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Integrated farming system model involving tuber crops for food, nutrition and socio economic security of tribal farmers of Chhattisgarh

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Abstract

An investigation for tuber crops based cropping system studies under the project Tribal Sub Plan, AICRP on Tuber Crops was conducted at Village: Bademarenga, Tokapal Block, Bastar District of Chhattisgarh state (19 0483° N and 81.9438° E) with different farming components conducted from 2019-20 to 2021-22 for the period of 3 years. The Socio-economic profiles of the farmers were recorded before and after intervention of the farming system studies. Farming component system involved vegetable crops, tuber crops and fish component along with rice and maize and laid out as agri-horti-fishery model in 1ha tract among 15 farmers at Bademarenga village. After the intervention the average gross and net income of farmers increased to Rs.471009.75 and Rs. 361843, respectively. The gross and net income increased 503.85% and 582.91% respectively after intervention of tuber based cropping system. The B: C ratio increased from 2.12 to 3.32. The employment generation increased from 135 to 230 man days. The increase in income was due to integration of tuber crops, fish component and vegetable component along with rice and maize. Tuber crops based cropping system is an integrated approach to farming as compared to monoculture. This model could increase land productivity, income of the farmers, balance nutrition, employment and sustainability of the farmer. This could be a model to attract and retain present generation farmers who are very migrating to urban areas. The model developed has the potential to transform the tribal region of Chhattisgarh, especially the Bastar district.

Keywords: Tuber crop, cropping system, intervention, income, component

Introduction

India is the second most populous country in the world. With the population growth rate of over two percent, the population is increasing year after year. Therefore, the challenge of meeting the basic requirements of this increasing population is a major concern. More than 60% of population still depends on agriculture. Chhattisgarh is the 9th largest state in India, with an area of 135,192 km² situated at central part of India and located in 17°-24° N and 80°-40'-83°-38' E. It is constituted with 33 districts. Total area of tuber crops in Chhattisgarh is 1569.4 ha with the production of 202.13 MT. By population, it ranks as the 16th most-populated state of the nation. The Chhattisgarh state is agro climatically divided into three zones viz. Bastar plateau, Chhattisgarh plain and Northern Hills. Almost all the tuber crops are more or less grown in these three agro climatic zones. Sweet potato, colocasia and elephant foot yam commercially cultivated where dioscorea and other minor tuber crops limited to *badi* areas only. Bastar plateau zone of Chhattisgarh is known for its rich diversity in all major and minor tuber crops like cassava, greater yam, colocasia, sweet potato, *Costus speciosus*, aerial yam, *Curcuma angustifolia*, *Dioscorea hispida*, *D. rotundata*, *D. pulchella*, *tannia*, lesser yam etc. The Bastar region is predominantly a tribal area, with tribal communities forming approximately 70% of its total population, which was over 1.4 million in 2011. The farmers of Bastar district majorly cultivated rice-maize and millet during *kharif* season. The irrigated area is 1.67% and irrigation coverage is only 1.2 percent in the Bastar plateau whereas use of fertilizer are very less (4.6 kg/ha.), which is insufficient to supply adequate nutrient to the crop. The usage of traditional agricultural implements and monocropping system has lowered the production of agriculture.

Farmers prioritize mono-cropping without considering the environmental impact, it can result in a depletion of resources and reduced productivity (Lu *et al.*, 2019) [5]. Poverty and paddy cultivation have become nearly synonymous worldwide where livestock and crop diversification with commercial crops can be savior from the situation. The repeated natural calamities as food and drought, poor cropping intensity, lower return and profitability, poor and uneconomical land holding pattern and existing socio-politico-economic penury further aggravate the above problems (Damodaran *et al.*, 2011) [2]. The future of Indian Agriculture depends heavily on the development of appropriate farming system as applicable to resource poor farm families and as suited to different agro ecological zones. The endowment of abundant sunshine, long growing season, responsive soil types and combination of surface water, ground water and seasonal rains, above all a progressive presently, offer vast scope for an intensive farming system through multiple cropping and diversified farming including animal husbandry, forestry, sericulture, fisheries and the like (Patil *et al.*, 2008) [3]. IFS is a component of farming system which takes in to account the concepts of minimizing risk, increasing production and profits which improving the utilization of organic wastes and crop residues (Radhamani *et al.*, 2003) [4].

