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Impact of Economic Assessment of Crop Production along with Agroforestry Adoption in Bundelkhand Region

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ABSTRACT

Background: Bundelkhand region is far behind in the availability of soil and water both natural resources due to erratic rainfall and hard rock terrains (Tyagi, 1997). Conservation of such type of natural resources for livelihood security with a strong commitment would be the foremost challenge of the 21st century. The home of over 15.62 million humans and 8.36 million livestock, suffers from water scarcity, natural resource degradation, low crop productivity (1-1.5 Mg/ha), low rainwater use efficiency (35-45%), poor soil fertility, frequent droughts, poor irrigation facilities, inadequate vegetation cover and frequent crop failure resulting in scarcity of food, fodder and fuel (Palsaniya *et al.* 2008). Under such circumstances, the goal of doubling farmer's income by the year 2022 has been dubbed as impossible and unrealistic by some experts (Gulati and Saini, 2016). Hence, this study was conducted to assess the impact of agroforestry based crop production for provide an economic feasibility as well as perfect diet.

Methods: The study was conducted at Garhkundar-Dabar (GKD) watershed located between 78° 52′ 39″ to 78° 54′ 44″ E longitude and 25° 26′ 23″ to 25° 28′ 32″ N latitude with an altitude varying from 208 to 285 m above mean sea level in Bundelkhand region of central India. The net return was calculated by subtracting the cost of cultivation incurred from sowing to harvesting, for each crop from the gross return and then benefit-cost ratio was estimated by dividing the net returns with cost of cultivation.

Result: The study has revealed that after watershed interventions and agroforestry based Crop cultivation, the expenses on irrigation and labour will decrease, crop productivity will improve as well as benefit-cost ratio.

Key words: Agroforestry, B:C ratio, Crop production, Natural resource.

INTRODUCTION

Agriculture and agricultural productivity depends on efficient use of two most vital natural resources *viz* soil and water but availability of sufficient amount of water and reduction of soil fertility due to constant use of fertilizers becomes a big challenge. Under the present scenario, India's land resources are under immense pressure. These share only 2 per cent of the world's geographical area, but support around 18 per cent of global population and over 15 per cent of the world livestock number (Katyal, 1998). It was estimated that by 2025, one-third of the world's population (especially in the developing countries) would face severe water scarcity (Secklar *et al.,* 1998). Anonymous (2000) discussed the application of fertilizers on soil and probability of their response for plant growth.

Absolute poverty, high livestock and human population pressure and degradation of production base are some of the problems defying solution in most developing countries including India in these regions (Grewel *et al.* 2001). In India, 65% of the 142 million hectares of arable area is rainfed with very low productivity (1-1.5 Mg/ha), largely due to low rain water-use efficiency (35-45%) for crop production. Integrated watershed management has been a prominent approach for resource conservation and livelihood security in these areas (Samra 1997). Meta-analysis of 627 watershed case studies was done under a comprehensive assessment of watershed programs in India by ICRISAT led consortium (Wani *et al.,* 2007). The agroecosystem of Bundelkhand is characterized by undulating and rugged topography, highly eroded and dissected land, poor soil fertility, scarce groundwater resource, erratic rainfall leading to frequent droughts, poor irrigation facilities, heavy biotic pressure on forests, inadequate vegetation cover and frequent crop failures resulting in scarcity of food, fodder and fuel (Palsaniya *et al.* 2008).

The average annual rainfall of the area is around 900 mm, bulk of which (>90%) is received during June-September. The cultivated area under different crops like wheat, gram, barley, groundnut, sesamum and blackgram was 202.20 ha, 36.80 ha, 9.12 ha, 12.60 ha, 109.30 ha and 8.60 ha respectively. The majority of the area was cultivated

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under wheat crop during *rabi* and sesamum during *kharif*. It has been observed that in a cycle of five years, two are normal, two are drought and one is excessive rainfall year (Tiwari *et al.,* 1998). In discriminate extraction of the ground water, scarcity of fuel and fodder, over grazing by livestock and unscientific land uses are further threatening to the livelihood and agro-ecosystem of the region (Palsaniya *et al.* 2010). The region is amongst the most degraded ecosystems characterized by undulating and rugged topography, highly eroded and dissected land, poor soil fertility and low water-holding capacity, scarce groundwater resources, erratic distribution of rainfall, lack of assured irrigation facilities, heavy biotic pressure on forests, inadequate vegetation cover and frequent crop failures, resulting in scarcity of food, fodder and fuel (NRCAF, 2012*)*. Hence keeping the facts in forefront, the study was carried out to increase the crop productivity and benefit-cost ratio along with adoption of agroforestry.

