Agricultural Economics Research Review
Vol. 30 (No.1) January-June 2017 pp 151-162
DOI: 10.5958/0974-0279.2017.00014.3

Forestry-based Livelihood Diversification Strategy for Socio-economic Development of Tribes in Jharkhand§

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Abstract

To evolve a region-specific forestry-based livelihood diversification strategy for livelihood security and ecological stability, the paper has studied socioeconomic-cum-demographic aspects (population, caste profile, sex ratio, income profile, manpower potential, occupational status, etc.) and natural resource scenario (land-use pattern, forest, soils, etc.) of Bundu block in Ranchi district of Jharkhand. The study has suggested eco-friendly livelihood options like *tasar* sericulture, *lac* culture, fruit culture and mechanized *sal* leaf plate making to develop a precise, region-specific livelihood diversification strategy for socioeconomic development of tribal people. The income and employment opportunities expected from the interventions per annum are: *tasar* sericulture (₹ 54.16 lakh, 21100 person-days), *lac* culture (₹ 36.88 lakh, 8790 person-days), fruit culture (₹ 63.58 lakh, 19180 person-days) and mechanized *sal* leaf plate making (₹ 40.26 lakh, 36900 person-days). The proposed strategy is likely to yield an income of ₹ 194.88 lakh/ annum and employment potential of 85970 person-days/ annum besides securing the basic needs by mobilizing the existing natural resources. The financial viability of proposed interventions have been worked out by intricate economic calculations of NPV, BCR and IRR. The study has shown that shifting of excessive livelihoods pressure from the existing forest to the proposed strategy would develop sustainable livelihood opportunities for the tribes, reinforce the forest conservation, wastelands reclamation, carbon sequestration and climate change mitigation in the area.

Key words: Livelihood diversification, socioeconomic status, tribes, forestry intervention, Jharkhand

JEL Classification: Q23, Q13

Introduction

Household livelihood security ascertains an adequate and sustainable access to income and resources to meet the basic needs like food, potable water, health care, educational opportunities, housing, community participation and social integration (Frankenberger and McCaston, 1998). Livelihoods can be made up of a range of on-farm and off-farm activities which together provide a variety of procurement strategies for food and cash (Bhatia *et al*., 2011; Usman *et al*., 2016). The risk of livelihood failure determines the level of vulnerability of a household to income, food, health care and nutritional insecurity (Drinkwater and McEwan, 1992). Livelihood approaches are a comprehensive way of thinking about the objectives, scope and priorities for development, which places people and their priorities at its centre (Rahman and Akhter, 2012; Langat *et al*., 2016). The focus of these livelihood approaches is on empowering the poor by

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§ The paper is drawn from the Ph.D. thesis entitled "Studies on forest based tribal livelihood in Bundu block (Ranchi, Jharkhand)" submitted in 2013 to FRI University, Dehradun, Uttarakhand.

building on their own opportunities, supporting their access to assets and in developing an enabling policy and institutional environment (Sharma *et al*., 2015). Livelihoods have a ma-jor bearing on many basic issues that affect the forest-fringe tribal people in developing countries (Pandey, 2009; Singh and Quli, 2011). Many vital problems among the tribes are due to lack of purchasing power which is dependent on employment and income security — the two crucial components of livelihood security which requires immense emphasis (Shit and Pati, 2012). The low-income tribal people living in the remote areas are engaged in a variety of formal and informal labour activities to support themselves and their families (Islam *et al*., 2014b).

The livelihood security of forest-dependent tribes (*Munda*, *Oraon* and *Lohara*) of Bundu block in Ranchi district of Jharkhand is a crucial problem for state as well as central governments (Islam *et al*., 2015b). The destitute tribes of the block traditionally derive most of their livelihood requirements from the forests available in and around their hamlets (Sivaji, 2009). The brunt of livelihoods load on the existing forest areas has been detrimental, leading to precarious recessions in the natural green wealth, which in turn has given way to the serious stress on the dependent populations (Pal, 2009). The area has a predominant rain-fed agricultural tradition, being practised over nutrient-deficient soil with anomalous pH, and farmers can hardly afford quality seeds and adequate inputs due to poor purchasing capacity. Hence, the agricultural returns have become quite insufficient to bear the livelihoods burden, leading to ever rising dependences on forest resources (Islam *et al*., 2014a). Due to excessive pressure and irreversible recessions in productivity, the forest resources have lost their sustainability (Anonymous, 2010). The low forest-productivity, with ever-increasing loads of local livelihoods, has generated a progressive vicious circle, leading to drastic qualitative and quantitative depletions of forest resources, and this has added much to the adversities of climate change (Islam *et al*., 2015b).

