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Full Length Research Paper

Change in extent of irrigation due to '*Sunehra Kal*' initiated soil and water conservation interventions in two semi-arid districts of Madhya Pradesh

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Conservation and judicious use of soil and water play an important role for sustainable crop production and improving the livelihood of people especially in the semi- arid and arid belts of India. The present work evaluates the changes brought about by soil and water conservation interventions in the beneficiary villages of Ratlam and Mandsaur districts, Madhya Pradesh in terms of cropped area, irrigated area and number of irrigations applied. An exploratory survey and evaluation through questionnaire based interview of the respondents was conducted. The post intervention period recorded a net increase of cropping area with ensured irrigation cover and more number of irrigations applied to the crop by the farmers of the beneficiary villages even in water scarce Rabi season.

Key words: Irrigation, watershed, soil and water conservation, '*Sunehra Kal.*'

INTRODUCTION

Water is a scarce and precious national resource and is one of the most crucial elements in developmental planning. In the Indian semi-arid tropics, water management projects aim to maximize the quantity of water available for crops through on-site soil and moisture conservation, infiltration into aquifers and safe run-off into surface ponds (Kerr and Chung, 2002). According to The National Water Policy of India (2002), watershed management can be realized through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and construction of check-dams. Ensuring proper and efficient irrigation will lead to successful watershed or Soil and Water Conservation (SWC) project (Deb, 2003). Concern about widespread of soil degradation and scarce, poorly managed water resources has led to the spread of watershed management investments throughout Asia, Africa and Latin America (Lal, 2000). These projects, which often operate at the level of a micro-watershed within a single village, focus on conserving soil moisture for rain-fed agriculture, recharging aquifers to augment groundwater irrigation, and capturing surface run-off water in small ponds. Where water harvesting is the main objective, the projects involve construction of small check dams in drainage lines (Kerr, 2002). Many developmental projects with the aforementioned objectives were initiated in India and one such was '*Sunehra Kal'* initiated by Indian Tobacco Company. Different types of SWC works accomplished by the 'Sunehra *Kal*' project were Stop dam/ Stop dam-cum-causeway, new well excavation, renovation of wells, pond/ percolation tank/water harvesting tank, contour trenching and field bunding along with revegetation of the villages.

The present work was carried out to evaluate the effects of SWC measures in terms of cropped area, irrigated area and number of irrigations applied. The evaluation was done to check whether the benefits have really tricked down to the real stakeholders. The implementation of conservation measures requires

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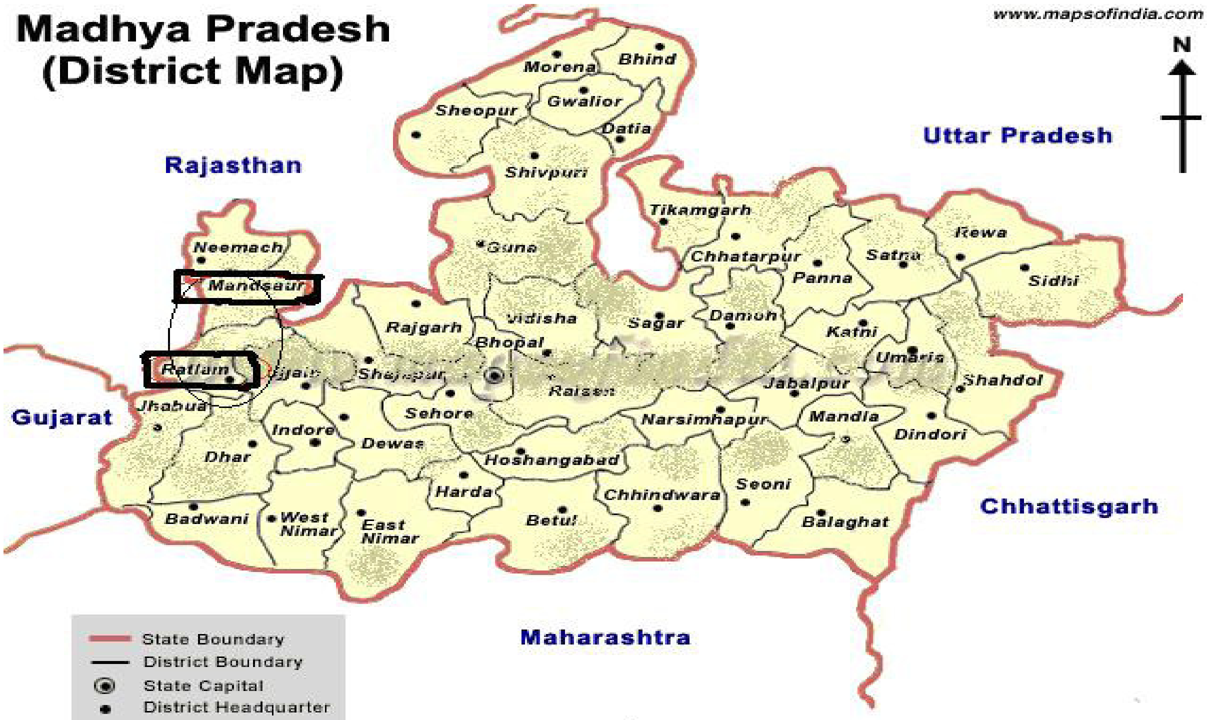

Figure 1. Map of Madhya Pradesh and the study districts.

considerable human and sometimes material resources and it is necessary that one evaluates to what extent these measures are effective (Hengsdijk et al., 2005).

