Drought Mitigation in Bundelkahand Grassland Ecosystem for Improving Livelihood of Farming Community-A Case Study

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Key Words: Conservation of rain water; Participatory Water shed management; Restoration of grassland biome.

Abstract

Bundelkhand grassland ecosystem (23º20′ and 26°20′N latitude and 78°20′ and 81°40′E longitude) is an undulating rain fed region (annual rain fall, 768-1087 mm) spread over an area of 7.08 m ha in central India in the states of *Madhya Pradesh* and *Uttar Pradesh*. This region has to support 16 million human and 8.5 million animal populations. Area is prone to surface run off losses, severe soil erosion and increasingly more drought events, leading to only mono-cropping. Lively-hood of the people, which is mainly the live-stock rearing and marginal agriculture, is at stake. In-situ conservation of rain water, forage management, and environmental services are the main issues to be addressed at priority to enhance productivity per unit area of this biome. Development funds amounting to about 1000 million US$, provided for constructing sustainable infrastructure like check-dams, dug-wells, embankments, rising of crest height etc. has significantly improved the surface and ground water resources. Impact evaluation as discussed in this paper includes water resource development, watershed management, crop and live-stock productivity, and rural drinking water. A robust and resilient management system has been developed through farmer's participatory integrated watershed management program. Major aim is in-situ conservation of the rain water and recharging the dug wells, open wells, village ponds, and farm ponds. It has remarkably improved the financial condition of farming community. Initiation of restoration process of this grassland biome has increased its carrying capacity by 41%. An additional 25% land area has come under irrigation resulting in increase of net-sown area by 11%, cropping intensity by 6%, and farm income by 35%.

Introduction

Climate change greatly impacts grassland ecosystems due to increase in the minimum temperature, change in precipitation pattern and increase in the rain fall intensity (Pasricha 2015). Increased atmospheric temperature results in rapid depletion of soil-water through surface evaporation and greater transpiration demands. Increase in the frequency of high intensity rain fall events result in run-off losses of water as the infiltration rate of the soils may not keep pace with the high intensity rain fall. *Bundelkhand* mostly consist of black soils which are known to have very low permeability. Under such conditions, more than 70% of the water received as rain fall is lost as run-off. High speed run-off water is always accompanied with severe erosion loss of organic matte-rich surface soil. Increase in temperature with severe aridity can be a major driver of grassland destruction due to frequent wild-fires. The impact of increased aridity in future is likely to be more marked in the areas like *Bundelkhand* which can face 2.0 to 3.5^0 C raise in temperature by the end of this century (Kedia 2010). Under such conditions, loss of vegetation cover and climate-induced reduction in the stability of soil aggregates can enhance the process of soil erosion, resulting in rapid degradation. This is, exactly the case of *Bundelkhand* grassland. This region is inflicted with increased frequency of droughts, impacting adversely its productivity and under-mining lively-hood of its inhabitants. Animal husbandry and crop cultivation are the main source of lively-hood of the people (Samra 2008). There is hardly any industrial activity in the region to support the livelihood of the people. However, because of continuous drought conditions, a majority of the poor inhabitants resort to seasonal out-migration to save themselves from starvation. The impact of recurrent drought in the last few decades has become so intense that it is considered palpably devastating for the region (Gupta *et al.* 2014).

For integrated management of *Bundelkhand* grassland, forage management and environmental services are necessary to enhance productivity and farm income (Ghosh *et al.* 2016). Government of India under a special

package of around US$1000 million , started implementing drought mitigation program with the prime motive to (i) create additional water storage capacity by in-situ rain water conservation as a long-term drought mitigation strategy, (ii) enhance net sown area with increased availability of water for assured irrigation, and protected and life-saving irrigation, (iii) provide lively-hood opportunities especially to the land-less and weaker sections of the community, and (iv) ensure enough supply/availability of clean drinking water. We have discussed in this paper the impact evaluation survey report on the implementation of the project as submitted by the NABARD Consultancy Service for National Rain fed Area Authority, Government of India.

Methodology

The farm house-holds falling under the project catchment villages of major, medium and minor irrigation projects were selected randomly for the sample survey work. The survey work was undertaken by NABARDCON. A total of 630 house-holds in 21 sample irrigation (major, medium, and minor) projects of 6 districts of *Madhya Pradesh* and 870 samples irrigation projects in the 7 districts of *Uttar Pradesh* part of *Bundelkhand* region were covered. The sample adequately represented the head; middle and tail reach of the irrigation systems. The carrying capacity was calculated by multiplying the total amount of forage at the end of growing season with correction factor, and then dividing by the average yearly feed requirements of live-stock unit. A use-factor of 55% was used in these calculations (Van Wijngaarden, 1985). NABARDCON developed structured questionnaires' for all activities. There were separate questionair for site inspection and focused group discussion. The questionnaires so developed were adequately designated to give information on the physical progress and financial progress.

