watershed [20]; (6) additional employment generated and additional farm income realized.

A list of perceptible benefits of watershed development programme was prepared based on the discussion with key informants (representatives of the selected villages who were well informed about the physical and demographic characteristics of the village) and village leaders. Respondents were then asked to rank the benefits as per their observations and perceptions during the personal interview, and Garrett's ranking technique [5] was employed to rank the benefits using the formula: $Gi = \frac{100(Rij-0.50)}{Nj}$, where G_i = percentage position of i^{th} benefit, R_{ij} = rank given for ith benefit by jth respondent, and N_j = number of benefits ranked by jth respondent. Using Garrett's table, the percentage position of individual benefit was converted into scores for preparation of final rank of benefits.

Details of Land-Based and Non-land-Based Interventions

Different types of land-based interventions were taken up as per the needs and priorities of the watershed community and their technical feasibility. The interventions included soil and moisture conservation measures in agricultural lands, treatment of drainage line, development/management of water resources, crop demonstrations, horticultural plantations and afforestation works. The measures related to water resources development (both surface and groundwater) were given the top priority by project implementing authorities. These activities accounted for around 42% in terms of total project expenditure through the creation of additional water storage capacity by constructing and rejuvenating existing ponds and wells, *dabri* (a natural depression in the agricultural field used as small pond/reservoir), construction of gully control structures as *nala bunds* (embankments constructed across water channels/gully for checking velocity of runoff, increasing water percolation and improving soil moisture regime), check dams, percolation tanks, etc. (Table 2). The second important category of measures which consumed a considerable share of expenditure (around 27% of total project cost) was soil conservation activities like *bunding* (contour/field *bunding,* graded *bunding*), trenches (staggered/continuous), drainage line treatments (check dams and retaining walls), followed by vegetative measures such as plantation and biomass development activities. Barring few watersheds, relatively lesser funds were allocated for improvement of farm productivity through activities like crop demonstrations, improved varieties' seed production, integrated farming systems and livestock improvement. Surprisingly, the least priority (with a mere allocation of 1.38% project fund) was accorded to support or enhance the livelihood of the beneficiaries (viz. support for small entrepreneurship, dairy, poultry, sericulture, cottage industry, etc.), which is mainly meant for the landless farmers as they cannot obtain the direct benefits of watershed interventions and ensure the equity of watershed benefits among different categories of farmers. Further, the allocation of fund for management component (which includes administrative expenses and expenditure for capacity building of stakeholders) was low (15%) in comparison with the prescribed norms (about 22.5 to 25% of project fund) [16]. This was attributed to the fact that more emphasis was given to land-based treatment, which

Table 2 Watershed-based interventions[a] and their expenditure share[b]. *Source*: Compiled from project documents of selected watersheds

Work components	Physical quantity (average per watershed)	Expenditure share (%)
A. Management component	–	14.79
B. Development component		
1. Soil conservation		26.81
i. Gully control structures (number)	269 (8)	
ii. Staggered trenches (number)	10,192 (5)	
iii. Continuous contour trenches (running metre)	4074 (1)	
iv. *Bunding* (running metre)	9072 (3)	
2. Water resources development		42.08
i. Water harvesting structures (ponds, *dabri*, *nala bunds*, check dams, etc.) (number)	29 (8)	
ii. Well construction (number)	55 (2)	
iii. Percolation tanks (number)	5 (3)	
3. Plantation & biomass development		8.82
i. Fodder and grassland development, horticultural plantation and afforestation (hectare)	29.08 (6)	
ii. *Bund* plantation (number of plants)	6467 (4)	
4. Farm production enhancement activities		6.12
5. Livelihood support activities		1.38
Total		100.00

Figures in parenthesis indicate number of watersheds where the particular intervention has been taken up

[a]Average area of the selected watersheds ranged between 500 and 1000 hectares

[b]Average expenditure per watershed project was INR 2.57 million

have a more noticeable impact in the fields as compared to livelihood development programmes.

Results and Discussion

Demographic Particulars and Resource Characterization

The characteristics of sample households (composition of families, education and land holdings) have an important bearing in determining the size and quality of labour force. Various resources that are available with them indicate the nature of economic activities that can be taken up to improve the socio-economic well-being. The results indicated that the average family size in watershed areas was smaller than that of control villages and education level among watershed farmers was higher (Table 3). Further, labour force participation rate was higher in watershed areas, which can be attributed to higher cropping intensity and crop production that led to the generation of additional employment opportunities in post-watershed development period. When we have counted the number of wells owned per family in watershed villages, it was found significantly higher than the control villages, which can be attributed to the augmentation of groundwater recharge in the areas that have encouraged the farmers to install new wells or rejuvenate many existing defunct wells. Fodder production activities were taken up in arable areas, and grass/tree-based treatments were taken up in non-arable areas of the watersheds to improve fodder availability. However, there were no significant differences in livestock numbers per household observed, and the average milk production per household (2.43 and 2.26 litre, respectively, at watersheds and control villages) was also found to be very low, which was definitely due to lower productivity of native breeds of animals reared by the farmers in the region.