METHODOLOGY

Both the study districts were situated in Western part of Madhya Pradesh state. Ratlam is situated towards south of Mandsaur and they also make the state boundary with Rajasthan (Figure 1). Ratlam is situated in North-West region of Madhya Pradesh extended between latitude 23° 05' North to 23° 52' North and longitude 74° 31' east to 75° 41' East. About 70% population in the district lives in rural areas, out of the total population 26% belong to tribals, 13% scheduled caste and about 36% were engaged in agriculture and agriculture depended activities. The basic area of concern in the region were undulating topography, erratic rainfall, very high biotic pressure, lack of irrigation and poor productivity especially in tribal villages, high surface run-off in the absence of natural vegetation cover, excess extraction of ground water by deep tube wells leading to water stress, poor socio economic status of tribals (http://ratlam.nic.in/profile). Mandsaur district forms northern-western projection of the state. It lies between the parallels of latitude 23° 45' 50" North and 24° 45' 42" North and between the meridians of longitude 74° 52' 43" East and 75° 55' 27" East. About 3.17 and 17.93% of the total population in the district were scheduled tribes and scheduled caste, respectively. The general problems of the area were shallow soil and impervious basalt strata, high biotic pressure, high run-off, sheet erosion, poor water regime and frequent droughts (http://mandsaur.nic.in/profile.htm).

The climate of the area was dry except in monsoon. Maximum temperature of the region goes maximum up to 40°C and minimum up to 9°C. Most of the rain occurs in the month of July and August. The average rainfall was 792 to 896 mm with number of rainy days about 35. The rivers Mani, Retam, Siwna, their tributaries and Malani were the main source of irrigation in the districts. The average land holding is 1.55 ha. About 8.5% of agricultural land had the irrigation facility. Except for a minority of 8 to 10%, the entire agriculture was rain-fed and vulnerable to the vagaries of monsoon. Soyabean is the main crop Kharif in Ratlam district followed by maize, cotton and others. In Mandsaur district, soyabean is the main Kharif crop followed by maize and black gram etc. In Rabi, wheat was the major crop grown in both the districts mainly in the irrigated area while mustard and chickpea followed with residual moisture (http://ratlam.nic.in/profile; http://mandsaur.nic.in/profile.htm). In general, the crop productivity for major crops is 3 to 4 times lesser than the state and country's average.

Looking to the constraint of limited time, instead of taking all the project villages for study, the study was limited to certain sample villages that were representative in nature. About 50% of the intervened villages (that is, six out of thirteen in Ratlam district and three out of five in Mandsaur district) were chosen for the present study along with one control village in each district to compare and draw the inferences. Two stage stratified random sampling techniques were used. First stage included the selection of certain villages out of the total project villages in both the districts. The project villages imply the villages covered under the *Sunehra Kal* project in both the districts till date. Non project villages were the control villages that were selected for the study. For control village, it was ensured that no physical work related to SWC was under taken in the last ten years by any agency and location of the village was near the project villages. Tribal villages mean the villages inhabited by the Schedule Tribe families mostly and non tribal as the name suggests implies the villages in which members of other caste are more. After the selection of villages, the second stage included selection of respondents. The variables used for selection of respondents were location as per physiography- farmers of

Table 1. Change in number of irrigation: Kharif.

Sample villages	Number of irrigation during Kharif		Net change	% change
	Pre	Present		
Karmadi	2.88	3.10	0.22	7.64
Kaneri	6.36	7.09	0.73	11.48
Sagod	3.27	4.33	1.06	32.42
Ghodakheda	5	8	3	60
Morwani	5.57	10.86	5.29	94.97
Borda	1	2	1	100
Ratlam district	4.01	5.90	1.89	
Non-beneficiary (C1-NT)	NA	9.5	NA	NA
Non-beneficiary (C1- T)	NA	2.33	NA	NA
Bilantri(LR)	0.25	0.33	0.08	32
Bilantri (UR)	1.83	2.17	0.34	18.58
Surkheda (LR)	0.42	0.67	0.25	59.52
Surkheda (UR)	1.17	1.17	0	0
K. Shivgarh (LR)	1.17	1.42	0.25	21.37
K. Shivgarh (UR)	3.60	4.40	0.8	22.22
Mandsaur district (LR)	0.61	0.81	0.20	
Mandsaur district (UR)	2.2	2.58	0.38	
Non-beneficiary (C2- LR)	NA	0.29	NA	NA
Non-beneficiary (C2- UR)	NA	0	NA	NA

C1- control village for Ratlam district- Kalukhedi, NT- Non tribal, T- Tribal; C2- control village for Mandsaur district- Hanadi, LR- Lower reaches, UR- Upper reaches, NA- not applicable.

