# Response of Drainage Line Treatment of a Ravinous Watershed on Resource Conservation in North -Western India

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**Abstract**: Study was undertaken to evaluate the performance of watershed management programme on natural resource conservation in North – Western India. The watershed planning was based on Participatory Rural Appraisal (PRA) and the technologies are being executed for development of watershed in participatory mode through watershed committee. Out of 682.5 ha watershed area, about 460 ha has been treated with silt retention masonry check dams, water storage check dams, masonry spillways, masonry gully plugs, graded bunds with loose boulder waste weirs, leveling and small farm pond. A total of 538 ha cm surface runoff was harvested by constructing two small farm ponds on community land, and three small earthen and two masonry check dams on private waste lands to recharge ground water/drinking water otherwise going waste. It was observed that silt retention behind stone masonry check dams in upper, middle and lower reaches of the watershed was 59.6, 16.7 and 9.9 t/(ha • yr) respectively and 618.27, 23.49 and 1,775.81 kg of available nitrogen (N), phosphorus (P) and potassium (K) were arrested. It was found that soil moisture at 0cm—15cm, 15cm—30cm and 30cm—60cm depth was 27.66,32.23 and 38.11% higher respectively as compared to gullies without check dams. Nearly 2.65ha gullied land was reclaimed for cultivation due to nine small check dams. The average yield of mustard and chickpea in reclaimed gullies was 48.82 and 58.82% higher respectively than normal yield of these crops in the region.
**Keywords**: ravinous watershed, sustained production, check dam, participatory rural appraisal

## 1 Introduction

Out of 5.5 million ha ravinous area in India (Sehgal and Abrol, 1994) 0.456 million ha (8.22%) is situated in Rajasthan in which 0.36 million ha (80%) exists in South-eastern Rajasthan along the river Chambal and its tributaries. Ravines are slowly but steadily engulfing the adjoining tablelands. Prakash *et al.* (1990) reported that ravines in the region were extending @ 0.865% per annum on compound scale. Almost same findings have also been reported by Sharma (1980). In view of increasing demographic pressure on available lands in the region, there is no other option but to manage these ravinous watersheds for sustained production of food, fodder, fuel, timber, etc., A research-cum-development project was taken up in a representative ravinous watershed in 1997 by the Central Soil and Water Conservation Research and Training Institute, Research Centre, Kota for demonstration and field evaluation of watershed development technologies in Badakhera, which is a typical ravinous watershed located at 25° 36′ N latitude and 76° 15′ E longitude in Bundi district of South-Eastern Rajasthan of North – Western India (Fig. 1). Watershed is having an area 682.5 ha with very high drainage density and about 80% of it constitutes as private waste land. The soils of the watershed are black soils of recent alluvial origin, which belong to hyperthermic family of Chromusterts and Pellusterts under the order vertisols. Three soil series namely Sultanpur, KotaVariant and Chambal have been identified in the watershed (calcareous phase). The texture of watershed soils varies from clay loam to silty clay loam. The soils are low in available N, P and organic matter and moderately high in available K with pH 7.8 to 9.0. The climate of the region is semi-arid and annual rainfall is about 750 mm. The distribution of rainfall is highly erratic as more than 90% is received during June to September in intense storms. May with 41.9$^{o}$C mean maximum temperature is the hottest month and

January with 6.5°C mean minimum temperature the coldest. The average relative humidity of the area is above 70% during monsoon season and remaining 30% during March to June. About 95% of the watershed area is under rainfed cultivation of the crops predominantly sorghum, soybean, mustard and chickpea, etc. on 2%—8% multidirectional slopes.

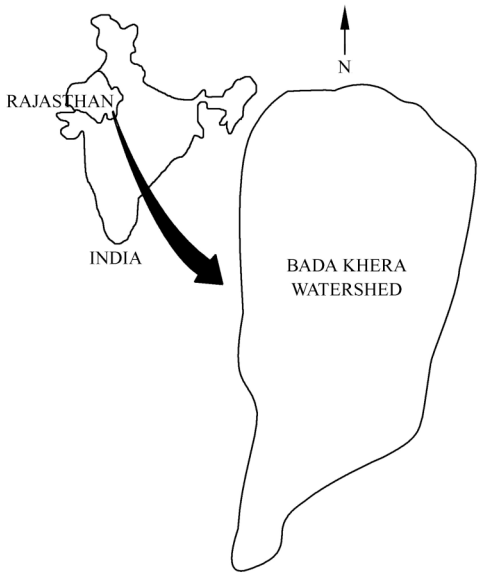


**Fig.1** Location map of a ravinous watershed

## 2 Materials and methods

The information collected through participatory rural appraisal (PRA) exercise includes topography, slope, soil, climate, vegetation, land uses, socio-economic status of farmers (population, literacy, self-employment, labour opportunity etc), need of soil and water conservation measures, food, fodder, fuel, etc. The watershed management plan was prepared and executed in participatory mode by watershed committee. Out of 682.5 ha watershed about 460.00 ha (67.40%) has already been treated with stone masonry check dams (16 nos) for drainage line treatments to stabilize the drainage channels and to improve the water regimes and ground water recharge in the watershed. Masonry spillways (9 nos) were also constructed for safe disposal of excess runoff from tablelands to gully beds. For in-situ moisture conservation the work of bunding (35 ha) with loose boulder waste weirs, levelling (14 ha), stone masonry gully plugs (7 nos) were constructed. Two farm ponds with capacity of 1.60 ha • m and 0.84 ha • m were constructed for harvesting the surface runoff otherwise going waste. The paper presents the response of drainage line treatments such as check dams and farm ponds based on data recorded for two seasons.

