

Original Research Article

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Tuber Crops Based Integrated Farming System Studies in Bastar and Kondagaon Districts of Chhattisgarh

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ABSTRACT

An investigation for tuber crops based farming system studies under the project Tribal Sub Plan, AICRP on Tuber Crops was conducted with different components of farming conducted during the year 2012-13 to 2015-16 at two locations of Bastar division of Chhattisgarh. The Location-1 was Village: Gumiyapal, Tokapal Block, Bastar District, Chhattisgarh State (N 19° 07.181' and E 81° 50.905'; 506 msl) and Location -2 was Village: Tatirash, Keshkal Block, Kondagaon District, Chhattisgarh State (N 19° 59.961' and E 81° 35.427'; 644 msl). The Socio-economic profiles of the farmers of both locations were recorded before and after intervention of the farming system studies. After the intervention of tuber crops based integrated farming system in the farmer's field in Gumiyapal village, the farmers gross and net income increased to Rs 5,33,110/- and Rs 403720 ha⁻¹, respectively. The increase in income was due to integration of tuber crops, fruit crops, fish, poultry and ducks along with cereals and pulses. The gross and net income increased 463 and 610% respectively after intervention of tuber crops based integrated farming system. The B: C ratio increased from 1.56 to 4.12. The employment generation increased from 199 to 261 man days. After the intervention of tuber crops based integrated farming system in the farmer's field in Tatirash village, the farmers gross and net income increased to Rs 5,28,660/- and Rs 3,97,960/ha, respectively. The gross and net income increased 397 and 447% respectively after intervention of tuber crops based integrated farming system. The B: C ratio increased from 2.18 to 4.04. Under the farming system studies different crop component, animal component, fruit crops component has been tested at field of tribal farmers at village- Gumiyapal (Tokapal, Bastar) and Tatirash (Keshkal, Kondagaon). Under the crops component *Amorphophallus/Zimikand* given highest BC ratio 1: 3.35 followed by *Dioscorea bulbifera* (1:3.20) and *Colocasia* (Bunda) (1:2.75) as compare to other crops. The employment generation increased from 203 to 263 man days. However, more than additional employment, spread of employment through-out the year was attained in tuber crops based integrated farming system. Tuber crops based farming 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. 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 the Bastar and Kondagaon districts.

Keywords

Farming system,
Tuber crops,
Integrated, Bastar,
Fish components, B: C
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Introduction

India is the second most populous country in the world. With the population growth rate of over two per cent, the population is increasing year after year. Therefore, the challenge of meeting the basic requirements of this increasing population is a major concern. Agriculture is the backbone of India. More than 60 % of population still depends on agriculture. Presently the food production of India is 260 mt and the rate of increase in food production outpacing the rate of population increase. Yet 20 % of the Indian population would go undernourished as per the estimate of Indian Planning Commission in 2012 (Nayar, 2014). 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). Poverty and paddy cultivation have become nearly synonymous worldwide where livestock and crop diversification with commercial crops can be saviour from the situation (Damodaran *et al.*, 2011).

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). Radhamani *et al.*, (2003) describes IFS as 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.

Chhattisgarh is the 10th largest state in India, with an area of 135,190 km². Chhattisgarh is situated at Central part of India and location is 17° - 24° N and 80° 40' - 83° 38' E. Chhattisgarh is constituted with 27 district. By population, it ranks as the 16th most-populated state of the nation. It is an important electricity and steel-producing state of India. Chhattisgarh accounts for 15% of the total steel produced in the country. 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. In Bastar plateau zone Cassava, Dioscorea, Colocasia (Arvi) and Sweet Potato; in Chhattisgarh plain Colocasia (Arvi), Amorphophallus and Sweet potato are under cultivation; whereas, in northern hills Sweet potato and Colocasia (Banda) are cultivated in large scale. Looking into the higher yield potential of the crops, its agro-climatic suitability and popularity among different zones of the state, an "All India Coordinated Research Projects on Tuber Crops (other than potato)" was sanctioned and established during the seventh five year plan at Indira Gandhi Krishi Vishwavidyalaya, Centre Jagdalpur with five mandatory crops Cassava, Colocasia, Dioscorea, Elephant foot yam and Sweet Potato in the year 1988.