Recharge zones (Upper Reaches- UR) and Discharge zones (Lower Reaches- LR) of watershed and beneficiary of project activity (Kakade, 2005). The physiography criterion was only applied for district of Mandsaur district because in Ratlam district the implementing agency was not following a conventional watershed approach. The respondents in 'non- *Sunehra Kal*' villages (non-beneficiaries) were classified as tribal (C1-T) and non-tribal (C1-NT) in Ratlam district whereas in Mandsaur district as upper (C2-UR) and lower (C2-LR) reaches. About 10% of the total village households in Mandsaur district and 20% cent of the beneficiaries in project villages of Ratlam district were interviewed for primary data collection. The reason for different sampling intensity was that in Mandsaur district project, whole of the village was considered beneficiary of the project whereas in Ratlam project, the members of water user association were considered beneficiary. In the control villages sampling of ten percent of population was done. In Mandsaur, out of total 521beneficiaries, 53 were selected while 11 farmers selected were non-beneficiaries. Similarly, in Ratlam district 54 respondents were selected from a total of 354 beneficiaries while 7 respondents were non-beneficiaries. Respondents were selected in proportion of the landholding of the village in the upper reaches/ lower reaches (Salunkhe, 2000; Shah, 2001) and beneficiaries of SWC work (Sharma, 2005). All these respondents were interviewed for primary data collection. The research design adopted for the study was an exploratory survey and evaluation to document response of the stakeholders on the related objectives of the present study. Exploratory research is justified in the context of the study since there was no pre-conceived hypothesis or any specific assumptions made concerning the objectives. Focused group discussions were done to know the views, perceptions, ideas and suggestions of the villagers. Community valuation of different SWC interventions by Pebble Distribution Method (PDM) was also done to understand and draw the wisdom and perceptions of the beneficiaries on the interventions following Sheil (2002) and Sharma (2005).

RESULTS AND DISCUSSION

The cultivated area in Ratlam district increased and the highest was in the village Karmadi with an increment of 0.75 acre (Table 1). However, the net change in cultivated land was highest in the village Ghodakheda (9.18%) followed by Borda (8.25%) and Morewani (6.03%). This indicates that there was an increment of 0.35 acre of cultivated land per household due to soil and water conservation interventions in the district that is, from 8.15 to 8.50 acres. In case of Mandsaur district, the increase in cultivated land was observed only in the village of Bilantri. There had been a net change of 0.08 and 0.09 acre in lower reaches and upper reaches of Bilantri village, respectively. The net change in lower reaches was 0.12 acres per household whereas it was only 0.06 acres in upper reaches. The increase of cultivated area in Bilantri village was 5.65% in lower reaches and 2.26% in upper reaches. The farmers reported that the increase in net cultivated land was due to the intervention of the project which yielded benefits in a short period of time. This single indicator itself benefited the villagers in term of production and mandays spent in