Observed Impact of Watershed-Based Interventions

In all the selected watersheds, an increase in cultivated area and cropping intensity was recorded since the area sown more than once increased over the pre-project period. On the other hand, the area under current fallows (cultivable waste) was brought under cultivation, especially for crops grown in *kharif* season (July–October), which is predominately taken under rainfed conditions (Table 4). Most importantly, a considerable decline in area under wasteland was observed through pasture development and/or afforestation activities. Water resources development activities also helped in increasing the potential irrigated area and thereby increased the irrigation intensity in comparison with pre-project period. The results also reveal that sizeable area of permanent fallow (wasteland) was converted into cultivable land and put under cultivation both during *kharif* and *rabi* (October–March) season resulting in expansion of the total cropped area in all watershed villages. Positive improvement in crop diversification index (CDI) and cultivated land utilization index (CLUI) was observed in the watersheds owing to various soil and water conservation measures as well as better agronomic practices (Table 4). The value of crop yield index (CYI) was found to be greater than unity which indicated that average yields of major crops were higher in the watersheds in comparison with pre-project period as well as control villages (Tables 4, 5) endorsing the results

Table 3 Demographic particulars and resource characteristics of sample households

Particulars	Watershed villages	Control villages
Family details		
Average family size (number)	6.20 (− 0.96***)	7.16
Labour force participation rate (%)	47.57 (4.54**)	43.03
Education of respondent (years of schooling)	5.87 (2.40***)	3.24
Farm details		
Average land holding size (hectare)	1.74 (− 0.03^{NS})	1.94
Value of farm assets (INR in thousands)	76.44 (6.28^{NS})	70.16
Wells owned (number)	1.33 (0.22*)	1.11
Average livestock holding size (SAU[a])	3.75 (0.22^{NS})	3.53
Milk production (litre per day)	2.43 (0.19^{NS})	2.26

Figures in parentheses indicate absolute differences of values in watersheds over control areas

[a]*SAU* standard animal units [19], *NS* not significant

***, ** and *Significant at 1%, 5% and 10% level

Table 4 Changes in various indicators/indices due to watershed development programmes measured over pre-project period

Sl. no.	Indicators/indices	Pre-project	Post-project	Absolute change	% change
I	Average cultivated area (hectare)	229.04	306.59	77.55	33.86 (25.29)
II	Current fallow (hectare)	111.96	34.41	− 77.55	− 69.27 (− 25.29)
III	Double cropped area (hectare)	87.93	158.47	70.54	80.22 (22.78)
IV	Cropping intensity (%)	92.95	136.98	44.03	–
V	Forest/pasture/plantation	105.69	141.74	36.05	34.11 (17.23)
VI	Wasteland (hectare)	103.56	67.51	− 36.05	− 34.81 (− 17.23)
VII	Net irrigated area (hectare)	59.91	147.87	87.96	146.82 (28.69)
VIII	Irrigation intensity (%)	124.12	137.15	13.03	–
IX	Crop diversification index (CDI)	1.61	2.22	0.61	–
X	Cultivated land utilization index (CLUI)	0.34	0.43	0.09	–
XI	Crop yield index (CYI)	1.31			
XII	Watershed eco-index (WEI)	0.27			
XIII	Temporary employment creation (man-days per hectare)	42			

Figures in parenthesis indicate per cent change over total arable land (Serial No. I, II, III & VII) or non-arable land (Serial No. V & VI)

Table 5 Changes in various indicators/indices due to watershed development programmes measured over control villages

Sl. no.	Indicators/indices	Watershed	Control	Absolute changes	% change
I	Crop yield index (CYI)	1.04			
II	Labour absorption into crop enterprises (mandays per household per year)	426.20	418.68	7.52^{NS}	1.80
III	Labour absorption into crop enterprises (mandays per hectare per year)	80.17	66.35	13.82***	20.83
IV	Household income (INR in thousand per year)	60.17	48.53	11.64*	23.99
V	Income from crop enterprises (INR in thousand per hectare per year)	20.18	12.87	7.31***	56.80
VI	Persons per family migrate during lean season (number)	1.35	1.39	0.04^{NS}	− 2.88
VII	Average duration of migration (days)	57.72	60.96	− 3.24*	− 5.31

*** and *indicates significant at 1% and 10% level; *NS* not significant

of earlier studies [10, 11]. Planting of trees, as well as fodder and grass development activities at private farmland and field bunds, was very popular among the farm communities aiming to strengthen field *bunds* and increase the fodder availability (through the planting of perennial grasses) that supports livestock during drought years. Further, increased availability of soil moisture improved green cover and resulted in the positive value of watershed eco-index (WEI) to the extent of 0.27, which implies that up to 27% additional green cover has been developed (Table 4). Thus, results clearly suggest that interventions under the watershed development programme have generated positive externalities with respect to many biophysical and environmental indicators such as land and water resources, cropping pattern and productivity along with improved vegetation and biomass cover.