Total area of tuber crops in Chhattisgarh is 2391.13 ha, total production is 64880.25 t and average productivity of all tuber crops 22.70 t which data were recorded through conventional survey from all 27 districts of Chhattisgarh during the year 2013-14. Raipur is the district with maximum Amorphophallus area (61.0 ha) and production (3440.40 t) followed by Mahasamund and Raigarh districts. Bastar is the district with having maximum area and production of Cassava (25.05 ha and 881.76 t),

Colocasia/Arvi in Kharif season (77.05 ha and 2272.30 t), Greater yam (26.95 ha and 867.79 t), Sweet Potato (39.40 ha and 1103.20 t), Aerial yam (10.09 ha and 263.75 t) and Kewkand (10.09 ha and 314.81t). In Kawardha district area of Summer Colocasia is 303.50 ha and production is 5857.55 t under irrigated condition followed by Bastar and Jashpur. Summer colocasia in Kawardha district is mostly concentrated the river bank of *Sankri* River.

Surajpur district is the largest producer of Bunda (1607.58 t) in 46.80 ha area followed by Surguja and Balrampur during kharif season. Surguja is the district with maximum summer irrigated Bunda area (12.90 ha) and production (440.15 t). Bijapur district having maximum area and production of *Curcuma angustifolia* (10.97 ha and 284.56 t) followed by Dhamtari (10.87 ha and 223.75 t) and Kondagaon (8.83 ha and 223.75 ha). Kanker is the district with maximum other minor tuber crops area (6.55 ha) and production (79.13 t) followed by Rajnandgaon (4.40 ha) and Dhamtari (3.60 ha and 53.64 t) list of other minor tuber crops given in Table 3. Dugukondal block of Kanker and Bhairamgarh block of Rajnandgaon districts were identified as special pockets for major growing area of *Dioscorea esculanta* during survey, Bastar division and Surguja for *Curcuma agustifolia* and *Dioscorea floribunda*, Nagari block of Dhamtari district for *Dioscorea hispida*, Pakhanjur block of Kanker for Swamp taro; Bastar-Narayanpur-Sukma-Damtewada districts for *Dioscorea pentaphylla*, *Dioscorea spicata* and *Dioscorea rotundata* (Shankar and Singh, 2018).

AICPRP on Tuber Crops, SGCARS, Kumhrawand, Jagdalpur under Tribal Sub Plan has conducted demonstrations on Tuber Crops based integrated farming system in Bastar and Kondagaon districts of Chhattisgarh.

Tuber crops based integrated farming system study (1.0 ha model)

Location – I: Village: Gumiyapal, Tokapal Block, Bastar District, Chhattisgarh State (N 19° 07.181' and E 81° 50.905'; 506 msl)

Year: 2012-2016

Socio-economic profile before intervention

Bastar District is a southern district of the state Chhattisgarh and Jagdalpur is the district headquarters. The district has an area of 8755.79 km². Bastar District is bounded on the northwest by Rajnandgaon District, on the north by Kondagaon District, on the east by Nabarangpur and Koraput districts of Oridha state, on the south and southwest by Dantewada District, and on the west by Gadchiroli District of Maharashtra state. According to the 2011 census Bastar district has a population of 11,93,650 in which more than 65% population (7,87,809 schedule tribes) belong to tribes like *Maria*, *Muriya*, *Bhatra*, *Halba*, *Gond*, *Parja*, *Dhurva* etc. The district has a population density of 140 inhabitants per square kilometre.

Rice is grown predominantly during *kharif* season as rainfed crop having 2.39 lakh hectare area but the productivity of this crop is very low 0.85 t/ha in Bastar region of Chhattisgarh. The irrigated area is 1.67% and irrigation coverage is only 1.2 percent in the Bastar plateau whereas fertilizer use (4.6 kg/ha.) in the Bastar district are very less, which is insufficient to supply adequate nutrient to the crop. The pattern of livelihood in Bastar continues to be dictated by tradition. Even today, agricultural practices are traditional. Use of wooden ploughs is overwhelming while the number of iron ploughs is negligible. The same is true of bullock carts. The number of tractors is negligible while the bullock carts are all

pervasive. The usage of traditional agricultural implements has lowered the production of agriculture. The *kharif* crops grown here are paddy, small millets, horse gram, urd, arhar, jowar and maize. The rabi crops include ramtil (niger), alsii, moong, mustard and gram. Collection and sale of forest produce and other forest-related work supplements meager agricultural incomes.

