Management of Land and Water Resources with Peoples Participation in Shivalik Foothills of Northern India

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Abstract: Sustainable livelihood, poverty alleviation, productive employment generation and environmental securities through natural resource conservation and management are the major concerns in Shivalik foothill region. Amongst the various alternative strategies being developed to tackle these problems, rainwater harvesting and recycling has proved to be most promising and viable. Stabilization of catchment area and preventing movement of sediment to the reservoir with vegetative/bio-remedial measures, supported by structural treatments, have proved to be most effective. Availability of irrigation water has motivated the farmers to improve land qualities by levelling their fields. Consequently crop yields and biomass production from common land have increased manifold. Community participation and social benefits emanating from the project, suggest a very positive impact of watershed approach for natural resource management in Shivalik foothills. Creation of watershed level institutions have empowered these communities for managing their resources.
Keywords: participatory watershed management, rainwater harvesting, bioremedial measures, social fencing

1 Introduction

Watershed management is a single window, integrated, participatory and sustainable area development programme of a geo-physically defined natural drainage unit of land. Watershed management programmes implemented earlier in the Shivalik foothill region, have established that rainwater conservation and management increased manifold the biomass production from the watershed area, moderated floods and drought, augmented groundwater, generated employment and improved socio-economic condition of the people (Mittal *et al.,* 1986, Mittal and Singh, 1990).

The problems of Shivalik foothill region of about three million hectares, spread in the northwestern States of Punjab, Jammu and Kashmir, Haryana, Himachal Pradesh and part of Uttar Pradesh are particularly serious. Failure in rainfed agriculture in the region tend to create pressure on the nearby hills. Ever increasing biotic pressure has led to devastation of fragile eco-system resulting in soil erosion, sedimentation of reservoirs, flash floods and loss of fertile agricultural lands.

Among the various alternative strategies being developed to tackle the above problems, rainwater harvesting techniques have proved to be most promising and viable (Mittal *et al.,* 1986, Mittal and Singh 1990). This has given a new direction to the management of natural resources for the mutual benefit of the people as well as the hilly eco-system.

This paper vividly describes the techniques of rainwater harvesting including catchment treatment, utilization of harvested rainwater for crop production and creation of village based institution for social actions and management of common property resources, in a village called Relmajra, disctirct Nawanshahar, Punjab.

2 The project background

The region receives an average rainfall of 1,021 mm. About 80 percent of this is received during the monsoon season (June end to September). The winter (December to March) rain is insignificant. An yearly rainfall of 1,021 mm is not too low to manage two good crops, but its skewed pattern of distribution is the major concern. Crops sown in the months of October/November (mainly wheat,

chickpea and mustard) usually suffer due to soil moisture deficit. The rainfall distribution pattern indicated distinct possibilities of harvesting excess rainwater from hilly catchments in monsoon season for subsequent irrigation during the dry periods.

3 Rainwater harvesting

Water harvesting largely depends on rainfall and will, therefore, be more successful in areas where rainfall is sufficient and variability during the main monsoon season is not excessive. Besides rainfall, water harvesting depends on several factors including soil type as well as depth, vegetative cover and slope of the catchment area. For the water harvesting programmes to be successful, it is essential that moderately large catchments and sufficient storage capacity may be kept in mind.

A 59 ha hilly catchment area situated in the vicinity of the village was surveyed in 1990. Fortunately an excellent site for construction of an earthen dam with a reservoir storage capacity of 13.7 hectare metres (ha • m), was available very close to the village. The catchment area owned by the community was open to grazing and other biotic interference. Consequently most of the rainwater ended in runoff carrying with it huge amount of sediments and detritus. The catchment area, therefore, required intensive soil conservation measures to reduce the meanace of soil erosion, to save the reservoir from siltation and improve ecology of the watershed.

4 Catchment treatment

A number of structural interventions coupled with vegetative or bio-remedial measures were carried out to reduce soil erosion in the catchment, break length as well as degree of slope, prevent scouring and undercutting of hills and stabilize channel bed slope. The following bio-remedial measures were provided in drainage channel upstream of the reservoir submergence area (Samra *et al.*, 1998).

(1) Vegetative/brushwood check dams (60 cm — 90 cm high) across the channel.