## 3 Results and discussion

### Runoff harnessing

A total of 538 ha cm surface runoff was harvested , otherwise going waste from watershed by constructing two small farm ponds on community lands, and three small earthen and two masonry check dams on private waste lands for recharging ground water, drinking watershed's

bovine, improving soil moisture regime down slope, irrigating the small patches of field for growing vegetables to meet house hold need of the watershed inhabitants.

**Table 1 Silt and nutrient retention in upstream of the stone masonry check dams in reclaimed gullies**

| Location of the watershed | Area (ha) | Silt retention ( t/ha ) | Nutrient retention (kg) | | | Land use |
|---|---|---|---|---|---|---|
| | | | N | P | K | |
| Upper reach | | | | | | |
| WUR1 | 26.6 | 56.4 | 112.71 | 4.21 | 274.92 | 86% ravineous land having sporadic occurance of scrub vegetation and 14% table land under agriculture with 6%—15% slope. |
| WUR2 | 18.5 | 67.2 | 92.31 | 3.12 | 251.75 | 92% ravinous land and 8% table land under agriculture with 6%—18% slope. |
| WUR3 | 31.2 | 63.5 | 148.09 | 4.82 | 368.99 | 83% culturable wasteland and 17% agricultural land with 5%—16% slope. |
| WUR4 | 9.8 | 68.7 | 50.58 | 1.89 | 123.38 | 79% culturable wasteland and 21% agricultural land with 6%—20% slope. |
| WUR5 | 14.5 | 42.2 | 38.24 | 1.66 | 115.34 | 65% agricultural land and 35% culturable wasteland with *Prosopis juliflora* having 6%—14% slope. |
| Middle reach | | | | | | |
| WMR1 | 51.2 | 11.4 | 44.39 | 1.43 | 112.36 | 61% culturable wasteland with *Prosopis juliflora* and 39% agriculture land with 2%—8% slope. |
| WMR2 | 65.6 | 18.3 | 85.53 | 2.69 | 211.59 | 69% culturable wasteland and 31% agriculture land with 4%—9% slope. |
| WMR3 | 39.2 | 20.6 | 55.31 | 1.68 | 155.65 | 83% culturable wasteland and 17% agricultural land with 3%—8% slope. |
| Lower reach | | | | | | |
| WLR1 | 74.7 | 9.9 | 54.11 | 1.99 | 161.83 | 83% culturable wasteland and 17% agricultural land with 2%—5% slope. |

### 3.1 Silt retention

A profile survey at 10 m horizontal interval was carried at upstream side of a small stone masonry check dams of 1.25 m to 2.75 m fall constructed as drainage line treatments. It was found that average rate of silt deposited behind check dams in upper, middle and lower reaches of the micro-watersheds was 59.6, 16.7 $t \cdot ha^{-1} \cdot yr^{-1}$ and 9.9 $t \cdot ha^{-1} \cdot yr^{-1}$ respectively (APR, 1999—2000). The highest retention of silt in upper reaches of the watershed was mainly due to very high drainage density, bed slope of the stream, slope of the watershed, scarce vegetation etc., whereas the lowest sediment deposit in lower reaches was attributed to series of obstructions/barriers (check dams) in upper and middle reaches of the watershed. The amount of fertile soil retained due to nine checkdams was 9341.01 tones in one monsoon season (Table 1).

### 3.2 Plant nutrients

Plant nutrients in deposited soil behind the small stone masonry check dams were analyzed by standard methods. It was observed that 618.27 kg, 23.49 kg and 1775.81 kg of available nitrogen (N), phosphorus (P) and potassium (K) were arrested from nine small stone check dams, otherwise, going

waste from the arable lands. Arrested plant nutrients not only reduced erosion hazards for maintaining the soil productivity, but also prevented the degradation of water quality of down slope farm ponds, open wells etc.

### 3.3 Soil moisture

The drainage line treatments with masonry check dams promoted *in-situ* moisture conservation in reclaimed gullies. Random profile soil moisture sampling was carried out in reclaimed land at upstream side of check dams in the month of September 2000 and 2001 prior to sowing of *winter season* crops. Soil moisture at 0 cm—15 cm, 15 cm—30 cm and 30cm—60cm depths was 11.73%, 17.65% and 19.61% respectively. It was also found that soil moisture at 0 cm—15 cm, 15 cm—30 cm and 30 cm—60 cm depths was 27.7%, 32.2% and 38.1% higher respectively than gullies without checkdams.

### 3.4 Productivity of land

The survey of catchment of 9 small check dams indicated that 2.56 ha gullied land was reclaimed for cultivation. An attempt was also made to quantify the impact of check dams on crops yield during the winter season of 1999—2000. It was observed that yield of local chickpea (*Cicer arietinum L.)* and mustard (*Brassica compestris L. var. sorson*), being the most remunerative crops for reclaimed gully beds, was 928.0 kg/ha and 765.0 kg/ha respectively, which was 48.8% and 58.8% higher than normal yield of these crops in the region. This was mainly due to improvement in profile soil moisture level and deposition of fertile silt. Considering the prevailing market prices of mustard and chickpea 21% and 16 % cost of check dams respectively was recovered in the first year itself after gully reclamation.

## 4 Conclusion

On the basis of result obtained in the ravinous watershed planned and treated under participatory mode in semi-arid region of north-western India it was concluded that watershed development treatments could provide tangible benefits on short term basis apart from the protection of resource base and long term intangible benefits..

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