The options of the proposed livelihood diversification strategy, with enormous potential, in terms of both goods and services, are expected to be the best alternatives to resolve the multifaceted socioeconomic-cum-environmental problems (Islam *et al.,* 2014b). The economic returns have been worked out after meticulous considerations of all the parameters to mitigate the quantum of regression during the execution of the proposals. The database of the applied researches (Acharya and Alam, 2009; Ansari and Ansar, 2011; Bhatia *et al*., 2011; Islam *et al*., 2015a; Pal, 2009; Sarkar and Chatopadhyay, 2006) revealing profitability of the eco-friendly land-use options, have been very carefully extrapolated to propound a magnificent strategy for diversification of the existing natural resources with multiple goal of socioeconomic development of the tribal people, which have been pushed back to walls, due to livelihood stress (Islam *et al*., 2014a). The implementation of the proposed strategy would have substantial positive impact on easing stress on the forest resources for climate resilience by virtue of accelerated carbon sequestration through large scale afforestation and reforestation wastelands.

Data and Methodology

Study Locale, Population Statistics and Climate

The geographical area of Bundu block is 25097 ha with 69.25 per cent un-irrigated land, 17.44 per cent forests, 8.41 per cent irrigated land, 3.59 per cent culturable wasteland, 1.29 per cent unculturable wasteland and 0.02 per cent non-agricultural land. The Northern Tropical Dry Deciduous Forest ($5B/C_2$) forms the forest cover lying under the Bundu Range of Khunti Forest Division in the block (Champion and Seth, 1968). The total human population is 62509 (31624 males and 30885 females) living in 88 villages and 11495 households comprising 60.74 per cent Schedule Tribes, 4.76 per cent Schedule Castes and 34.50 per cent other caste groups. The block is characterized by tropical climate divided into three seasons, viz., summer, monsoon and winter with average annual rainfall of 1413 mm, mean minimum temperature of 24 °C and mean maximum temperature of 37 °C (Anonymous, 2009).

Simple random sampling technique (Ray and Mondol, 2004) was employed to select nine (10%) sample villages, namely Korda, Jojoda, Husirhatu, Banaburu, Nehalgara, Ghagrabera, Hesapiri, Roredih and Kuchidih from the block. A complete enumeration of the sample villages was carried out and the village level data on land-use pattern, chemical analysis of soil, demographic profile, manpower potential, occupational status and household annual income were collected

from secondary sources, namely, village records, officials documents, reports of block office, Bundu and Jharkhand Space Application Centre (JSAC), Ranchi and internet. Simple descriptive statistics, viz. frequency (f), mean (x), percentage (%) and range were used for data analysis (Snedecor and Cochran, 1967) and the results are displayed through tables and chart.

Economics of Forestry Interventions

The strategy for livelihood diversification of tribes through forestry interventions was developed using *tasar* sericulture, *lac* culture, fruit culture and mechanized *sal* leaf plate making, based on resources availability, socio-economic status, public preferences, productivity and soil-plant compatibility. Standard project worth measures like net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) were computed to work out the financial viability of forestry interventions (Singh, 2007).

$$NPV = \sum_{t=1}^{n} (B_t - C_t)/(1+i)^t$$

where, B_t is the benefit in year t, C_t is the cost in year t, n is the number of years, and i is the discount rate (12%).

$$BCR = \left[\sum_{t=1}^{n} (B_t)/(1+i)^t\right] \Big/ \left[\sum_{t=1}^{n} (C_t)/(1+i)^t\right]$$

IRR is the discount rate i such that:

$$\sum_{t=1}^{n} (B_t - C_t)/(1+i)^t = 0$$

where, Bt is the benefit in each year; C_t is the cost in each year; i is the discount rate; t = 1, 2, ..., n and n is the number of years.

Results and Discussion

Demographic Profile of Tribal Villages

The demographic profile of sample villages (Table 1) revealed that the total human population is 4386 (1862 males, 1876 females and 648 children) residing in 816 households. The number of literate people was only 1380 (36.92%) comprising 975 males (52.36%) and 405 females (21.59%). The majority of population was dominated by Schedule Tribes (74.46%), followed by Other Backward Classes (14.77%), Others (8.44%) and Scheduled Castes (2.33%). The average household size was 5.38 and the population density was 152.35/ sq. km.

Manpower Potential, Occupational Status and Household Annual Income

The total labour force (both earners and non-earners) in the sample villages was 3738, in which 2054 was employed and 1684 was un-employed. Among unemployed persons, 1532 were workable people, between 15 and 60 years and rest 152 were the aged people, above 60 years. Among the work force of 2054 persons, 1315 (64.02%) were the main workers and 739 (35.98%) were marginal workers. The main workers were further categorized as 956 cultivators, 231 wage labourers, 10 household industry owners and 118 other occupation holders (Table 2).