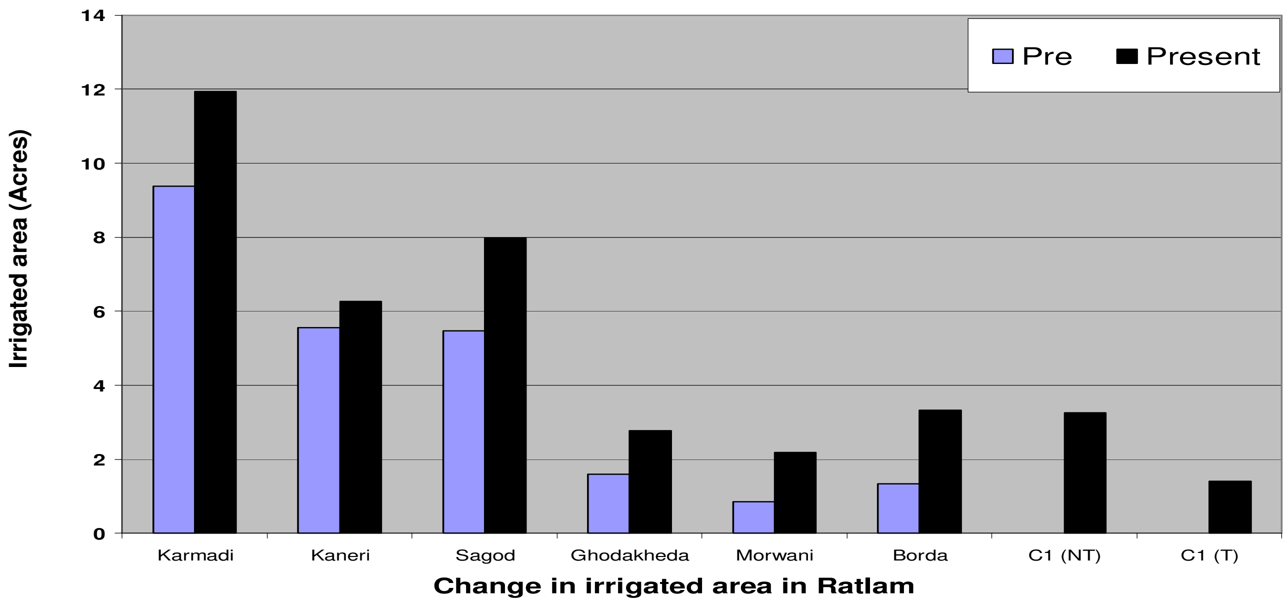

Figure 2. Status of irrigated area in Ratlam district.

agriculture as well as higher land appreciation. The soil and water conservation activities yielded highest in the lower reaches due to geological set-up and groundwater movement following the natural slope gradient within the watershed. Most of the fallow land existing during the 'pre- *Sunehra Kal*' phase in the villages was utilized for agriculture or horticulture. This is an indicator of availability of enough water and also increase in the economy in the tribal belts. Irrigation is extremely essential for better productivity of land. Increase in irrigated land signifies better production and higher land value. In the beneficiary villages of Ratlam district, the price of irrigated cultivated land ranged ₹ 1.5 to 2.0 lakhs Indian National Rupee (INR) per acre and for uniirigated land; it was about ₹ 0.7 to 0.8 lakh INR whereas, in Mandsaur it was ₹ 0.7 and 0.4 lakh INR per acre for irrigated and unirrigated cultivated land, respectively.

The acreage of irrigated land in the beneficiary villages of Ratlam district increased which was attributed to the structural interventions by the villagers and also due to good rains in the last season (Figure 2). The net change in average irrigated area was highest in the village Karmadi (2.56%) and closely followed by the village Sagod (2.5%).There was no irrigation source in these villages and after the excavation of new wells as well as renovation of existing wells, the irrigated land has increased to a large extent. In Mandsaur district (Figure 3), the change was very high in village Bilantri as compared to other villages. The renovation of village pond in Bilantri had led to this increase. In other villages, the impact of project on irrigated land was less observed as the structures made were not used for direct water harvesting.

Further, it was observed that the net increase in lower reaches almost doubled when compared to the upper reaches (Figure 3). Overall, the change in Ratlam district was more compared to Mandsaur district and within Mandsaur district, the change was more in the lower reaches. It was observed that the percent change in irrigated to cultivated land was highest in the village Morwani followed by Borda, Sagod, Karmadi and the least in village Kaneri of Ratlam district (Figure 4). Comparing with the non-beneficiary villages, it was observed that except village Sagod all other beneficiary villages had a higher percent of irrigated land. In Mandsaur district (Figure 5), the change was higher in lower reaches (14.88%) compared to the upper reaches (3.75%). The change in the villages Bilantri (both LR and UR) and Surkheda (LR) was higher compared to other regions. Comparing with both the reaches of the non-beneficiary villages reveals that the soil and water conservation measures had a positive impact on the irrigation status of the beneficiary villages. The percent increase in Ratlam district ranged from 47.27 to 73.85% whereas, in Mandsaur district the change ranged from 43.27 to 58.15% in lower reaches and 42.19 to 45.94% in upper reaches. The change in number of irrigation after the soil and water conservation intervention was recorded in beneficiary and non-beneficiary during Kharif season is given in Table 1. In Kharif season, most of the irrigation demand was met by natural rainfall and there is need of irrigation in only drought years for most of the crops.

However the choice of crop to be cultivated may affect the irrigation need. Irrigated area in Kharif was very less in the beneficiary villages of Mandsaur district as compared to Ratlam district. This was because most of the farmers were growing soyabean which do not require any irrigation normally. In Ratlam district, the farmers

