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Diversification and intensification in crop and dairy farming through watershed interventions

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ABSTRACT

Watersheds are part of our natural social unit. Assessment of watershed interventions helps us understand the productivity enhancement as well as issues impacting the performance of watershed. The present study aimed to assess the impact of watershed interventions on farm productivity was conducted in Chitradurga district of Karnataka during 2019 by selecting 120 beneficiary and 40 control farmers. The positive impact was reported on control of soil erosion and also improvement of soil fertility. Additional improvement was perceived in the control of surface run off. About 67 respondents reported more than 25 % rise in their crop income. Cropping intensity increased significantly in all the watershed villages. Productivity of crops in the farmer field increased by 9.34% in cotton, 11.60% in onion, 15.17% in sunflower, 21.75% in maize and 27.83% in chickpea. The productivity of two major crops of the region, viz. groundnut (*kharif*) and finger millet (*rabi*) increased by 23.28 and 33.02%, respectively. Water management is one of the potential tools of productivity augmentation and resource saving, where the findings of present study would act as a supporting evidence for sustainable development of crops and dairy farming.

Keywords: Cropping intensity, Impact, Productivity, Soil erosion, Watershed

The thrust of Indian agriculture in the post-green revolution period is on enhancing agricultural productivity through sustainable farming practices. Government of India implemented national level programmes for the development of rainfed areas through the watershed approach like Drought Prone Area Program (DPAP), Desert Development Program (DDP), River Valley Project (RVP), National Watershed Development Project for Rain-fed Areas (NWDPRA) and Integrated Wasteland Development Program (IWDP). These approaches aimed at augmentation and stabilization of production and productivity, minimizing ecological degradation, reducing regional disparity and opening up opportunities for employment of rural poor in the rainfed areas in different hydro-ecological regions consistently affected by water stress and drought like situations.

The present study was undertaken to assess the impact of watershed on various bio-physical and socio-economic conditions in the six watershed areas of Chitradurga district of Karnataka. Chitradurga district was purposively chosen due to maximum drought affected area in the state. The meta analysis indicated a mean benefit cost ratio of 2.14 with participatory watersheds performing better than technocratic ones. Projects covering more than 1250 ha have performed better than those covering less than 1250 ha. However, 1250 ha is not the cut-off for assessing the impact of watershed. The more important factor is whether the watershed covers more than one village or not (Joshi *et al.* 2005).The best performance was observed in the NGO-government collaborative projects having social organization focus dealing specifically with the uneven distribution of benefits and costs, and they operated in smaller watersheds within a single village (Kerr *et al.* 2002).Watershed approach has the full potential to develop sustainable crop and dairy farming in the drought prone areas with involvement of farmers based on their felt and unfelt needs. Hence, it was felt appropriate to assess the impact of watershed interventions for further planning and development.

MATERIALS AND METHODS

The study was undertaken in six watershed villages, viz. Alagatta (628.67 ha), Hulitotlu (874.39 ha), Marammanahalli (842.32 ha), Turuvanuru (1027.35 ha), Upparigenahalli (737.43 ha) and Valase (656.24 ha) as well as two control villages namely Thimmappaiahnahalli and Marabagatta of the Chitradurga District in Karnataka state during 2019. All the taluks of the district were considered for the study to assess the impact of watershed interventions comprehensively for the entire district. Chitradurga district receives low to moderate rainfall and is one of the drought prone districts in the state. The normal annual rainfall of the district based on 30 years is 574 mm. The rainfall

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is scanty, erratic, uncertain and unevenly distributed. Integrated Watershed Development Programme (IWDP) was implemented in these watersheds between 2009 and 2015. The study comprised 120 beneficiary farmers from watershed villages and 40 non-beneficiary farmers from control villages selected randomly. Before and after project approach was adopted for impact assessment.