A perusal of Table 2 indicted that a sizeable percentage (45.73%) of the households belonged to low-income category, followed by medium income (25.61%), very low income (19.51%) and high income (9.15%) categories. The average annual income of

Table 1. Demographic profile of sample villages in Bundu block of Jharkhand

Human population		Literacy		Caste structure		Sex ratio (Females per thousand males)	
Particulars	No.	Category	No. of people	Category	No. of people	Category	No.
Households	816	Illiterate	2358 (63.08%)	ST	3266 (74.46%)	ST	1028.22
Total Population	4386	Literate	1380 (36.92%)	SC	102 (2.33%)	SC	821
Male	1862 (42.45%)	Male	975 (52.36%)	OBC	648 (14.77%)	OBC	970.43
Female	1876 (42.77%)	Female	405 (21.59%)	Others	370 (8.44%)	Others	929.33
Children	648 (14.78%)	-	-	Total	4386	-	-

Source: Anonymous (2009)

Table 2. Manpower potential, occupational status and household annual income in sample villages of Bundu block

Manpower potential		Occupational status		Household annual income (₹)	
Particulars	No. of people	Particulars	No. of people	Category	Household (%)
Labour force	3738	Main workers	1315	Very low income (Up to ₹ 15000)	159 (19.49)
Work force	2054	Cultivators	956	Low income (₹ 15001 to ₹ 30000)	373 (45.71)
Unemployed	1684	Wage labour	231	Medium income (₹ 30001 to ₹ 60000)	209 (25.61)
Workable people (15-60 years)	1532	Household industry	10	High income (> ₹ 60000)	75 (9.19)
Aged people (above 60 years)	152	Others	118	Total	816
Percentage of work force to labour force	54.95	Marginal workers	739	-	-

Source Anonymous (2009)

₹ 27908 in a tribal household indicated the preponderance of low annual income households. Such a low annual income is due to the fact that majority of the tribal people are either farmers having small landholdings or are wage labourers. Low agricultural production due to lack of irrigation facilities, scientific know-how, improved equipments and machinery, mono-cropping system, low fertility of land and erratic climatic condition accrue paltry income to the farmers. Also, the majority of wage labourers are unskilled and do not get regular income.

Land-use Pattern and Chemical Analysis of Soils

The land-use pattern (Table 3) in the sample villages indicated the dominance of land area under cultivation (53.06%) with 47.10 per cent un-irrigated and 5.96 per cent irrigated land. Of the sown area 58.89 per cent is lowland (*Doin*) and 41.11 per cent is upland (*Tanr*). Forest (28.47%) is the second important land-use category, followed by cultivable waste (10.68%), non-agricultural land (7.79%) and fallow land (4.10%). Most of the land lying unproductive is upland and predominantly red sandy loam, 1.0-1.5 m deep. The mixed calcareous and *murrammy* soils are also found in some areas. The chemical analysis of soil has indicated that the soils are acidic in reaction with pH of 5.6, resulting in low availability of several plant nutrients and poor soil fertility status. The organic carbon content is low (0.45%) and the available nitrogen (327.60 kg/ ha), phosphorus (22.88 kg/ ha)

Table 3. Land-use pattern and chemical analysis of soil in sample villages of Bundu block

Land-use pattern		Chemical analysis of soil	
Particulars	Area (ha)	Parameters	Mean value
Forest	819.50 (28.47%)	pH	5.6
Cultivable waste land	189.43 (6.58%)	Organic carbon (%)	0.45
Fallow land	118.08 (4.10%)	Available N (kg/ ha)	327.60
Non-agricultural land	224.29 (7.79%)	Available P (kg/ ha)	22.88
Net sown area	1527.64 (53.06%)	Available K (kg/ ha)	142.27
Irrigated	171.49 (5.96%)		
Un-irrigated	1356.15 (47.10%)		
Village area	2878.94		

Source: Anonymous (2009)