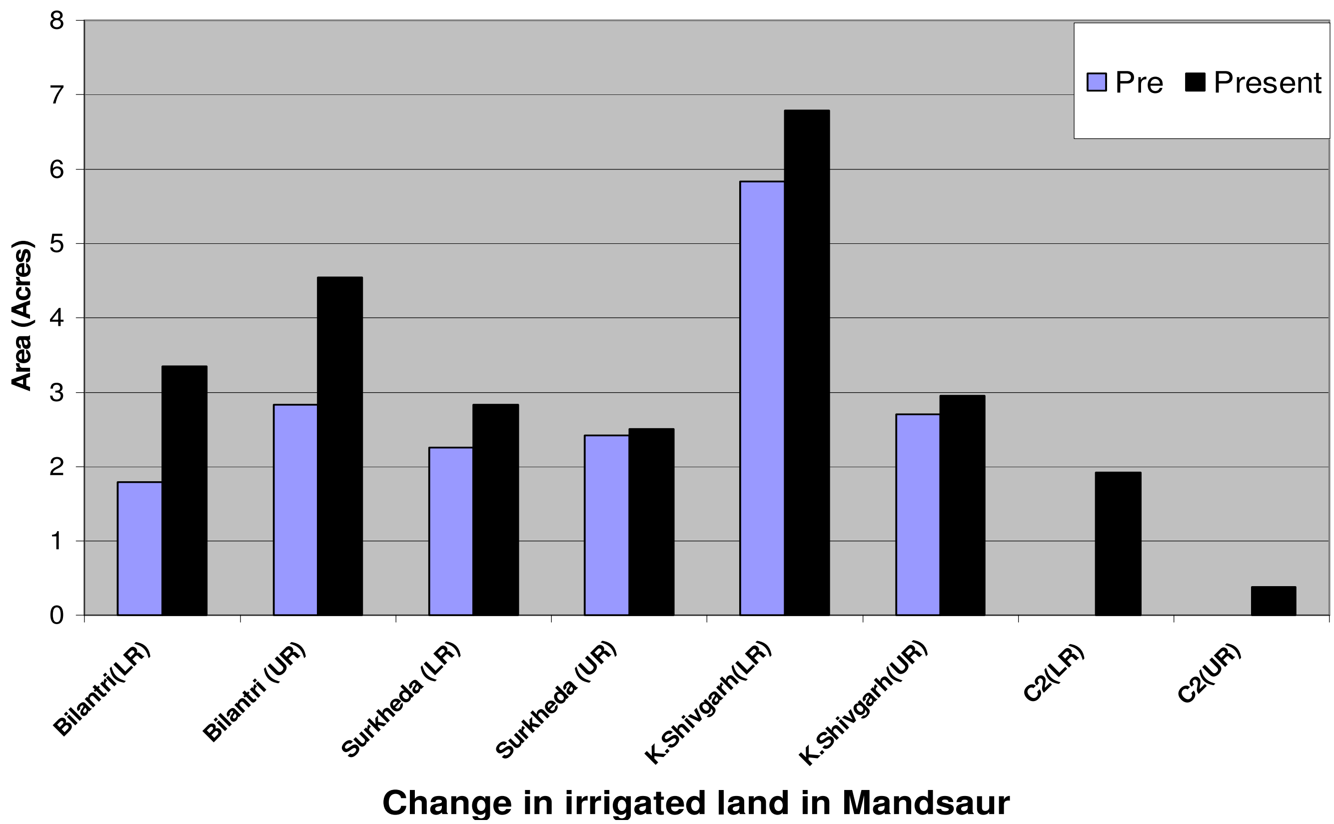

Figure 3. Status of irrigated area in Mandsaur district.