For measuring watershed impact, five major indicators comprising the dimensions of crop, livestock, conservation of soil, water and biodiversity, income and employment, and village basic amenities and community participation were considered by reviewing the literature and according to the relevancy judgement of indicators (Ponnusamy 2006). Twenty five experts have given judgement for the validation of these indicators. Weighted average method was used to calculate the value of each of these indicators and the scores obtained has been given in parenthesis. Experts considered soil, water and biodiversity conservation as the most important indicators for measuring impact of watershed (26.79). Income and employment (20.24), crop dimension (20.17), and village basic amenities and community participation (19.66) got second, third and fourth rank respectively. Livestock dimension was the least weighted (13.14). Anova test was carried out between perceived change in soil fertility and control of soil erosion due to watershed intervention across watershed villages. Paired t test was conducted between perceived surface run-off before and after the watershed development.

RESULTS AND DISCUSSION

Perceived impact on soil fertility, surface run-off and soil erosion: Positive impact on control of soil erosion and improvement in the soil fertility was seen in the study area as a result of watershed intervention. Out of 120 respondents, 111 perceived positive effect on soil fertility and 118 respondents experienced positive results on control of soil erosion. More positive benefits of increase in soil fertility may be perceived in due course of time. Moderate change in soil fertility was felt by 72.50% of respondents while 70.83% of them perceived greater change in control of soil erosion due to watershed interventions. Watershed treatment activities improve conservation of soil and moisture, besides improving and maintaining the fertility status of soil and reduce soil and water erosion. Many studies have revealed a significant reduction in soil and water erosion (Sikka *et al.* 2000) as well as increase in socio-economic status, land productivity and annual income of the small and marginal farmers was seen as a result of watershed development programmes.

The surface run-off is an important phenomenon in dry land farming. It was observed that run-off drastically reduced in all the villages where watershed intervention took place. Pre- project, 69.17% respondents felt more run-off and 27.50% medium run-off but post implementation, 80.83% felt low run-off. Quality water and soil as well as attitude of farmers were major issues in developing sustainable integrated farming system in dryland and coastal areas (Ponnusamy 2006). Anova test was conducted between perceived change in soil fertility and control of soil erosion due to watershed intervention across watershed villages and P value was found to be 0.30395 which is more than the tabulated value of 0.05 indicating that there is no significant difference in perception of respondents across different villages regarding improvement in soil fertility after watershed intervention. A paired t test was conducted between perceived surface run-off before and after the watershed development. The calculated t value (13.250) being more than the tabulated t value (0.000044), established that there is a significant difference between perceived surface run off before and after watershed intervention across the watershed villages.

Ground water table level: The increase in the level of groundwater is an indicator of progressive water table of a village. There is an improvement in the level of groundwater in the 5 out of 6 villages after the intervention. It was maximum in the case of Turuvanur where water table level rose by 83.25 ft than before. Similarly, groundwater level was increased by 82.5 ft in Marammanahalli, 57.75 ft in Alagatta, 41 ft in Upparigenahalli and 38.75 ft in Valase respectively revealing the significant contribution of watershed projects.

Economic impact of watershed interventions: Economic impact was observed through the crop income of respondents after the watershed interventions. Out of 120 respondents, 67 reported more than 25% rise, 44 reported up to 25% and 9 reported no change. Similarly, while 19 farmers felt no change in their dairy income, 28 reported up to 25% rise and 22 reported more than 25% increase. In case of allied farming income, it was 13, 6 and 6 respondents reporting no change, up to 25% rise and more than 25% rise respectively. Only 10.83% respondents were having income from non-farm source. Watershed interventions on arable and non-arable lands in a participatory mode significantly reduced run-off and soil loss which in turn improved crop productivity on an average by 28%. The average annual income per family had increased by 49% through employment and income generating activities in the watersheds of India (Sharda *et al.* 2005).