Results and discussion

Surface irrigation projects

Impact evaluation as presented in this paper covered water resource development, watershed management, forest and environment service and rural drinking water supply. The implementation of the project as envisaged, created additional irrigation capacity to the extent of 1,553,00 ha in *Madhya Pradesh* (MP) and 96,500 ha in *Uttar Pradesh* (UP) part of the region besides restoration of an area of 38,700 ha from the earlier irrigation area which was lost to degradation. However, on physical verification, it was found that the actual additional irrigated area created is only 88% in MP and 61% in UP of the envisaged area in the two states falling in *Bundelkhand* region. However, this is the situation at the time of mid-term survey; it is felt that once all the projects are completed in full measure, the anticipated targets for the irrigated area will be more or less fully achieved (Table1).

Table1. Achievements of targeted acreage under surface irrigation development projects of *Bundelkhand* .

Project category	Targeted, ha	Achieved, ha	% achieved
	***Madhya Pradesh* (MP)**		
Rajghat canal command area	26,624	26,624	100
New and on-going, minor projects (146)	50,232	42,272	84
Bariyarpur canal command area	43,850	43,850	100
Sighpur barrage, medium	10,200	0	0
Canal renovations	24,391	24,391	100
Total	1,552,97	1,371,37	88
	***Uttar Pradesh* (UP)**		
Rajghat canal command area	69,500	39,140	56
Betwa canal system	27,000	20,570	76
RRR scheme of canals	28,400	12,379	44
RRR of water bodies	10,000	10,000	100
Others	300	300	100
Total	1,352,00	82,389	61

Total for *Bundelkhand*	2,904,97	2,195,60	75.6

Among the four major/medium/minor irrigation projects in MP, total canal command area (CCA) has increased from 1, 370, 00 ha in 2008-09 to 1, 880, 00 ha in 2013-14, recording an increase of 37%. The reported irrigation potential increased to 1, 130, 00 ha from 68,000 ha in 2008-09. This has resulted in almost 200% increase in irrigated area in the *Rabi* season, fully devoted to high yielding wheat crop. This has been made possible because of the availability of assured irrigation. Based on the sample survey of 630 farmer beneficiaries by the select projects impact has been observed in the form of changing cropping pattern, increased cropping intensity, and increased crop productivity. Average irrigated area per house-hold of select sample farmers increased from 1.126 ha (2009-100) to 1.89 ha (2012-13), an average increase of 68% of irrigated area per house-hold dramatically increase the area under high yielding wheat varieties. With improved irrigation, the crop yields increased because of availability of life-saving irrigation during *kharif* season, and assured irrigation during *rabi* season. Wheat yield increased from 1.94 tons/ha (2008-09) to 2.79 tons/ha (2013-14), a 44 % jump.

In the UP part of the region, increase in the irrigation potential of the project envisaged was 1,100 ha with average per ha cost of US$ 14,600. Average irrigated land of the sample farmers in this part increased from 1.17 ha in the pre-development period (2008-09) to 1.364 ha in 2012-13. This also helped farmers to increase the cropped area from 2.24 ha to 2.39 ha and cropping intensity from 145% (2008-09) to 152% (2012-13) during this period. Wheat yield increased by 36% from 1.44 tons/ha in 2010-11 to 1.93 tons/ha in 2012-13. Similarly, there was 39% and 42% increase in the yields of chickpea and peas in the *kharif* season. Impact in terms of house-hold income is apparent from the increase of 34%. It increased from US$ 596.23 in 2010-11 to US$ 802.70 in 2012-13.

Water shed management projects

The watershed management activity in MP included mainly the construction of dug-wells, check dams or stop dams and provision of water lifting devices. About 73% of the dug-well work was completed. Of the 352 projects to be implemented, only 218 completed. Inaccessibility of the construction sites is cited as the main reason. With the construction of stop dams, the number of beneficiary farmers increased to 1989 from the earlier number of 874 before the start of this program in the sample survey. Estimated data of the number of house-holds benefited would be in the range of 10,852 to 14,175 at 95% confidence interval. The water storage capacity due to creation of stop dams aggregated 1,967,215 million cubic meters, resulting in an increase of 216.8 % of the project storage capacity. The incremental irrigated area due to these projects aggregated to 1,740 ha at the marginal cost of US$ 1,047.62 per ha. There occurred a significant increase in the water in the targeted area, in some districts by more than 50% due to creation of water storage. On an average, the ground water level increased by 3.15 m from 7.6 m to 4.51 m. This resulted in significant increase in area under vegetables during *kharif* season and wheat during *rabi* season. With the completion of stop dams, an additional irrigated area of 10,000 ha is now available, and fully devoted to high yielding wheat crop. The additional production of wheat in MP due to stop dams alone is estimated at 30,000 M tons.