Details of intervention

The tuber crops based integrated farming system study (1.0 ha model) was laid out in 15 tribal farmer's field in Gumiyapal village in consecutive five years (2012-2016). Every year the farmers were changed. 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, farmers resources and needs also assessed before selecting the components. The components included are field crops (rice, maize and pigeonpea), tuber crops (elephant foot yam, colocasia (Arvi and Bunda, greater yam, aerial yam, sweet potato, tikhur and kewkanda). Vegetable crops (cowpea, Indian baen and okra), fish, poultry, ducks and fruit crops (papaya and banana). The area of each component was given in the Table 1. In both the locations field preparation for the tuber crops based farming system was initiated with pre-monsoon rain. With the onset of monsoon (June second fortnight) planting/ sowing of various crop components initiated and completed within fifteen days. Method of planting, manures 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 poultry, ducks and fish. The poultry was stall fed and ducks were allowed to feed in the open field. The gross income was calculated based on the

total yield and market rate of the farm produce.

The results (mean of five years) of the tuber crops based integrated farming system revealed that elephant foot yam gave greater corm yield of 4356 kg and it was followed by colocasia (bunda) 3119 kg, sweet potato 2664 kg and colocasia (arvi) 2423 kg. The higher yield in the above crop was due to larger area they were cultivated (0.1 ha). Though rice was cultivated in same level of area (0.1 ha), the grain yield was just 251 kg. The minor tuber crops tikhur and kewkand recorded 2027 and 1429 kg, respectively in 0.05 ha, yield of Cassava 1301 kg tuber in 0.05 ha. Maize and pigeonpea cultivated in 0.02 and 0.03 ha recorded 94 and 63 kg respectively. The vegetable (cowpea, Indian bean and okra) recorded 721 kg/0.05 ha. Fish, poultry and duck registered 250, 112, and 67 kg meat respectively. The fruit crops (papaya and banana) gave 1149 kg/0.05 ha. The gross and net returns from the tuber crops based integrated farming system were Rs 533110/- and Rs 403720/-, respectively.

Socio-economic profile after intervention

After the intervention of tuber crops based integrated farming system in the farmer's field in Gumiyapal village, the farmers gross and net income increased to Rs 5,33,110/- and Rs 403720/ha, respectively. The increase in income was due to integration of tuber crops, fruit crops, fish, poultry and ducks along with cereals and pulses. The gross and net income increased 463 and 610% respectively after intervention of tuber crops based integrated farming system. The B: C ratio increased from 1.56 to 4.12 (Table 2). The employment generation increased from 199 to 261 man days. However, more than additional employment, spread of employment throughout the year was attained in tuber crops based integrated farming system.

Table.1 The base line survey and farm household profile in the tribal village was conducted before taking up intervention

S. No.	Details of Survey	:	Data Recorded
1.	Total households	:	147
2.	ST households	:	129
3.	Name of the tribe	:	Gond, Mariya, Bhatra and Halba
4.	Family size	:	6.5
5.	Land holding	:	2.23 ha
6.	Crops/ Cropping system	:	Rice, maize, sem, horse gram, colocasia, suran, sweet potato, niger, cucurbits, toriya and minor tuber crops
7.	Annual income from agriculture	:	Rs 94630/ha
8.	B: C ratio	:	1.56
9.	Employment	:	199 man-days/ha

Table.2 Yield and economics of tuber crops based integrated farming system in Gumiyaal (Pooled mean of five years)