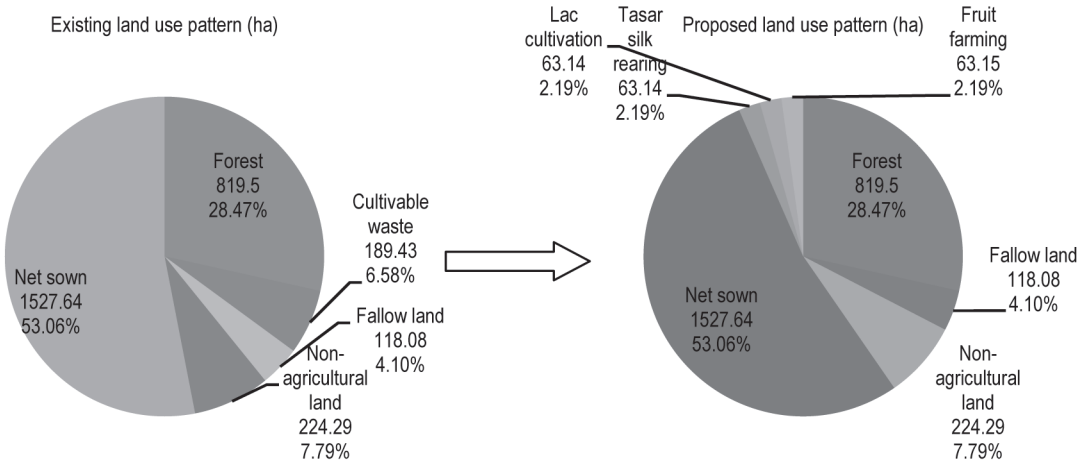

Figure 1. Suggested strategic re-orientation of land-use pattern in sample villages of Bundu block

and potassium (142.27 kg/ ha) status is medium (Table 3). These sandy loam soils are inadequate for cultivation of rain-fed agricultural crops. However, these lands can be utilized and managed efficiently under forestry interventions such as *tasar* sericulture, *lac* culture and fruit culture (Islam *et al*., 2014b).

Livelihood Diversification Strategy

The imperfect occupational pattern of the workforce has become unviable; consequently, people are unable to derive even subsistence living leading to their miserable conditions. The continuous unemployment causes poverty, diminishes the standard of living and ruins dignity and lives among the tribal populace. Hence, there is an urgent need to generate sufficient employment opportunities for the unemployed and under-employed people. Owing to lack of livelihood opportunities in agriculture, fruit culture, livestock husbandry, wage labour, industries, etc. and scarcity of alternative non-farm livelihood sources, the tribal households are striving to secure their livelihoods from unconventional options (Singh and Quli, 2011). The development and diversification of non-traditional and economically-viable livelihood options based on forest resources can mitigate the livelihood stress besides contribution to resource conservation and restoration of ecosystem services in the tribal landscape (Islam *et al*., 2014b). The study has found that *tasar* sericulture, *lac* culture, fruit culture and mechanized *sal* leaf plate making are the viable eco-friendly interventions for livelihood security in these tribal households. Accordingly, the re-orientation of land-use pattern in the sample villages has been suggested based on need, topography, productivity and soil-plant compatibility (Figure 1). The livelihood diversification through these interventions has tremendous potential for fuel, fodder and timber security, food and nutritional security, hunger elimination, poverty reduction, socio-economic development, improvement in quality of life and ecological stability.

Tasar Sericulture

Agri-silvi-sericulture on 63 ha of cultivable wastelands can produce about 15 lakh cocoons/ annum from the fourth year onwards, *gamhar* (*Gmelina arborea*) timber production of 1010 m^3 in the 10^{th} year from 50 per cent harvesting and another 2020 m^3 in the 20^{th} year from final harvesting, 316 tonnes of fuel wood per annum @ 5 tonnes/ ha/ annum from *arjun* (*Terminalia arjuna*) and *asan* (*Terminalia tomemtosa*) from the fourth year onwards as rearers prune trees after the cocoon harvest every year, besides crop production in interspaces of 31.67 ha every year. The 63 ha of block plantation on cultivable wastelands will fetch a net revenue of ₹ 54.16 lakh/annum from the sale of silk cocoon, timber, fuel wood and crop products and will generate an employment potential of 21100 person-days/ annum. The *tasar* sericulture was estimated to have a NPV of ₹ 217.64 lakh, a BCR of 4.43 and an IRR of 49.15 per cent at 12 per cent annual discount rate at 20-year rotation period (Table 4).

Tasar sericulture is an important forestry-based cottage industry having enormous potential for generating income and employment opportunities for

Table 4. Livelihoods through *tasar* sericulture in sample villages of Bundu block in Jharkhand