The impact of dug-wells in enhancing irrigated area in UP can be judged from the increase from 126.5 ha in 2010-11 to 174.14 ha in 2012-13 in the sample area, corresponding irrigated to rain fed area ratio increased from 0.72 in 2010-11 to 1.18 in 2012-13. In most of the land, there was double cropping due to availability of irrigation water. There was almost a 63% increase in the irrigated area due to installation of dug-wells. The yield of *kharif* crops of soybean, chick pea and rice increased by 59%, 11%, and 76%, respectively. Similarly, there was almost 74% increase in the yield of wheat in *rabi* season. With the availability of assured irrigation water, farmers opted for cash crops like onion. Cropping intensity due to dug-wells in the test area increased from 138% in 2010-11 to 167% in 2013-14. Although deepening of the existing dug-wells was not very impressive in UP part and only 10% of the targeted work could be completed, it, however remarkably increased the water column from 0.89 m (mid June) and 3.4 m (mid November) before implementation of the project) to 5.44 m (mid June) and 7.05m (mid November), after the implementation of the project. Deepening of the dug wells proved very effective and increased the house-hold income from US$ 354.5 to US$568.49, a more than 60% increase in the farmer income. There were 18,000 beneficiaries of HDPE pipes; each received a total length of 600 feet costing between US$

306.67 to US$ 400.0. Although pipe irrigation is a bit more expansive but it definitely reduces not only the conveyance loss of water but also significantly reduces time taken to irrigate a unit area of land.

Forest and environment projects

For restoration of forest lands, the major activities undertaken were contour bunding, earthen check dams, concrete check dams and deepening of the existing ponds. Only about 50% of the total forest area marked for treatment could be completed in the MP. In case of UP, all the 60,000 ha marked for treatment was successfully done. The treatment effect was visible from the flourishing growth of grass and trees which reflected in the increase of carrying capacity from 1.14 ACU/ ha in 2008-09 to 1.62 ACU/ ha in 2013-14, a 41% increase. Earthen dams were slightly less efficient and could not stand the flow of water during rainy days but concrete dams were very effective in having anticipated level of water storage. Similarly deepening of the ponds also helped storage of more water so as to make an assured availability throughout the year. These structures greatly helped in cutting run-off losses of water, allowing more time for the water to percolate and get storied in the soil profile. As a consequence, it also protected the land from degradation by preventing soil erosion. Conserving of more water in the soil profile in the adjoining areas was also evident from greater stored water in the nearby dug-wells.

Rural drinking water projects

Bundelkhand region is very complex, has wide variations both in terms of geographical as well as economical, social and political aspects. There are all out efforts to make available enough drinking water both for human and domestic animal consumption. Enough money has been provided for installing hand-pumps and piped water supply for augmenting availability of drinking water. Of 1287 projects envisaged for piped water supply, only 904 (70%) could be completed in the stipulated time in the MP. In UP, however, hand pumps were more preferred and there was 100% success in installing all the 2725 hand-pump sets. The availability of drinking water has substantially reduced the distance (average, 55%) travelled by the village women to fetch water. The increased availability of water has tremendously improved the in-house sanitation facilities of *Bundelkhand* inhabitants. Beneficiaries in the MP part are quite satisfied with piped water supply, however, the popular decision to fix the charges at very nominal rate of US$ 0.40 per month may not be enough to meet the maintenance and operational costs, and the system may collapse sooner than later.

Conclusion

With robust financial support from the government, there has been a significant improvement in the water resources in the drought prone *Bundelkhand* region, resulting in increased crop productivity due availability of life-saving irrigation water for *kharif* crops during stress situations and for wheat crop sown on increasingly more area due to availability of assured irrigation in *rab*i season. Restoration of the grazing land improved the carrying capacity to help increase live-stock productivity. Participatory integrated water-shed management for in-situ conservation of rain water, recharging of the new and old dug-wells, village tanks and ponds and open wells has apparently improved the income and lively-hood of the farming community in the region.

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