MATERIALS AND METHODS

This Study was carried out in Garhkundar -Dabar watershed located at Tikamgarh district of Madhya Pradesh in Semi-Arid Tropics, Bundelkhand region of Central India (Fig 1). Location of watershed is varying between 78° 52′ 41″ to 78° 54′ 44" E longitude and 25° 26′ 24″ to 25° 28′ 31″ N latitude.

The agro-climate of the watershed is characterized by dry and hot summer, warm and moist rainy season and cool winter with occasional rain showers. Mean annual temperature ranges from 24 to 25°C. The mean summer temperature is 34°C which may rise to a maximum of 46 to 49°C during the month of May and June. The mean winter temperature is 16°C which may drop to 3-5°C in December and January. The mean annual relative humidity varies between 40 to 60 per cent. Rainfed agro-ecosystem occupies the major cropped areas of the Bundelkhand region. Although agriculture is the mainstay of the people, only 20 per cent of the net sown area is irrigated (Tyagi, 1997).

The annual rainfall of the Bundelkhand region varies from 800 to 1300 mm, about 90% of which is received during South-West monsoon period (Singh *et al*., 2002). The length of growing season of *rabi* and *kharif* crops in Bundelkhand ranges between 90 to 150 days depending upon rainfall and temperature regimes. Low rainfall and drought are common features. The soils of the watershed are shallow (10-50 cm), raddish to brownish red in color which is characterized by coarse gravelly and light textured with poor water holding capacity. Nearly 30% watershed area is under agricultural use and rest is covered by degraded forest, wasteland and scrub land. Wheat is the major crop during *rabi* season and groundnut is the major crop in the *kharif* season along with teak, lemon or guava based agroforestry.

Data collection

The area and productivity of cultivated crops were noted yearly through survey and sampling. To get uniform samples of crops from cultivated fields some specific area selected

Table 1: Economics of crop production of various crops during *rabi* and *kharif* season in GKD watershed.

Crop	Area (ha)	Productivity (q/ha)		Total Productivity (q)		Rate (Rs./q)		Income (Rs./ha)		Income (lakh)		Total Income (lakh)	Input cost (Rs./ha)	Total Input (lakh)	B:C ratio
		Grain	Fodder	Grain	Fodder	Grain	Fodder	Grain	Fodder	Grain	Fodder				
Wheat	202.20	31.20	24.00	6308.64	852.80	1840	200	57408	4800	116.08	9.71	125.78	41762.60	84.44	1.49
Gram	36.80	11.40	8.40	419.52	95.76	4620	200	52668	1680	19.38	0.62	20.00	42652.00	15.70	1.27
Barley	9.12	29.10	25.00	265.39	727.50	1440	200	41904	5000	3.82	0.46	4.28	37231.00	3.40	1.26
Groundnut	12.60	11.20	10.50	141.12	117.60	4400	200	49280	2100	6.21	0.26	6.47	39821.00	5.02	1.29
Sesamum	109.30	5.40	0.00	590.22	0.00	5120	0	27648	0	30.21	0	30.22	20478.60	22.38	1.35
Blackgram	8.60	7.70	0.00	66.22	0.00	5600	0	43120	0	3.70	0	3.71	36456.70	3.14	1.18
Total	378.62	96.00	67.90	7791.11	793.66	23020	800	272028	13580	179.42	11.04	190.46	218401.90	134.07	1.42

(1 m × 1 m size) and get about 72 crop samples for measurements from whole watershed (Fig 2). All data has been collected through survey of 30% households of watershed and then all these data subjected to statistical analysis in the laboratory. There are 116 wells in the GKD watershed under which 68 wells daily monitored manually at a fixed interval for measurement the water table depth. Average depth of wells is 8.7 in the study area. Water in these wells is being used for agricultural and domestic use. Amount of irrigation application (pumping hours and date of irrigation) are recorded for each well.