Therefore, a cropping system based on tuber crops was evaluated for its effectiveness in improving small and marginal farmer's livelihood and environmental sustainability. Tuber crops, especially elephant foot yam and taro, are grown, but scientific cultivation techniques are lacking; otherwise well suited under existing rainfed conditions. A very high demand for elephant foot yams was also observed in the regions for quality planting materials. Therefore, a tuber crop-based cropping system was introduced at the farmer's field for to study the farm economics and sustainability.

Materials and Methods

Tuber crop based farming system model conducted at village Bademarenga, Tokapal Block, Bastar District, Chhattisgarh State during 2019-20 to 2021-22 for the period of 3 year. Agri-Horti-Fishery model was established in 1 ha. area and laid out among 15 farmers. The components involved rice and maize, tuber component viz., (elephant foot yam, colocasia, greater yam, aerial yam and Costus), vegetable component (cowpea, okra, tomato, cluster bean and bottle gourd) and fish component included. To enhance farmers food and nutrition security and livelihoods, the components were selected in such a way that sufficient production of carbohydrate, protein, minerals and vitamins. Further, farmer's resources and needs also assessed before selecting the components. In the locations field preparation, method of planting and fertilizer applications and intercultural operations were carried out as per recommended practices. The crops were harvested as and when matured. Broken and chaffy grains, the damaged and culled vegetables were chopped and fed to fish. The gross income was calculated based on the total yield and market rate of the farm produce.

Results

Before Intervention

Before intervention the cropping pattern and socio-economic status of 15 farmers are given in table 1 & 2. All

15 selected tribal farmers engaged in rainfed farming system cultivating rice & maize only. Few farmers had partial irrigated condition. The number of family member ranges from 3 to 7 person among 15 farmers family. The average land holding area was 1.91 ha in which 1.43 ha utilized for cultivation. And the mean employments days were 135.46.

After intervention

After intervention of tuber, vegetable and fish component along with rice and maize at village Bademarenga, Bastar, Chhattisgarh (19 0483° N and 81.9438° E) in the year 2019-20, 2020-21 and 2021-22, the average gross income, net return, BC ratio and mean employment (man days) was worked out among 15 farmers. The area of each component and BC ratio was given in the Table 3. The farmers gross income increased from Rs. 78000 to Rs. 471009.75 and net income increased from 53000 to 361843 Rs. The increase in income was due to integration of tuber crops, fish, along with rice and maize. The gross and net income increased 603.85 and 428% respectively after intervention of tuber crops based integrated farming system. The B: C ratio increased from 2.12 to 3.32 (Table 4). Part of the yields of grains, tuber crops, vegetables, meat and fish were sold for cash income. The employment generation increased from 135 to 230 man days. However, more than additional employment, spread of employment through-out the year was attained in tuber crops based integrated farming system. In the tuber based cropping system model, EFY had the highest gross income (Rs.) 125333.33 followed by ginger 84400 and turmeric 78666.67, and the net return was highest in EFY 103333.33, followed by ginger 68400, and turmeric 62666.67, and the B:C ratio was highest in fish component 5.27 followed by EFY 4.70, and ginger 4.28.

The average results of year (2019-22) of the based cropping system revealed that elephant foot yam gave greater corn yield of 3133.33 kg and it was followed by ginger 2110 kg, turmeric 1966.67 kg and colocasia (arvi) 1943.58 kg. The higher yield in the above crop was due to larger area they were cultivated (1.0 ha). Though rice was cultivated in same level of area (0.1 ha), the grain yield was just 300 kg. The minor tuber crops *kewkand* recorded 890 kg, respectively in 0.06 ha, yield of greater yam 810 kg tuber in 0.04 ha. Maize cultivated in 0.10 ha recorded 750 kg respectively. The vegetable (cowpea, tomato, cluster bean, Bottle gourd and okra) recorded 950 kg/0.2 ha. Fish registered 256.67 kg, meat respectively.

Tuber crops based cropping system is an integrated approach to farming as compared to monoculture. By marketing of vegetable, tubers and fish a farmer is able to earn sufficient money to meet out daily needs. Further, the availability of tubers for household consumption for long period due to high storability along with other vegetables, rice and fish enhanced food and nutritional security of the household. The cash income improved the livelihoods of the farm families. This model could increase land productivity, income of the farmers, balance nutrition, employment and sustainability of the farmer. This could be a model to attract and retain present generation farmers who are very migrating to urban areas. However, we need to frame policies to help the small farmers to diversify their activities towards both on-farm and off-farm activities for enhanced sustainability and productivity. The model developed has the potential to transform the tribal region of Chhattisgarh, especially Bastar district.