S. No.	Components (Crop/Animal)	Area (ha)	Yield in (kg)	Price Rs. per kg.	Gross Income (Rs.)	Input cost (Rs.)	Net Income (Rs.)	B:C Ratio	Employment Generation (Mandays)
1.	Elephant foot yam	0.10	4356	30	130680	26580	104100	4.92	26
2.	Colocasia/Arvi	0.10	2423	20	48460	16750	31710	2.89	23
3.	Greater yam	0.05	1335	20	26700	5970	20730	4.47	12
4.	Aerial yam	0.05	835	60	50100	9940	40160	5.04	10
5.	Cassava	0.05	1301	10	13010	3740	92703	3.48	11
6.	Sweet Potato	0.10	2664	15	39960	8710	31250	4.59	11
7.	Colocasia (Bunda)	0.10	3119	25	77980	18920	59060	4.12	27
8.	Tikhur (<i>Curcuma angustifolia Roxb.</i>)	0.05	2027	15	30400	7490	22910	4.06	15
9.	Kewkand (<i>Costus speciosus</i>)	0.05	1429	10	14290	4340	9950	3.29	12
10.	Rice	0.10	251	20	5020	1330	3690	3.77	21
11.	Maize	0.02	94	10	940	260	680	3.61	2
12.	Pigeon Pea	0.03	63	55	3470	880	2590	3.94	5
13.	Vegetable component (Cow pea, Indian bean & Okra)	0.05	721	25	18030	7980	10050	2.26	10
14.	Fish	0.10	250	105	26250	5710	20540	4.60	22
15.	Poultry	75 Nos.	112	150	16800	3490	13310	4.81	27
16.	Ducks	45 Nos.	67	120	8040	1750	6290	4.59	17
17.	Fruits (Papaya & Banana)	0.05	1149	20	22980	5550	17430	4.14	10
Total		1.0	22196	-	533110	129390	403720	4.12	261

Table.3 Socio-economic conditions of the farmer before and after intervention at Village-Gumiyapal

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	94630	37780	56850	1.56	199
2.	After intervention	533110	129390	403720	4.12	261

Table.4 The base line survey and farm household profile in the tribal village was conducted before taking up intervention

S. No.	Details of Survey	:	Data Recorded
1.	Total households	:	203
2.	ST households	:	118
3.	Name of the tribe	:	Gond, Maria and Halba
4.	Family size	:	7.30
5.	Land holding	:	2.23 ha
6.	Crops/ Cropping system	:	Rice, sweet potato, tomato, black gram, arhar, cowpea, niger, toriya, turmeric, greater yam and minor tuber crops
7.	Annual income from agriculture	:	Rs 106300/ha
8.	B: C ratio	:	2.18
9.	Employment	:	203 man-days/ha

Table.5 Yield and economics of tuber crops based integrated farming system in Village: Tatirash (Pooled mean of five years)

S. No.	Components (Crop/Animal)	Area (ha)	Yield in (kg)	Price Rs. per kg.	Gross Income (Rs.)	Input cost (Rs.)	Net Income (Rs.)	B:C Ratio	Employment Generation (Mandays)
1.	Elephant foot yam	0.10	4359	30	130770	25840	104930	5.06	25
2.	Colocasia/Arvi	0.10	2432	20	48640	16780	31860	2.90	23
3.	Greater yam	0.05	1379	20	27580	5980	21600	4.61	12
4.	Aerial yam	0.05	822	60	49320	10070	39250	4.90	12
5.	Cassava	0.05	1379	10	13790	4190	9600	3.29	12
6.	Sweet Potato	0.10	2540	15	38100	9340	28760	4.08	11
7.	Colocasia (Bunda)	0.10	3069	25	76730	19130	57600	4.01	27
8.	Tikhur (<i>Curcuma angustifolia Roxb.</i>)	0.05	1918	15	28770	7530	21240	3.82	15
9.	Kewkand (<i>Costus speciosus</i>)	0.05	1357	10	13570	4460	9110	3.04	13
10.	Rice	0.10	252	20	5040	1330	3710	3.79	21
11.	Maize	0.02	96	10	960	270	690	3.56	2
12.	Pigeon Pea	0.03	62	55	3410	910	2500	3.75	4
13.	Vegetable component (Cow pea, Indian Bean & Okra)	0.05	740	25	18500	8180	10320	2.26	11
14.	Fish	0.10	250	105	26250	5760	20490	4.56	23
15.	Poultry	75 Nos.	109	150	16350	3480	12870	4.70	26
16.	Ducks	45 Nos.	62	120	7440	1750	5690	4.25	17
17.	Fruits (Papaya & Banana)	0.05	1172	20	23440	5700	17740	4.11	9
Total/Average*		1.0	21998	-	528660	130700	397960	4.04	263

Table.6 Socio-economic conditions of the farmer before and after intervention

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	106300	33570	72730	2.18	203
2	After intervention	528660	130700	397960	4.04	263

Part of the yields of grains, tuber crops, vegetables, fruits, egg, meat and fish were sold for cash income. By marketing of vegetable, tubers, fruits, egg, fish and meat 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, fish, egg and meat enhanced food and nutritional security of the household. The cash income improved the livelihoods of the farm families.