Economic feasibility of crop production

To evaluate the economic feasibility of *crop cultivation* in Garhkundar-Dabar Watershed, the economics of all the crops grown during kharif and rabi was worked out. All the fields *were digitized* in the ArcGIS environment and the coverage of different crops in both the seasons was marked on a *map* and estimated using ArcGIS version 10.3. All the data were collected at the time of harvest of crop and employment generation was calculated with mathematical expressions. The productivity of different crops was computed by taking samples (No. 75) from the field at selected patches and processed for yield estimation. Income from different crops was worked out on the basis of current procurement price (CACP, 2013). The net return was calculated by subtracting the cost of cultivation incurred from sowing to harvesting, for each crop from the gross return and then benefit-cost ratio was estimated by dividing the net returns with cost of cultivation.

RESULTS AND DISCUSSION

Economic assessment along with agroforestry

Agroforestry based crop production was found satisfactory economically as well as environmentally and also supportive for doubling income farmers. In teak based agroforestry crop cultivation during *rabi* and *kharif* season, loss of production

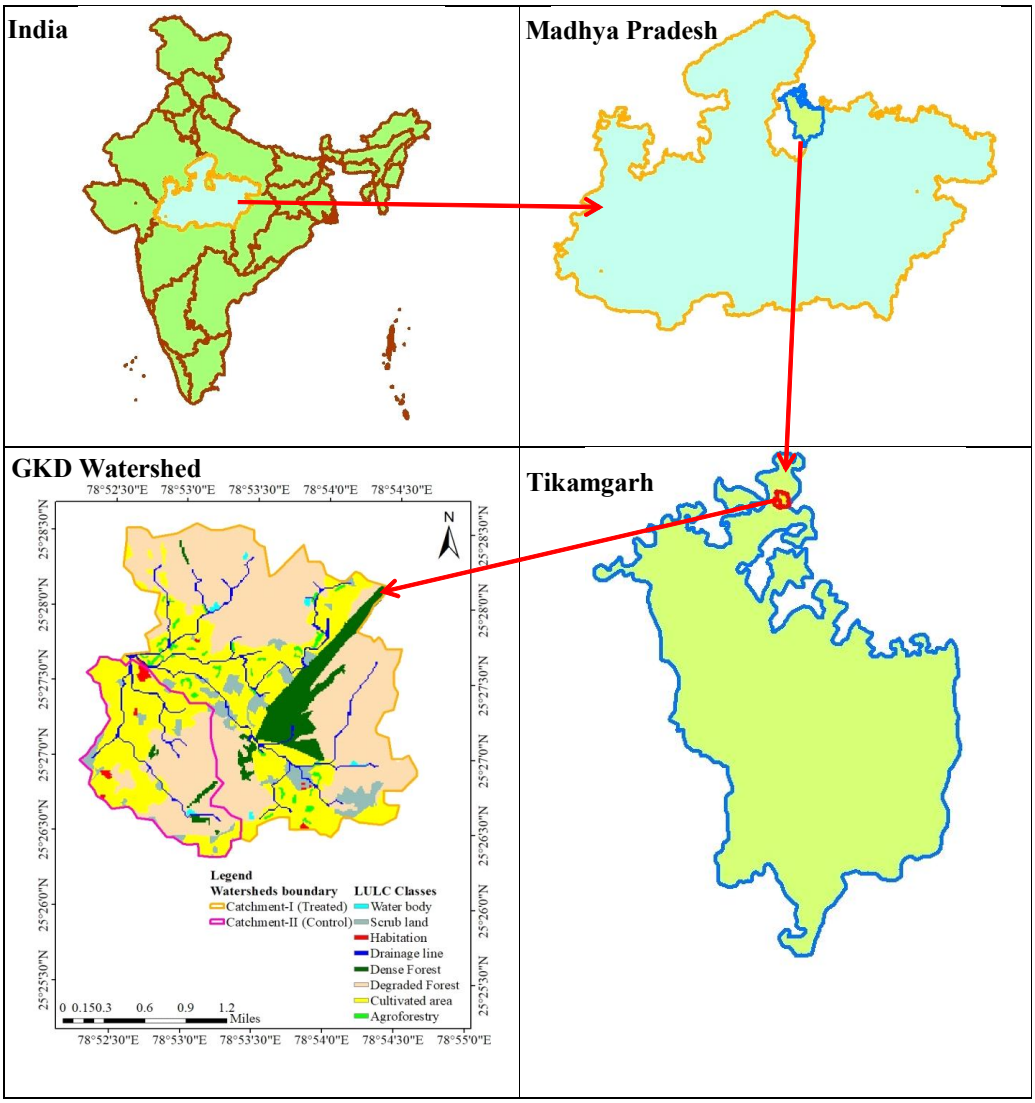


Fig 1: Location map of Study area (GKD watershed).