Increased cropping area and productivity of various crops

Effective soil and moisture conservation measures like check dams, trench cum bunding, waste weirs, farm ponds, boulder bunds and gully plugs have besides reducing the soil erosion and run-off, also improved the *in situ* soil moisture, groundwater level and perennial water flow in *nalas* (rivulet). Due to the improvement in the retention of soil moisture, net cropped area has increased while reducing the extent of fallow and wastelands in the study villages.

Cropping area increased in *rabi* than *kharif*. In case of groundnut, the increase was 6.07 ha while 3.04 ha of uncultivated area was brought under cultivation of onion in *kharif*. Moreover, finger millet area in *rabi* increased by 21.46 ha. After the implementation of the watershed project, a drastic change was noted in agricultural production. Due

to the increased water availability, the farmers were able to enhance their crop diversity and intensity besides water-use efficiency through drip irrigation. The cultivation of high value-crops such as carrot, cabbage, tomato and chilli, as well as flowers, is possible only due to the water conservation structures and the enhanced water-use efficiency.

The area under minor millets increased sharply (23.08%), followed by vegetables (12.12%) and pulses (11.54%) in *kharif* as a result of watershed intervention. There was an increase in the productivity of finger millet (31.18%) but area decreased by 14%. The % change in the area of minor millets was found highest (71.49%), followed by pulses (36.36%) in *rabi*. Similar results were reported by Rathore *et al.* (2011) in tribal area of Dungarpur and Banswara districts of Rajasthan where maize and wheat yields were 675 and 1885 kg/ha respectively prior to the project and increased to 1025 (51.58%) and 2175 (15.38%) kg/ha respectively after project. The yield of various crops increased from 6.36–91.67%. The productivity of crops grown in *kharif* and *rabi* has increased along with the area under cultivation.

The productivity of crops increased in the range of 9.34–31.18% for *kharif* crops and 22.79–33.02% for *rabi* crops. Maximum yield increase was observed in case of finger millet (33.02%). Yield of groundnut and finger millet which are the two major crops of the region were 451 and 633 kg/ha respectively prior to the project and increased to 556 (23.28%) and 842 kg/ha (33.02%) respectively after project implementation (Table 1). Increase in the cultivation of commercial crops like onion, vegetable and cotton in the watershed has a positive impact on economic status of the respondents. The project activities have improved water potential and soil condition and have resulted in moisture availability during the stress period. The factors responsible for this change were being priority given to crops in the project and fallow land brought under cultivation. Distribution of improved varieties' seeds, fertilizers and other inputs was also responsible. Significant increase in socio-economic status, land productivity and annual income of the farmers was seen as a result of watershed development programme (Ponnusamy and Devi 2017).

The cropping intensity had increased by 7.80% in Hulithotlu, Alaghatta (7.19%), Marammanahalli (25.19%), Turuvanur (8.29%), Uppariganahalli (1.72%) and 14.08% in Valase (Table 2). The cropping intensity of overall watersheds before intervention was 151.62% and after intervention it was 166.82% showing an increase of 10.03%.

Cattle population and milk production: Dairy farming as a complementary enterprise along with the crop cultivation provides a sustainable livelihood to the farmers of the country. The impact on dairy farming due to watershed intervention was measured in terms of increase in milk yield and milch cattle with the respondents. Positive change was observed in all the watersheds with milk yield increase in the range of 0.38 litres to 0.62 litres per animal per day. Before watershed implementation, the average milk yield was 1.62–2.65 litres per animal per day which after the project increased to 2.12–3.25 litres per animal per day, against 1.5 to 2.73 litres per animal in control area per day. It was observed that a significant increase in the number of dairy animals from 185 to 202 was due to the project activities which increased fodder availability, water resources and health and vaccination services and animal health camps during the intervention process. Mahnot *et al.* (1992) reported that adoption of rain water harvesting and soil water conservation played a key role in the development of the foot-hill of Aravalli region. In the study conducted at Saliyur watershed of Coimbatore district in Tamil Nadu, the overall People's Participation Index (PPI) was observed to be 62% indicating that the stakeholders' overall participation was high. This was taken to be a good indicator of making