Various mechanical measures for soil conservation and water resources development as well as plantation activities were taken up manually by engaging labour, and casual/temporary employment to the extent of 42 mandays per hectare has been created during the execution period (Table 4). Total regular employment per household for cultivating crops was not much different due to the engagement of more family labour (because of disguised unemployment) in rural areas (Table 5). However, the utilization of labour per hectare was significantly higher in watershed villages than that of control villages indicating higher labour efficiency in the watershed areas that support the results of earlier researchers [1, 11, 13]. The results amply showed that the household income, as well as farm income per unit area, was significantly greater in villages where watershed programmes have been taken up. Though no significant differences in the average number of persons per family migrating from watersheds and control villages were observed, the duration of migration was longer for the people who reside at control villages indicating fewer employment opportunities locally.

Farmers' Perception about the Impact of Watershed Development Programmes

An analysis of the overall impact of watershed programmes was carried out by identifying perceptible benefits and ranked them based on the responses received from respondents, and results are presented in Table 6. About 78% of respondents perceived that watershed development programmes led higher yields, followed by groundwater recharge, resource-saving and increased farm incomes. About 15% of them perceived groundwater recharge as the most important benefit, as experienced through an enhanced number of wells, depth of water, pumping hours and reduced recuperation time after pumping. The creation of employment potential (both casual and regular) was also equally important as indicated by the respondents belonging to landless as well as marginal farmer categories because the availability of employment is very low due to unfavourable farming situation and less off-farm employment opportunities in the region. Other benefits like the increased availability of fuel and fodder, drinking water, reduction in forced-migration, higher social equity and improved living status were also perceived by beneficiaries as evident by the Garrett scores.

Observed vis-à-vis Perceived Impact of Watershed-Based Interventions

The collective outcome of various land-based activities and augmentation of water resources were observed in terms of changes in cultivated area, the area under wasteland and fallow lands. Extra water storage capacity created through construction and rejuvenation of ponds, wells, construction of structures to stabilize gullies as *nala bunds*, check dams, percolation tanks, etc., that have improved the groundwater table in nearby wells and results visible effect in terms of an increase in irrigated area and irrigation intensity. Crop diversification index and cultivated land utilization index were found to be higher over pre-project situations, and higher productivity levels for the major crops in watershed villages were evidenced by a higher value of crop yield index. With these results, the study strongly endorsed that watershed interventions have generated significantly positive externalities and improved the overall well-being of the farmers in treated areas through favourable changes in socio-economic conditions and conservation of natural resources. The beneficial effect of various interventions on-farm productivity as well as natural resources conservation is more direct and tangible as compared to its potential influence on household welfare, which is less obvious and more intangible in nature. However, watershed interventions have a relatively quick and direct impact on livelihoods through productivity enhancement and resource-saving, thereby increasing farm incomes and creating employment opportunities as perceived by the respondents, which was evident from the high Garrett score. Other direct benefits like the increased availability of fuel and fodder, drinking water, reduction in out-migration, improvement in social equity and living status, though recognizing their implications, were not readily perceived and prioritized by the farmers as evident from relatively low Garrett scores.

Conclusions

This study suggests that the watershed programme accrues multiple benefits at the watershed scale and has the potential for scaling up and sustaining rainfed agriculture. Additional water resources created under the programmes help in realizing the untapped irrigation potential, which is key for moderating the impact of drought in rainfed areas. Further, various soil conservation activities led to

Table 6 Perception of beneficiaries on impact of watershed-based interventions

Particulars	Per cent position	Garrett score	Final rank
Yield increase (78)	8.08	78	I
Groundwater recharge (15)	15.00	71	II
Increase farm income	36.58	57	IV
Resource saving (7)	21.92	66	III
Better drinking water availability	66.00	42	VII
Increase employment opportunities	43.83	53	V
Increase availability of fuel and fodder	88.00	27	IX
Reduction of migration	57.67	47	VI
Higher living status	89.92	26	X
Increase social equity	74.33	38	VIII

Figures in parenthesis indicate per cent of respondents perceived it as most important impact of watershed-based interventions

favourable changes in the cropping patterns and brought out an incremental area under cultivation. The desirable positive changes in crop diversification and an increase in crop yields, enhance farm income and created additional employment opportunities for landless and marginal farmers. It can be therefore recommended that watershed programmes may be extended to other disadvantaged regions. However, the allocation of fund for capacity building of stakeholders was low in comparison with the prescribed norms, and no fruitful efforts were made in any of the watersheds for development of livelihood support system due to biasness towards land treatment activities as effects are more visible in the field compared to livelihood enhancement programmes. Further, capacity building of beneficiaries is essential for creating awareness and achieving their active participation through training. Apart from the creation of formal arrangements (watershed institutions), several informal groups are also necessary to enhance the voluntary participation of people in the programme effectively which will ensure the success and sustainability of watershed programmes.

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Compliance with Ethical Standards

Conflict of interest The authors declare no conflicts of interest regarding the publication of this paper.

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