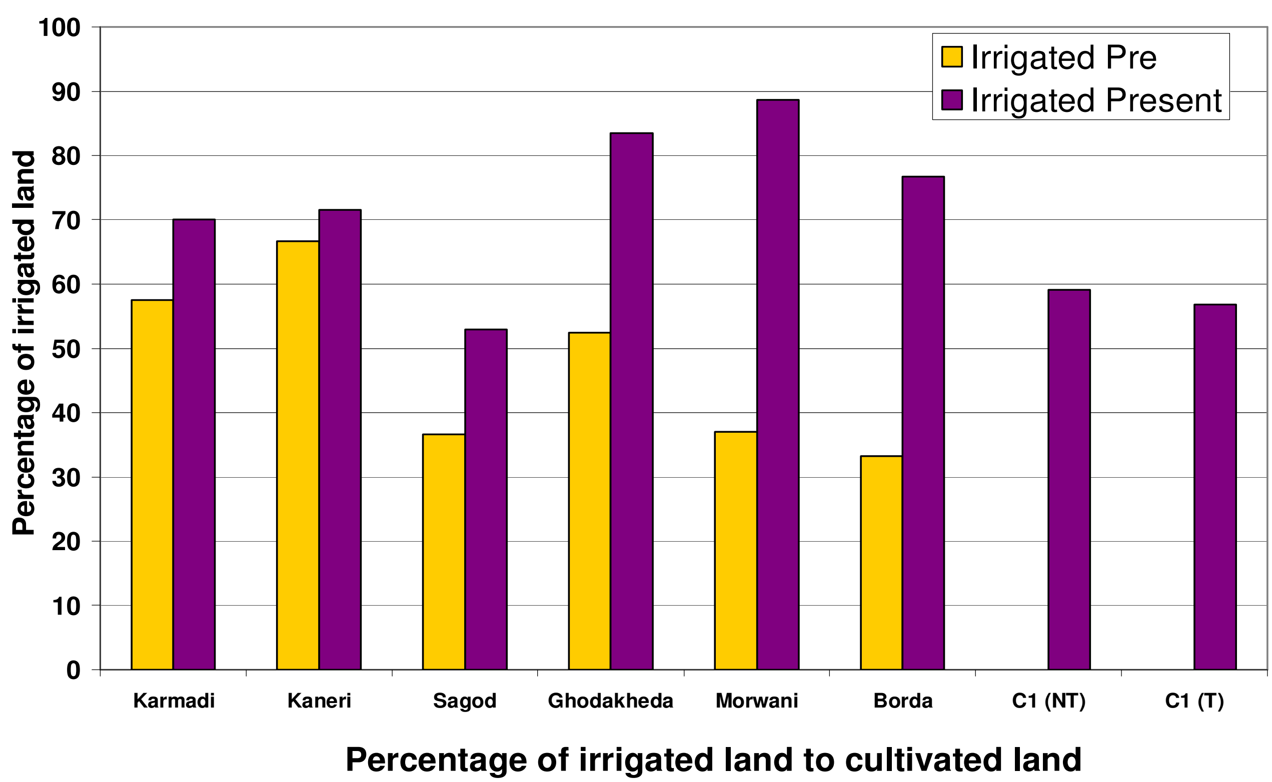

Figure 4. Percent irrigated land to cultivated land in Ratlam district.

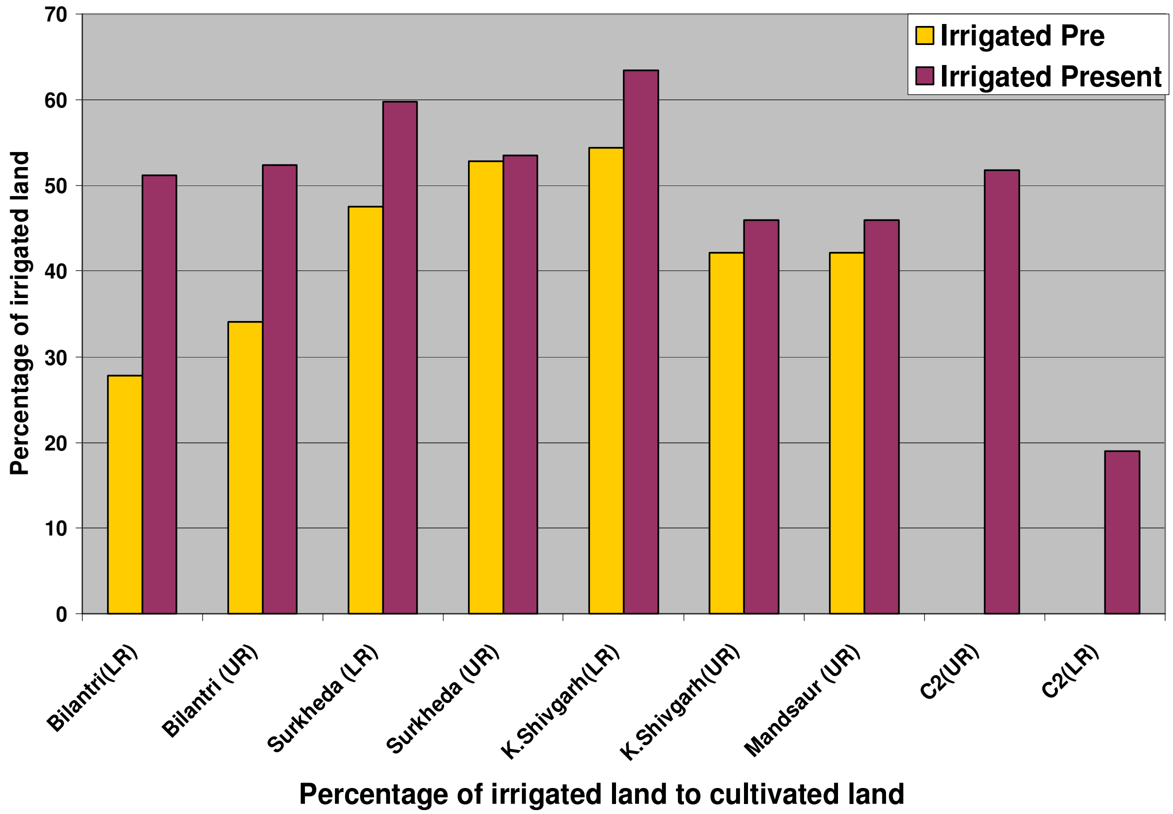

Figure 5. Percent irrigated land to cultivated land in Mandsaur district.

cultivated cotton and upon availability of water, cotton was irrigated 3 to 4 times. The change in average number of irrigations in Kharif season was recorded for crops like cotton and chilli. The overall increase in number of irrigations in Kharif was 1.89 in Ratlam district. The net change was highest in Morwani (5.29) followed by Sagod (1.06). In Mandsaur district, it was observed that the number of irrigations did not change much even after the soil and water conservation interventions. In India, water for irrigation is scarce during Rabi season. Many farmers are unable to raise crop due to absence of suitable source of irrigation and some are forced to cultivate those crops that give less monetary benefits. Post soil and water conservation intervention scenario reveals that area under irrigation increased during Rabi season in both the districts (Figure 6).