Table 1 Cropping area and productivity of various crops in *kharif* and *rabi* in the watershed study area

Crop	Pre-intervention		Post-intervention	
	Total area (ha)	Productivity (Qtl/ha)	Total area (ha)	Productivity (Qtl/ha)
Onion	47.9	48.00	51 (6.33)	53.57 (11.60)
Maize	35	13.98	36.2 (3.47)	17.02 (21.75)
Sorghum	22.7	8.75	23.5 (3.57)	10.98 (25.49)
Groundnut	82	4.51	88 (7.40)	5.56 (23.28)
Vegetables	6.9	7.45	7.5 (12.12)	9.31 (24.97)
Minor millets	7.9	6.35	9.7 (23.08)	7.76 (22.20)
Pulses	5.3	4.75	5.9 (11.54)	6.16 (29.68)
Sunflower	5.7	6.59	5.7 (0)	7.59 (15.17)
Cotton	27.1	4.82	28.7 (5.97)	5.27 (9.34)
Finger millet	10.1	6.80	8.70 (-14.00)	8.92 (31.18)
Sorghum	28.7	7.17	29.1 (1.41)	9.28 (29.49)
Vegetables	9.7	8.73	11.3 (16.67)	10.72 (22.79)
Minor millets	2.8	8.61	4.8 (71.49)	10.63 (23.46)
Pulses	2.2	14.87	3.0 (36.36)	19.20 (29.12)
Finger millet	126.5	6.33	148 (16.96)	8.42 (33.02)
Chickpea	19	6.00	22.7 (19.15)	7.67 (27.83)

(Figures in the parentheses indicate % age change)

Table 2 Change in cropping intensity of the watershed study villages

Parameter →	Total land area of the respondents (acre)		Total cropped area (acre)		Cropping intensity (%)	
Villages ↓	Before	After	Before	After	Before	After
Alagatta	146	146	222.5	238.5	152.40	163.36
Hulithotlu	111	111	165.5	179.5	150	161.71
Maramanahalli	117	117	139	174	118.80	148.72
Turuvanur	118.5	118.5	193	209	162.87	176.37
Uppariganahalli	122.5	122.5	204	207.5	166.53	169.39
Valase	128	128	202.5	231	158.20	180.47
Tippenahalli	111		145		130.63	
Marabagatta	160		295		184.38	

use of skill techniques given to the stakeholders to sustain the watershed development programme (Sikka *et al.* 2014). Further momentum can be possible in the project areas by adopting extension models like pashu sakhi (Ponnusamy *et al* 2017) and climate centric extension model (Ponnusamy *et al.* 2019).

Watershed activities have improved the profile of agriculture of the Chitradurga district. On a regional scale, construction of series of check dams increased the groundwater level helping to improve the water table. Construction of bunds along the farmers' field has facilitated retaining water in the soil. Rain water harvesting has also minimized the storm water run-off and soil erosion in most of the places. Increase in groundwater level has resulted in better yield of various crops and brought economic prosperity. Cropping area of groundnut in *kharif* and finger millet in *rabi* has started changing, whereas area under crops like onion, chickpea, cotton, maize and sorghum area is showing higher growth rate. Involvement of the farmers in the project has created awareness on watershed development. The watershed development initiative is economically sustainable as the investment made in the project has helped to solve the socio-economic problems of the local bodies. It has helped to create assets in the form of check dams in the catchment area affecting the groundwater level. Micro watershed approach may be creating hydrological problems that would be best addressed by macro watersheds. This would require working simultaneously to promote watershed governance capacity both within and between micro watersheds (Kerr 2007). Initially, the extension agents had to convince the farmers to build the water harvesting structure but later after realizing the benefits, it received full support and cooperation from the villagers. These structures were constructed with the financial support from various organizations (Sreedevi *et al.* 2006).

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