(2) Vegetative spurs (single and double lines) by driving in poles of *Lannea grandis* supported with brush and/or planting of *Arundo donax* (Nara) in two parallel rows about 60 cm apart closely spaced and at a slight angle to the channel.

(3) Construction of few loose boulder check dams in upper reaches of the main channel and also at the junction of two side channels to provide auxillary support to the bio-remedial measures in lower reaches.

(4) Staggered contour trenches (2 m × 0.45 m × 0.45 m) at vulnerable slopes were dug in the catchment and planted with various tree species numbering 20,700. Most of these trees are surviving.

5 Social fencing through peoples participation

In addition to the bio-remedial and structural measures, effective closure to grazing and illicit removal of vegetation was most effective in rehabilitation of degraded catchment. This was achieved through community driven participatory approach wherein the local people were involved in the planning, implementation, management and mutual sharing of various goods and services as well as responsibilities. However, the most important role of the community was in regulating/restricting biotic interference through the concept of `social fencing'.

6 Construction of earthen dam

A homogeneous earthfill dam with clay core wall was constructed at a narrow gorge at the foothill in 1992. For design purpose the average annual rainfall was assumed to be 1,000 mm. The average annual water yield from the 59 ha catchment was estimated to be 10.62 ha m (or 180 mm) at 20 per cent of the assumed average monsoon rainfall of 900 mm. The design details of the dam are given below:

7 Hydrologic

- Catchment area 59 ha
- Design storage capacity (at full lake level) 13.7 ha • m
- Dead storage 3.1 ha • m
- Live storage 10.6 ha • m
- Potential Command area (for 2 irrigations @ 75 mm each) 25 ha
- Water spread area(at full lake level) 2.95 ha

Dam specifications:

● Height	13.5 m		
● Top width	4.0 m	● Side slope	3:1 D/s & 2.5:1 U/s
● Base width	83.2 m	● Free board	1.5 m

D/s = Downward side, U/s = Upward side

Drop inlet type principal spillway, with two 450 mm diametre RCC pipes, was provided at a height of 10 m through the body of the dam. The spillway functioned only once in September 1994.

8 Water conveyance system

Since the stored water is very precious and available in small quantity, it was imperative to make its best use without incurring any transit losses. A 300 mm cast iron pipe was laid through the body of the dam at a gradient of one per cent with a discharge capacity of three cusecs. A network of 2.9 km long NP-2 RCC underground pipeline system was laid to convey harvested rainwater from the dam to the fields for providing supplemental irrigation. Risers with alfalfa valves were provided at appropriate places for delivery of water to the fields. Surface method of irrigation was adopted through irrigation channels within the fields. A coupon system was introduced by which members can draw water on pre-payment basis.

9 Use of harvested rainwater

The efficiency of rainwater harvesting system depends on the prudent utilization of surface water resource. The harvested water may be judiciously used for crop life saving (protective irrigation) or as supplemental irrigation to increase and stabilize crop yields and to increase crop intensity. Since harvested water is available in limited quantity its efficient management is of utmost importance. The quantity of water applied was just enough to take care of the critical growth period of crops. The endeavour was to cover as large an area as possible. The total number of irrigations varied from crop to crop. But keeping in view the limited quantity of water available, efforts were made to get maximum returns per unit of water applied. Prolonged storage might have reduced the amount of water available due to seepage and evaporation losses resulting in shrinkage of command area. It was therefore, necessary to make use of the stored water as early as possible. Pre-sowing irrigation for winter crops was done wherever possible to minimize storage losses.

10 Land leveling

Since the agricultural fields were undulating and uneven, farmers were encouraged to level their fields in order to make best use of precious water. Farmers levelled their land in a big way, using their own resources. As a result of land clearing, levelling and land shaping the cropped area in rabi increased from 1.54 in 1992 to 22.07 ha in 1999. More and more farmers are resorting to land leveling as they have been told that only those farmers will get water who level their fields.

11 Impact of irrigation on crop yield

Depending upon the availability of irrigation water, two to three irrigations could be provided to wheat, chickpea and mustard. This also motivated farmers to use fertilizer, farm- yard manure, improved varieties and other practices recommended for each crop. The response to irrigation at critical growth stages of these crops was tremendous as is evident from the data presented in Table 1.