Year	Investment		Income		Net income (₹ lakh)	Discount factor (@ 12%)	NPV (at 12%)	Employment (Person-days)
	Particulars	Amount (₹ lakh)	Particulars	Amount (₹ lakh)				
1st	Pe + Ic	25.37	Ic	3.79	-21.58	0.893	-19.27	13448.82
2nd	Pm + Ic	8.14	Ic	4.42	-3.73	0.797	-2.97	3788.40
3rd	Pm + Ic	8.35	Ic	5.05	-3.31	0.712	-2.36	3788.40
4th	Sr + Ic	6.53	Ic + Fw	22.42	15.89	0.636	10.11	22735.45
5th	Sr + Ic	4.27	Ic + Sc + Fw	26.01	21.75	0.567	12.33	22735.45
6th	Sr + Ic	4.43	Ic + Sc + Fw	29.39	24.97	0.507	12.66	22735.45
7th	Sr + Ic	4.55	Ic + Sc + Fw	30.86	26.30	0.452	11.89	22735.45
8th	Sr + Ic	4.68	Ic + Sc + Fw	32.40	27.72	0.404	11.20	22735.45
9th	Sr + Ic	4.82	Ic + Sc + Fw	34.02	29.21	0.361	10.55	22735.45
10th	Sr + Ic	7.45	Ic + Sc + Fw + Tr	212.52	205.07	0.322	66.03	27553.03
11th	Sr + Ic	5.41	Ic + Sc + Fw	37.52	32.11	0.287	9.22	22735.45
12th	Sr + Ic	5.56	Ic + Sc + Fw	39.39	33.82	0.257	8.69	22735.45
13th	Sr + Ic	5.73	Ic + Sc + Fw	41.36	35.64	0.229	8.16	22735.45
14th	Sr + Ic	5.90	Ic + Sc + Fw	43.43	37.53	0.205	7.69	22735.45
15th	Sr + Ic	6.08	Ic + Sc + Fw	45.60	39.53	0.183	7.23	22735.45
16th	Sr + Ic	8.76	Ic + Sc + Fw	47.87	39.11	0.163	6.38	22735.45
17th	Sr + Ic	6.46	Ic + Sc + Fw	50.27	43.81	0.146	6.40	22735.45
18th	Sr + Ic	6.67	Ic + Sc + Fw	52.79	46.12	0.130	5.99	22735.45
19th	Sr + Ic	6.89	Ic + Sc + Fw	55.42	48.53	0.116	5.63	22735.45
20th	Sr + Ic	7.12	Ic + Sc + Fw + Tr	411.77	404.65	0.104	42.08	32370.61
Total		143.17	-	1226.30	1083.14	-	217.64	421981.00 [a]

Notes: NPV = ₹ 217.64 lakh, BCR = 4.43, IRR = 49.15 per cent; Pe = Plantation establishment, Pm = Plantation maintenance, Sr = Silkworm rearing, Ic = Intercropping, Fw = Fuel wood, Sc = Silk cocoon, Tr = Timber.

tribal manpower. *Tasar* silk is extracted from the cocoons produced on *arjun* and *asan* by the larvae of the moth *Antherea mylitta*. Economics of establishing plantation of *arjun* and *asan* at 2.44m × 2.44m spacing, peripheral planting of *gamhar* spaced at 2m apart and *tasar* silk culture from third year onwards combined with cultivation of agricultural crops in the interspaces every year till 20 years of plantation, show that this rural enterprise can yield an IRR of 63 per cent per ha (Acharya and Alam, 2009).

Lac Culture

The agri-horti-lac culture on 63 ha of cultivable wastelands is estimated to produce about 60 tonnes of *lac* per annum from the fourth year onwards, 600 tonnes of *ber* (*Zizyphus mauritiana*) fruits/ annum @ 10 kg/ tree/ annum from the third year onwards, fuel wood of 683.81 tonnes from *ber* trees in the tenth year of plantation, besides crop production in interspaces of 50.51 ha during the initial three years of plantation. The 63 ha of block plantation on cultivable wastelands will fetch a net revenue of ₹ 36.88 lakh/ annum from the sale of *lac*, *ber* fruit, fuel wood and crop products and will generate an employment potential of 8790 person-days/ annum. The *lac* culture is an attractive financial alternative having NPV of ₹ 138.29 lakh, BCR of 2.02 and IRR of 77.84 per cent at 12 per cent annual discount rate at 10-year rotation period (Table 5).

The *lac* culture is a highly remunerative forestry-based cottage industry having tremendous potential to generate income and employment for the tribes inhabiting in and around forests. The *lac* is a valuable natural resin secreted by *Kerria lacca* thriving on the tender twigs of specific host trees viz., *palas* (*Butea monosperma*), *ber* (*Zizyphus mauritiana*) and *kusum* (*Schleichera oleosa*). The economics of establishing

Table 5. Livelihoods through *lac* culture in sample villages of Bundu block in Jharkhand

Year	Investment		Income		Net income (₹ Lakh)	Discount factor (@ 12%)	NPV (at 12%)	Employment (Person-days)
	Particulars	Amount (₹ lakh)	Particulars	Amount (₹ lakh)				
1st	Pe + Ic	20.08	Ic	9.09	-10.99	0.893	-9.81	5524.75
2nd	Pm + Ic	4.82	Ic	9.09	4.27	0.797	3.40	3788.40
3rd	Pm + Ic	4.82	Ic	9.09	4.27	0.712	3.04	3788.40
4th	Lc	8.83	Sl	14.40	5.57	0.636	3.54	9999.17
5th	Lc	7.93	Sl	14.40	6.47	0.567	3.67	9999.17
6th	Lc	17.87	Sl	47.99	30.12	0.507	15.27	9999.17
7th	Lc	23.15	Sl	53.99	30.84	0.452	13.94	9999.17
8th	Lc	58.04	Sl	134.36	76.32	0.404	30.83	9999.17
9th	Lc	58.78	Sl	134.36	75.58	0.361	27.28	9999.17
10th	Lc	112.77	Sl + Fw	259.13	146.36	0.322	47.13	14797.81
Total	317.09	-	685.90	368.81		138.29	87894.38	