Table 1: Before Intervention (2019-20 to 2021-22)

S. No.	Crops/Other components	Area (ha)	Yield (kg)	Gross income (rs)	Expenditure (rs)	Net income (rs)	B:C ratio
1	Rice	0.5	1200	24000	7000	17000	2.43
2	Maize	0.5	3000	54000	18000	36000	2.00
Total/average		1.0		78000	25000	53000	2.12

Table 2: Socio-economic status of farmers/farm families before starting of Farming system studies under TSP-AICRP on Tuber Crops at adopted Village-Bademarenga, Block-Tokapal, District-Bastar
Year: (2019-20 to 2021-22)

S. No.	Name and Fathers Name of farmers	No. of family members	Land Holding in (ha)	Cultivated area (ha)	Crops under taken	Irrigation facility	Employment Generation in a year (Days)
1.	Jagdish/Sonadhar	4	2.01	1.54	Rice, Maize, Vegetables	Partial-irrigated	152
2.	Dharmu/Sondhar	5	1.96	1.33	Rice, Maize, Vegetables	Rainfed	152
3.	Jaggu/Sonadhar	4	2.02	1.57	Rice, Maize, Vegetables	Partial-irrigated	152
4.	Phulchu/Bhagtu	3	2.54	2.03	Rice, vegetable	Rainfed	90
5.	Cheranga/Masu	5	2.63	2.10	Rice, Maize, Vegetables	Rainfed	152
6.	Padmu/Masiya	3	2.03	1.62	Rice, Maize	Rainfed	152
7.	Bangla/Masu	3	1.86	1.25	Rice, Maize	Rainfed	152
8.	Suduram/Kachra	4	1.25	0.78	Maize, Vegetables	Partial-irrigated	90
9.	Munu/Manglu	4	1.24	0.82	Rice, Maize	Rainfed	152
10.	Gonchu/Kamlu	4	1.27	0.87	Rice, Maize	Rainfed	152
11.	Sonu/Mahdev	3	1.52	1.03	Rice, Maize	Rainfed	152
12.	Raju/Boti	5	1.75	1.34	Rice	Partial-irrigated	90
13.	Jhimtu/Kamalu	6	1.42	1.05	Rice, Maize, Vegetables	Rainfed	152
14.	Peelu/Lachchhu	4	2.51	2.01	Rice, Maize	Rainfed	152
15.	Rayman/Milaku	7	2.71	2.13	Rice, Vegetables	Partial-irrigated	90
Total		64	28.72	21.47	-	-	2032.00
average		4.27	1.91	1.43	-	-	135.46

After Intervention

Table 3: Component wise average Yield and economics of tuber based Cropping system in Bademarenga village (2019-20 to 2021-22)

S. No.	Components (Crop/Animal)	Area	Gross Income (Rs.)	Input cost (Rs.)	Net Income (Rs.)	B:C Ratio	Employment Generation (Mandays)
1.	Colocasia	0.10	52090.41	17666.67	36590.42	2.36	22.33
2.	EFY	0.10	125333.33	16333.33	103333.3	4.70	30.00
3.	Dang kanda (Bulbifera)	0.06	20833.333	5400	15833.33	3.17	10.00
4.	Costus (Kaukanda)	0.06	17200	7133.333	11000	1.77	15.00
5.	Ratalu (G. Yam)	0.04	21083.333	9000	12083.33	1.34	15.00
6.	Turmeric	0.08	78666.667	16000	62666.67	3.92	21.00
7.	Ginger	0.08	84400	16000	68400	4.28	21.00
8.	Vegetable component Kharif (Okra, tomato, cowpea, clusterbean, Bottle Gourd)	0.20	23669.333	9250	14419.33	1.56	25.00
9.	Rice	0.10	6000	1550	4450	3.03	21.67
10.	Maize	0.10	13500	4166.667	9333.333	2.29	24.67
11.	Fish	0.09	28233.33	4500	23733.33	5.27	25.00
Total		1.0	471009.7	107000	361843	33.69	230.67

Table 4: Socio-economic status of the farmer before and after intervention from 2019 to 2022

S. No.	Particular	Gross Income (Rs/ha)	Expenditure (Rs/ha)	Net income (Rs/ha)	B: C ratio	Employment generation (man-days/ha)
1	Before intervention	78000	25000	53000	2.12	135
2	After intervention	471009.75	107000	361843	3.32	230.67
3	% increased	503.85	-	582.91	-	-

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