There was a net increase of 1.19 acres in Ratlam district and 0.81 and 0.77 acres in lower and upper reaches of Mandsaur district, respectively. The increase was very high in the tribal belts of Ratlam district as most of them had a permanent source of irrigation in form of dug wells sponsored by '*Sunehra Kal*'. Among the beneficiary villages in Mandsaur district, Bilantri recorded maximum increase in the cultivated land during Rabi season (1.45 to 1.80 acres per household) and in other villages this increment was much lesser. Increased number of irrigations ensures better production of crops most of the time in Rabi season which was possible only after the soil and water conservation interventions. Moreover, there was increase in number of irrigation during the Rabi season also. An average increase of 2.45 number of irrigation was recorded in Ratlam district whereas, it was 1.8 and 1.31 in the lower and upper reaches of Mandsaur district, respectively. The increase in numbers of irrigation was reflected in the higher crop production of both the areas. In summer, farmers having abundant resources could cultivate vegetables only. The overall crop grown area was just a small portion of the total cultivated land that generally ranged 0.1 to 1.0 acre. Water sources dried up during the summer season and resourceful farmers could afford irrigation. Most of the land remained vacant during summer because irrigation need of the crops was very high during this season as most of the soil moisture is lost due to intense evapotranspiration. On an average for each household, the cultivated land was found to be 0.063 acres in Ratlam district (net increase of 0.028 acres) and 0.14 and 0.07 acres in lower and upper reaches of Mandsaur district (net increase of 0.02 and 0.03 acres), respectively. The change was extremely high in Morwani village where the number of irrigations increased up to four times which may be attributed to the construction of new wells and renovation of old wells. Many of the respondents did not have a source of irrigation prior to the '*Sunehra Kal*'

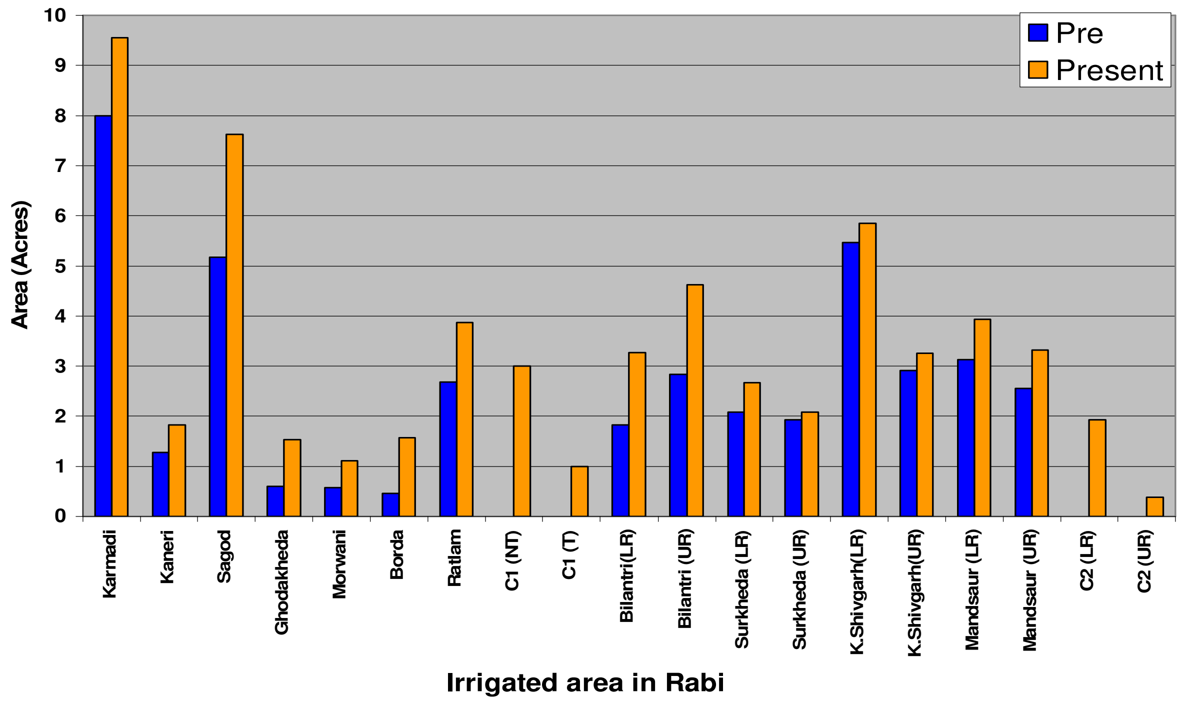

Figure 6. Change in irrigated area: Rabi.