Notes: NPV = ₹ 138.29 lakh, BCR = 2.02, IRR = 77.84 per cent; Pe = Plantation establishment, Ic = Intercropping, Pm = Plantation maintenance, Lc = Lac culture, Sl = Sale of lac, Fw = Fuel wood.

block plantation of *ber* at 3.25m × 3.25m spacing and *lac* culture (*Rangeeni* and *Kusmi* strains) from fourth year onwards up to 10th year of plantation combined with cultivation of agricultural crops in the interspaces up to initial three year of plantation, show that this rural enterprise can yield an IRR of 114 per cent per ha (Pal, 2009).

Fruit Culture

The economics of establishing block plantation of mango (*Mangifera indica*) at a spacing of 8m × 8m (50% cv. *Langra* and 50% cv. *Mallika*), quincunx plantation of guava (*Psidium guajava*) cv. *Allahabad Safeda* as filler crop in interspaces at 8m × 8m spacing, peripheral plantation of *gamhar* (*Gmelina arborea*) spaced at 2 m apart and fruit production from 3rd year onwards, timber harvesting in 10th and 20th year of plantation combined with cultivation of agricultural crops in the interspaces every year, show that this rural enterprise is highly profitable. The horti-silvi-agriculture on 63 ha of cultivable wastelands will yield mango fruits about 18.19-363.74 tonnes/ ha/ annum during 4th to 9th year and 363.74-1364.04 tonnes/ ha/ annum from the 10th year onwards and guava fruits 22.92-764.12 tonnes/ annum from the 3rd year onwards, *gamhar* timber production of 1010 m^3 in the 10th year from 50 per cent harvesting and another 2020 m^3 in the 20th year from final harvesting, 316 tonnes of fuel wood per annum @ 5 tonnes/ ha/ annum from mango, guava and *gamhar* from the fourth year onwards besides crop production in interspaces every year. The 63 ha of horti-silvi-agriculture plantation on cultivable wastelands will fetch net revenue of ₹ 63.58 lakh/ annum from the sale of fruits, timber, fuel wood and crop products and will generate an employment potential of 19180 person-days/ annum. The economics of fruit culture showed a NPV of ₹ 208.09 lakh, BCR of 1.96 and IRR of 30.35 per cent for a rotation of 20 years at discount rate of 12 per cent (Table 6).

The fruit culture plays a significant role in the household food and nutritional security, poverty reduction, rural economy and biodiversity conservation. To achieve nutritional security, meet industrial needs and have higher profitability from wastelands, the people have diversified towards horticultural crops which need less water and other inputs. Being labour-intensive, the fruit culture generates lot of employment opportunities for the rural people. The conducive agro-climatic conditions, surplus labour and abundant marketing opportunity offer high potential for commercial horticulture of mango and guava in the cultivable wastelands in the area (Ansari and Ansar, 2011). The fruit culture with its vast potential for income and employment generation can play an important role in improving the socioeconomic conditions and poverty alleviation in the tribal area.

Table 6. Livelihoods through fruit culture in sample villages of Bundu block in Jharkhand