Location – II: Village: Tatirash, Keshkal Block, Kondagaon District, Chhattisgarh State (N 19 ° 59.961' and E 081 ° 35.427'; 644 msl)

Year: 2012-2016

Socio-economic profile before intervention

Kondagaon District is a southern district of the state Chhattisgarh and Kondagaon also is the district headquarter. The district has an area of 7768.907 km². Kondagaon District is bounded on the northwest by Narayanpur District, on the north by Kanker District, on the east by Nabarangpur and Koraput districts of Oridha state, on the south and southwest by Bastar District, and on the west by Gadchiroli District of Maharashtra state (Table 5). According to the 2016 census Kondagaon district has a population of 5,78,326 in which more than 65% population (3,75,912 schedule tribes) belong to tribes like *Maria*, *Muriya*, *Bhatra*, *Halba*, *Gond* etc. The district has a population density of 75 inhabitants per square kilometre.

Details of intervention

The Tuber Crops Based Farming System study (1.0 ha model) was laid out in 15 tribal farmer’s field in each village in consecutive five years (2012-2016). Every year the farmers were changed. 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 farmers resources and needs also assessed before selecting the components. The components included are field crops (rice, maize and pigeonpea), tuber crops (elephant foot yam, colocasia (arvi and bunda), greater yam, aerial yam, sweet potato, tikhur and kewkanda) Vegetable crops (cowpea, Indian baen and okra), fish, poultry, ducks and fruit crops (papaya and banana). The area of each component was given in the Table 3. In both the locations field preparation for the tuber crops based farming system was initiated with pre-monsoon rain. With the onset of monsoon (June second fortnight) planting/ sowing of various crop components initiated and completed within fifteen days. Method of planting, manures 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 poultry, ducks and fish. The poultry was stall fed and ducks were allowed to feed in the open field. The gross income was calculated based on the total yield and market rate of the farm produce.

The results (mean of five years) of the tuber

crops based integrated farming system revealed that elephant foot yam gave greater corm yield of 4359 kg and it was followed by colocasia (bunda) 3069 kg, sweet potato 2540 kg and colocasia (arvi) 2432 kg. The higher yield in the above crop was due to larger area they were cultivated (0.1 ha). Though rice was cultivated in same level of area (0.1 ha), the grain yield was just 252 kg. The minor tuber crops tikhur and kewkand recorded 1918 and 1357 kg, respectively in 0.05 ha. Cassava yielded 1379 kg tuber/0.05 ha. Maize and pigeonpea cultivated in 0.02 and 0.03 ha recorded 96 and 62 kg respectively. The vegetable (cowpea, Indian bean and okra) recorded 740 kg/0.05 ha. Fish, poultry and duck registered 250, 109, and 62 kg meat respectively. The fruit crops (papaya and banana) gave 1172 kg/0.05 ha. The gross and net returns from the tuber crops based farming system were Rs 528660/- and Rs 397960/-, respectively.

Socio-economic profile after intervention

After the intervention of tuber crops based integrated farming system in the farmer's field in Tatirash village, the farmers gross and net income increased to Rs 5,28,660/- and Rs 3,97,960/ha, respectively. The increase in income was due to integration of tuber crops, fruit crops, fish, poultry and ducks along with cereals and pulses. The gross and net income increased 397 and 447% respectively after intervention of tuber crops based integrated farming system. The B: C ratio increased from 2.18 to 4.04 (Table 4). The employment generation increased from 203 to 263 man days. However, more than additional employment, spread of employment throughout the year was attained in tuber crops based integrated farming system.

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Tuber crops based farming 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. 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 the Bastar and Kondagaon districts.

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