Fig 2: Crop data collection for economics in teak and lemon based agroforestry system.

due to capturing the cultivated land by teak trees was found 10-12 tonne ha^{-1} during both season which average cost is Rs. 35000.00 and continuously loss upto 20-25 years with an amount of Rs. 7.0-8.75.0 lakh but after this period, the total cost gains by teaks will be 60.0-80.0 lakh approximately. Thus the result revealed that agroforestry based crop cultivation is beneficiary economically as well as environmentally.

The cropping intensity was recorded 94.3 per cent during *kharif* season crop and 90.2 per cent during *rabi* season crop, with 184.5 per cent for the whole year. The economics of cultivation of two major crops wheat for *rabi* and groundnut for *kharif* were calculated. The total output cost was Rs. 62208/ha and Rs. 51380/ha against the input cost of Rs. 41762.60/ha and Rs. 39821/ha in wheat and groundnut respectively. This estimation of output against input reveals the benefit-cost ratio which was worked out as 1.49 for wheat and 1.29 for groundnut. Presently, the cost on labour is Rs. 19500/ha in wheat and Rs. 17650/ha in groundnut cultivation.

The economics of crops production, their cost of cultivation during *rabi* and *kharif* seasons along with benefit-cost (B:C) ratio were computed and presented in Table 1. On the basis of input and output cost of different crops, B:C ratio was found more than 1 for all crops having 1.49 for wheat, 1.27 for for gram, 1.26 for barley, 1.29 for groundnut, 1.35 for sesamum and 1.18 for blackgram. After implementation of natural resource management, higher B:C ratio in GKD watershed was 1.42 with the total income of Rs. 190.46 lakh against the total input cost of Rs. 134.07 lakh.

The highest B:C ratio was recorded for wheat in *rabi* season because of availability of sufficient amount of water for irrigation and 1.35 for sesamum in *kharif* season because of less expenditure on irrigation component as well as higher rate of produce. The net gain through crop cultivation in watershed has been estimated to be of Rs. 56.39 lakh (Table 2).

Table 2: Net gain in different crops cultivation in GKD watershed.

Crop	Crop area (ha)	Net gain (Rs./ha)	Net gain (lakh)
Groundnut	12.60	11559.00	1.46
Sesamum	109.30	7169.40	7.84
Barley	9.12	9673.00	0.88
Black gram	8.60	6663.30	0.57
Wheat	202.20	20445.40	41.34
Gram	36.80	11696.00	4.30
Total	378.62	67206.10	56.39

Table 3: Employment generation in GKD watershed.

Crop	Crop area (ha)	Employment generation (humandays/ha)	Total employment generation (humandays)
Groundnut	12.60	69	869.4
Sesamum	109.30	44	4809.2
Barley	9.12	54	492.48
Black gram	8.60	34	292.4
Wheat	202.20	78	15771.6
Gram	36.80	47	1729.6
Total	378.62	326	23964.68

Employment generation

The main purpose of this phenomenon was to reduce the migration by increasing the employment generation. The employment generation of study area is presented in Table 3 which reveal that it was highest in wheat as 78 humandays/ha and 69 humandays/ha in groundnut while lowest 47 humandays/ha and 34 humandays/ha in gram and blackgram for *rabi* and *kharif* crops respectively. The major contribution for generation of employ throughout the year was observed in wheat and sesamum as compute the employment generation based on mathematical expressions 15772 humandays and 4709 humandays. The total employment generation in the selected crops was for 23965 humandays which accounted for Rs. 59.91 lakh at the prevailing wage rate of @ Rs. 250/ day in the watershed. It is expected that after natural resource management the labour requirement for cultivation will reduce but the total employment generation increase and migration decrease throughout the year because of available resources like agroforestry, livelihood security and reduce water scarcity problem.

CONCLUSION

Teak based agroforestry crop cultivation was found satisfactory and also provide a huge amount to maintain the socio as well as economic status of farmer. Sustainable availability of ground water recharge increase the crop production and benefit-cost ratio which generate the employment reduce the migration and increase the farmer's income and also helpful for providing nutritional based food productivity.

Conflict of interest

There is no conflict of interest between authors.

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