Year	Investment		Income		Net income (₹ lakh)	Discount factor (@ 12%)	NPV (at 12%)	Employment (Person-days)
	Particulars	Amount (₹ lakh)	Particulars	Amount (₹ lakh)				
1st	Pe	38.74	-	0.00	-38.74	0.893	-34.60	18945.00
2nd	Pm + Ic	18.81	Ic	8.12	-10.70	0.797	-8.53	14208.75
3rd	Pm + Ic	19.61	Ic	10.14	-9.47	0.712	-6.74	14208.75
4th	Pm + Ic	21.80	Ic + Mg	16.92	-4.88	0.636	-3.10	14208.75
5th	Pm + Ic	26.41	Ic + Mg	27.74	1.33	0.567	0.75	17366.25
6th	Pm + Ic	26.70	Ic + Mg	36.40	9.70	0.507	4.92	17366.25
7th	Pm + Ic	27.00	Ic + Mg	46.18	19.17	0.452	8.67	17366.25
8th	Pm + Ic	27.32	Ic + Mg	53.59	26.27	0.404	10.61	17366.25
9th	Pm + Ic	27.65	Ic + Mg	62.87	35.23	0.361	12.72	17366.25
10th	Pm + Ic + Th	34.30	Ic + Mg + Tr	257.26	222.96	0.322	71.79	23681.25
11th	Pm + Ic	28.58	Ic + Mg	77.84	49.26	0.287	14.14	20523.75
12th	Pm + Ic	28.97	Ic + Mg	81.73	52.76	0.257	13.56	20523.75
13th	Pm + Ic	29.38	Ic + Mg	85.81	56.43	0.229	12.92	20523.75
14th	Pm + Ic	29.79	Ic + Mg	90.10	60.31	0.205	12.36	20523.75
15th	Pm + Ic	30.24	Ic + Mg	94.61	64.38	0.183	11.78	20523.75
16th	Pm + Ic	30.70	Ic + Mg	99.35	68.63	0.163	11.19	20523.75
17th	Pm + Ic	31.20	Ic + Mg	104.30	73.10	0.146	10.67	20523.75
18th	Pm + Ic	31.71	Ic + Mg	109.52	77.80	0.130	10.11	20523.75
19th	Pm + Ic	32.24	Ic + Mg	115.00	82.75	0.116	9.60	20523.75
20th	Pm + Ic + Th	39.13	Ic + Mg + Tr	474.38	435.26	0.104	45.27	26838.75
Total		580.28	-	1851.86	1271.55		208.09	383636.30

Notes: NPV = ₹ 208.09 lakh, BCR = 1.96, IRR = 30.35 per cent; Pe = Plantation establishment, Pm = Plantation maintenance, Ic = Intercropping, Th = Timber harvesting, Mg = Mango and guava, Tr = Timber.

Sal (*Shorea robusta*) Leaf Plate Making

The forests in the area have abundance of *sal* trees which can support livelihoods for at least 10 per cent of the forest dwelling families. Ordinary *sal* leaf plates making by 82 families are estimated to produce 164 lakh raw *sal* leaf plates with an employment opportunity of 32800 person-days/ annum. The value addition of these hand-stitched and manually-pressed *sal* leaf plates by mechanized moulding can add rigidity, give good shape with raised edges to the plates and enhance the household income and employment opportunities substantially. The installation of household pressing unit and mechanized pressing of ordinary *sal* leaf plates into 82 lakh moulded plates by the 82 families has potential of earning up to ₹ 40.26 lakh/ annum[1] with an additional employment generation of 4100 person-days/ annum. *Sal* leaf plate making is a traditional household cottage industry yielding considerable employment and income opportunities for the tribal people. *Sal* leaf plates are cheap, disposable, biodegradable and ecological substitute for thermocol and plastic plates and are in high demand. The glistening dusky golden colour with wild deciduous essence makes the *sal* leaf plates ideal for parties and gatherings, hence, the *sal* leaf plates have ample local, domestic as well as global market (Islam *et al*., 2015a).

[1] *Notes:* (a) 2 lakh raw *sal* leaf plates/ annum (1000/ day x 25 days/ month x 8 months/ annum) @ 500 *sal* leaf plates/ person-day (Sarkar and Chatopadhyay, 2006); (b) 1 lakh machine pressed *sal* leaf plates @ 2000/ person-day (Islam *et al*., 2015a); (c) @ ₹ 60/ 100 plates; (d) Cost of production of mechanized *sal* leaf plates @ ₹ 109/ 1000 plates.

Table 7. Livelihood diversification through forestry interventions in sample villages of Bundu block

Livelihood intervention	Product/ Yield	Area (ha)	Rotation (Year)	Income (₹ lakh/ annum)	Employment (Person-days/ annum)
Tasar sericulture	Silk cocoons- 15.15 lakh/ annum (4th year onwards), *gamhar* timber- 3030.72 m^3, fuel wood-315.70 tonnes/ annum (4th year onwards), green herbage- 230.46 tonnes, field crops	63.14	20	54.16	21099
Lac culture	*Lac*- 59.98 tonnes/ annum (4th year onwards), fuel wood- 683.81 tonnes, *ber* fruits- 599.83 tonnes/ annum (3rd year onwards), green herbage- 230.46 tonnes, field crops (up to 3rd year)	63.14	10	36.88	8789
Fruit culture	Mango fruit- 18.19-1364.04 tonnes/ annum (4th year onwards), guava fruit- 22.92-764.12 tonnes/ annum (3rd year onwards), *gamhar* timber- 3031.20 m^3, fuel wood- 315.70 tonnes/ annum (4th year onwards), green herbage- 230.50 tonnes, field crops	63.14	20	63.58	19182
Sal leaf plate making	164 lakh ordinary pressed leaf plates and 82 lakh machine pressed leaf plates	-	-	40.26	36900
Total	-	189.43	-	194.88	85970

Prospects of Forestry-based Livelihood Diversification Strategy

The comprehensive summary of products, yield, income, employment, area and rotation of various components of the specific strategy suggested for livelihood diversification indicated that *tasar* sericulture, *lac* culture and fruit culture on cultivable wastelands together will procure 1315 tonnes/ annum of fuel wood, 691 tonnes/ annum of green herbage and 303 m^3/ annum of timber which can relieve substantial anthropogenic pressure on the forests, alleviating forest degradation in the locality (Table 7). The production of agricultural crops by intercropping, mango and guava production through fruit culture and *ber* fruits from *lac* culture compartments on cultivable wastelands will play a potent role in food and nutritional security for the tribes.