Farmers started growing berseem (Trifolium alaxandrinum), an important green fodder, with the availability of irrigation water. Some farmers are growing even vegetables for their own consumption. The availability of fodder has increased manifold which was instrumental in reducing biotic pressure on the hills. Hybrid napier (Pennisetum purpureum) was planted over 0.45 ha village common land. It gives 4—5 cuttings in a year. It was accepted by the farmers as it is meeting their fodder requirements.

Availability of fodder from agricultural fields and grass from hilly areas has given a fillip to the dairy industry. The total milk production increased from 341 litres in 1993 to 617 litres in 1999.

Table 1 Effect of supplemental irrigation from harvested rainwater on grain yield of different crops at Relmajra

Crop	Number of irrigations	Grain yield (kg・ha)	Net returns (Rs/ha)
Wheat	Nil	910	(-) 713
(Triticum aestivum)	One	2500	9945
	Two	2800	11642
	Three	3150	13675
Chickpea	Nil	390	1012
(Cicer arietinum)	One	810	7342
	Two	1040	10632
Mustard	Nil	200	(-) 2845
(Brassica juncea)	One	615	2254
	Two	810	4452

12 Community participation

The success of watershed development and management projects depends on community participation right from the beginning. The participation becomes easy if there is transparency right from the beginning and people are convinced with the aims and objectives of the project. Before taking up the project several meetings were held with the villagers. The entire programme and plans were discussed with them in these meetings. The villagers were asked to constitute a village society. Consequently a Water Users Society (WUS) was constituted with the inception of the project. The WUS has been registered under the Societies Registration Act XXI of 1860. The society has its own bye-laws and bank account. The WUS has been assigned the following responsibilities:

(1) Protection of hilly watersheds from grazing and illicit cutting of vegetation.

(2) Distribution of harvested rainwater among all its members equitably at the rate fixed by the society.

(3) Disposal, through auction, of fodder and commercial grasses from watershed area.

(4) Leasing out of reservoir for fish culture.

(5) Maintenance of dam, water conveyance system and other assets.

The WUA had generated by September 2001, a “Social fund” (revenue) of Rs.2,65,747 (one US$ = Rs. 49) through the sale of common property resources like water for irrigation, sale of grass, lease of reservoir for fish, fruit plants, etc. The funds of the WUS are being used for repair and maintenance of dam, water conveyance system, etc. thus obviating the necessity to depend on Government. Funds are

also used for welfare activities in the village. The WUS has so far spent an amount of Rs. 2,58,119 on these activities.

13 Lessons learnt:

(1) Watershed management programmes cannot be implemented without first convincing and motivating the local community to become actual partner.

(2) If the people living in the watershed area agree to and understand the importance of the works to be carried out, they will actively participate in implementation and maintenance of the assets created in the project.

(3) While implementation of the project could be done by an external agency, management of the project and distribution of common property resources developed within the project, should be the responsibility of the community.

(4) Establishing village level institutions like Water Users Society played a pivotal role in making the programmes successful.

(5) All benefits and liabilities arising out of the programme should be shared equitably by the community.

14 Conclusion

(1) The implementation of this project has translated into reality the Guiding Principle No.2 of International Conference on Water and Environment (ICWE) held in January 1992, in Dublin and endorsed by Agenda 21 of the Earth Summit held in Rio de Janeiro in June 1992 which reads as follows:

"Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels"

In true spirit of the above principle and to ensre efficient and judicious utilization of limited water, the local community was involved in planning, implementation and subsequent management of the assets.

(2) The conventional approach for the management of watersheds and resource conservation does not work. The strategy must be one of providing social and economic basis for conservation and development programmes. Once a productive resource (like harvested rainwater) has been made available to the people, they will indeed conserve the hilly watersheds as well as the natural resources to the best of their ability.

References

Mittal, S.P., Mishra, P.R., Grewal, S.S. and Agnihotri, Y. 1986. Success story of Sukhomajri watershed management project. Indian Journal of Soil Conservation, vol. **14** (3): p. 1-8.

Mittal, S.P. and Singh, G. 1990. Resource conservation and management in watersheds of Shivalik foothills. Proc. International Symposium on Water Erosion, Sedimentation and Resource Conservation. Oct. 9-13, Dehradun, p. 330-339.

Samra, J.S., Sikka, A.K. and Bansal, R.C. 1998. Efficacy of channel bio-remedial measures in retaining silt and reducing reservoir sedimentation. Institute of Engineers (India) Journal, vol. **79**, August, p. 67-72.