intervened soil and water conservation measures but the post intervention scenario in the beneficiary villages and almost all the farmers has one or other source of irrigation. The number of farmers having no source of irrigation had reduced from 32.23 to 5.41%. This is a critical factor to infer that the soil and water conservation efforts had a positive impact by improving the availability of water for crop production. Similar studies also had documented various benefits to community from watershed programmes and reported increase in agricultural productivity, cropping intensity and net income of farmers (Singh, 1999; Rangaraju et al., 1999; Diwate et al., 2002). Whether or not such SWC project achieves its objectives depends not only on watershed activities but also a variety of other factors. These include local agro-climatic conditions, land tenure arrangements, people's willingness and ability to work together to devise arrangements to share benefits and costs, infrastructure and market conditions that help shape farmers. As a result, it is difficult to pinpoint the specific contribution of a watershed project in improving land management and it can be difficult to compare across projects (Cramb et al., 1999). Various other studies also have classified watershed catchment areas into upper reaches and lower reaches for impact assessment and noted that benefits were more in the lower reaches (Salunkhe, 2000; Shah, 2001). Further, the watershed development programmes resulted to regeneration of degraded lands, improved moisture availability, a rise in the ground water level, better return from economically viable alternate crop and landuse management systems and improved fuel and fodder availability (Ninan and Lakshmikanathamma, 2001).

Rain-fed agriculture is practiced on two-thirds of the total cropland area of 162 million ha in India. India receives about 400 × 10^6 ha-m of rainfall annually, most of which is received in 100 h over a span of 25 non-consecutive rain days. Thus, 45% (or 180 × 10^6 ha-m) is lost as run-off or blue water (Lal, 2008). Conservation and judicious use of soil and water play an important role for sustainable crop production especially under dry land conditions in the semi-arid tropics (Diwate et al., 2002; Sharda and Dhyani, 2004; Goel and Kumar, 2005; Madhu et al., 2011). The water harvesting practices include *in situ* water conservation, micro-catchments and *ex situ* water harvesting and storage systems (Sharda and Dhyani, 2004) as was employed in the study area. These interventions were cost effective and environment friendly resource conservation technologies. Resource conservation technologies improve input use efficiency at low cost and preserve ecological integrity of crop production system which had encouraged the farmers in the area to increase their area of production even in water scarce Rabi season. Bangar (1998) conducted hydrological surveys in Ratlam district and inferred that ground water level had declined. The study recommended 9055 new ground water structures including 1509 tube wells to be made to use 100% utilizable potential of ground water. Similarly, other studies also had reported that SWC interventions had consistently improved the groundwater regime (Rao et al., 1996; Shah and Raju, 2002; Mwenge Kahinda, 2004).

In view of globalization of agriculture, the cost of production and energy requirement assume great significance. Economizing these parameters without compromising yield and soil quality is a call of the day to ensure sustainability of the ecosystem (Madhu et al., 2011). These SWC strategies would further strengthen sustainability to the agricultural production besides substantial increase in production and water resources conservation by impeding the environmental hazard of water logging and improving soil salinization (Singh, 2010). Harvesting run-off water under on-farm conditions with farmer participation and recycling it for supplemental irrigation will not only facilitate widespread adoption of these conservation technologies but also bring more marginal or less productive area under crop production and will also result in moderation of floods, mitigation of droughts, augmenttation of water ground recharge, employment generation and improvement of socio-economic conditions of the local people (Sharda and Dhyani, 2004; Lal, 2008).

CONCLUSION AND RECOMMENDATION

Agriculture was the major source of income for majority of rural households in the semi-arid villages of Ratlam and Mandsaur districts of Madhya Pradesh. The SWC interventions in these districts through '*Sunehra Kal*' had increased the cropping area due to availability of more water for irrigation and also the number of irrigations applied on crop increased not only in the Khariff season but also during the water scarce Rabi period. Availability of water for irrigation and increase in cropping area indicates successful cropping with good productivity and increase in income with livelihood improvement of the beneficiary farm families. However, the following measures are proposed for further improving the livelihood of these farm families. Vegetative barriers with suitable grass species like *Cenhrus*, *Panicum* and *Stylo* (Poaceae) along with suitable tree species like *Prosopis cineraria* (Fabaceae), *Acacia nilotica* L (Fabaceae), *Azadirachta indica* A. Juss. (Meliaceae), *Zizypus mauritiana* Lam. (Rhamnaceae), *Sygizium cumini* (L.) Skeels (Myrtaceae), *Mangifera indica* L (Anacardiaceae), *Emblica officinales* Gaertn (Euphorbiaceae), *Leucaena leucocephala* (Lam.) de Wit (Fabaceae) and *Butea monosperma* (Lam.) Taub. (Fabaceae) will not only meet the fodder and fuel wood needs of the community but will improve the soil fertility and structure, soil moisture conservation and prevent topsoil loss through erosion. Suitable silvipastoral treatment along all contour bunds is essential. Plantations of mixed multipurpose trees along with scattered tree plantation and gap filling in the village common land and other grazing lands can be done.

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