The total labour force (15-60 years age) in the sample villages was 3586, comprising 2054 working people (1315 main workers and 739 marginal workers) and 1532 unemployed people. The annual income from various sources was ₹ 27908/ household and the unemployment rate was 1.88 persons/ household in the tribes. Low earnings combined with acute unemployment in the tribal households was creating many socioeconomic, human, food & nutritional, migration, livelihood, ecological and cultural problems. The implementation of livelihood interventions suggested will generate an additional annual income of ₹ 23882/ household/ annum from the sale of *gamhar* timber, silk cocoons, *lac*, mango fruit, guava fruit, fuel wood, green forage, tree fodder, minor fruits and agricultural products besides securing an employment opportunity of 105 person-days/ household/ annum.

The augmentation of productivity, supply of basic needs, creation of employment opportunities, enhancement of income level of working poor, relief of pressure on nearby forests, safety net functions, training & capacity development, development of avenues for small scale industries, infrastructural development, ecosystem goods and services, maintenance of culture & traditions etc. through implementation of these interventions will build up the livelihood assets (physical, natural, human, financial and social) of the tribes. There is a multitude of studies suggesting strategies for livelihoods diversification focusing on one or two specific interventions such as *lac* culture (Pal, 2009), sericulture (Acharya and Alam,

2009; Bhatia *et al*., 2011), bamboo plantation (Kithan, 2014), *sal* leaf plate making (Sarkar and Chatopadhyay, 2006; Islam *et al*., 2015a), NTFPs (Anonymous, 2010; Singh and Quli, 2011; Pandit, 2011; Shit and Pati, 2012; Sharma *et al*., 2015), forest resources (Pandey, 2009; Chakraborty *et al*., 2009; Usman *et al*., 2016; Langat *et al*., 2016), agroforestry (Kareemulla *et al*., 2009; Bijalwan *et al*., 2011; Roy and Tiwari, 2012), medicinal and aromatic plants (Kalaichelvi and Swaminathan, 2009; Baishya and Begum, 2013), wicker handicraft (Sheikh Shah, 2015), etc. Hence, the specific interventions visualized in this study will be helpful in strengthening the forestry-based livelihoods for socio-economic improvement and poverty alleviation of the tribes besides ecological stability in the area.

Conclusions

The study has revealed that the condition of tribes in this area is unsatisfactory as is illustrated by their low socioeconomic status and poor employment opportunities. It is leading to out-migration. Development of livelihood systems based on education, health care communication and extension facilities is imperative. Traditionally, the tribal people exploit multiple forest resources for subsistence and livelihoods and derive a significant proportion of employment and income for their households. Hence, livelihood diversification through forestry interventions using the existing resources is needed as important strategy of poverty reduction and socioeconomic development of backward tribal people.

The study has suggested specific livelihood strategy consisting of forestry interventions such as *tasar* sericulture, *lac* culture, fruit culture and mechanized *sal* leaf plate making. It has to be implemented by re-orientation of the prevailing land-use system to revive the potentials of resources backing up the socioeconomic conditions, for ensuring sustainable livelihood for the tribes. The socioeconomic, psychological, communication and situational characteristics of the tribes having significant impact on livelihoods require due consideration during planning, implementation and execution of specific livelihood strategy. Participation of various groups like clan heads, local leaders, *panchayat* members, self-help groups, voluntary organizations, etc. should be ensured along with institutional support. To make the livelihood strategy more participatory, interactive and effective, further, appropriate measures should be taken to strengthen and streamline forestry-based livelihoods by creating forest-resources based secondary employment through establishment of forest-based industries, value addition of NTFPs and organized marketing system of forest produces. The proposed strategy options would boost the socioeconomic status of the tribes and would have far-reaching impact on the ecological stability as well, by restocking the existing forest in general and enhancing the green cover index of the non-forest wastelands.

Acknowledgements

The authors are grateful to *gram pradhans*, clan heads, local leaders, government officials and NGO workers for their support in carrying out the research in Bundu block of Ranchi district in Jharkhand. They also thank the anonymous reviewers for providing useful comments to improve the article.

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Received: July, 2016; Accepted: November, 2016