

Journal of Horticulture and Forestry

Volume 5 Number 8 September 2013

ISSN 2006-9782



*Academic
Journals*

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Full Length Research Paper

Site factor on nutritional content of *Arundinaria alpina* and *Oxytenanthera abyssinica* bamboo shoots in Ethiopia

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Accepted 29 July, 2013

The objective of this study was to characterise some of the nutritional values of the two bamboo species grown and consumed in western parts of Ethiopia. The bamboo shoots of each the two species were collected from each of the three sites and analyzed for their nutritional and mineral composition. The average moisture content of the bamboo shoots was more than 90% for both species but the fat content as determined on dry weight basis indicated a significant variation ranging from 0.6 to 2.2% for *Oxytenanthera abyssinica* and from 0.6 to 1.5% for *Arundinaria alpina*. Highland bamboo (*A. alpina*) shoots characterized with high nitrogen content (5.40%) implying that they may have high content of protein, but the lowland bamboo (*O. abyssinica*) was low in nitrogen content (3.10%). The average ash contents of the highland bamboo shoots collected from Tekur Incheny, Enjibara and Masha site were 14.20, 15.50 and 17.20%, respectively. The average nutrient elements in the shoots of *O. abyssinica* were in the order of K>N>P>Ca>Mg, whereas in *A. alpina* bamboo shoots observed to have slight variation in the arrangement of these elements with the order of K>N>P> Mg > Ca.

Key words: *Arundinaria alpina*, *Oxytenanthera abyssinica*, bamboo shoots, mineral elements, nutrients.

INTRODUCTION

Bamboo is a perennial grass with over 1200 species in 50 genera of bambusoideae and grows mainly in the tropics and subtropics (Zhang et al., 2002). In different parts of the world, it is used as a source of raw material for fodder, construction materials, paper production, laminated boards, energy, food, beverage and medicine (Choudhury et al., 2010). The bamboo shoots have been used as food for centuries in Asia. Their protein content is as high as 1.49 to 4.04% with 17 kinds of essential amino acids accounting for 35% of the total protein. They are also rich in other mineral nutrients which are highly valuable for human being (Hunter and Feng'e, 2000; Choudhury et al., 2010).

Ethiopia has two bamboo species: The African alpine Bamboo *Arundinaria alpina* (K. Schumann Lin) which grows between 2200 and 4000 m above sea level (asl) and the lowland bamboo *Oxytenanthera abyssinica* (A. Richard Munro) which grows between 1200 and 1800 m asl (Sylvia, 1995; Embaye et al., 2005). In Ethiopia the common use of bamboo resource is limited to fencing, house construction (tukul), waving, household furniture and utensils but there are the experiences of bamboo shoots consumption in the western and south western parts of Ethiopia. In general, the most common use of bamboo is for the construction purposes. The area coverage of bamboo in the country is reported to vary

from eight hundred thousand to one million ha (FRA, 1985; Embaye et al., 2003) but currently this figure may be reduced due to the expansion of mechanised agriculture in bamboo growing parts of the country. Recently, in response to the growing interest of utilizing the existing bamboo resource, some research activities have been going on in areas such as product characterization and different management options (Embaye et al., 2003, 2005; Seyoum et al., 2006, 2007).

In Ethiopia Bamboo shoots (BS) usually emerge after the spring rain, namely between April and June without disregarding its dependence on location and species. The quality of bamboo shoots for food depends on the biological characteristics of the bamboo such as species, shooting time, duration of shooting, the rate of shoot growth and the size of shoots.

Bamboo shoots are known for their low fat and cholesterol content and high content of protein, mineral and dietary fibre. Reports show that some species of BSs like other root crops such as cassava, have some cyanogenic glycoside composition which decrease following harvesting of the material and during the time of food preparation (Anonymous, 2004; Agatemor, 2009; Choudhury et al., 2010, 2012).

Bamboo has an immense potential in realizing the food security mechanism of the country. To achieve such objective, the indigenous knowledge of bamboo shoots consumption which accumulated over centuries can be easily introduced to other bamboo growing and potential areas. However, dissemination of such indigenous knowledge can be effective only when preceded by some improvement works which include taste and preparation ease that lead to getting fast adoption rate in the community. The traditional methods of preparing food from bamboo shoots by the indigenous people (ethnic community) of south western and western parts of Ethiopia demands some improvement work, especially with regard to nutritional analysis, the removal of the natural toxicants or bitterness prior to consumption and storability.

The objective of this paper was to identify and raise awareness on some of the parameters of the nutritional values of bamboo shoots of *O. abyssinica* and *A. alpina* species that used for food in south western and western parts of Ethiopia.

MATERIALS AND METHODS

Site description

The samples of bamboo shoots are collected from the following six sites. Masha forest which located in southwest Ethiopia (7° 30'N; 35° 30'E) has an altitude that ranges from 2400 to 3000 m asl, mean annual rainfall of over 2300 mm and annual temperature range 16 to 20°C (Embaye et al., 2005). Enjibara is located in northern parts of the country (10°56' N and 36°56'E) at elevation of 2560 m asl. Tikur Inchini is situated in western parts of the country (9°19' N and 38°24' E) and has an altitude of 2700 m asl. Pawe

found in northwest Ethiopia (11° 09' N and 36° 03' E) and has an altitude of 1120 m asl and mean annual rainfall of 1587 mm. Didhessa is located in the south-western of the country (8°41' N and 36°24' E) at the altitude of ~ 1300 m asl. Assosa is located in the western region of the country (10°7' N and 34°37' E) with an altitude of 1510 m asl.

Sample preparation

Lowland bamboo shoots (*O. abyssinica*) were collected from Asossa, Pawe and Dhidhessa while the highland bamboo shoots (*A. alpina*) collected from Enjibara, Masha and Tikur Enchiny. Shoot samples of both bamboo species were transported to the laboratory under liquid nitrogen to avoid spoilage of the shoots.

The outer cover of the hard sheath, the bottom and top portions of the shoots were removed by hand and the remaining middle portions (the edible part of the shoots) which account for 45% of the emerging ones were washed three times in cold water, sliced at the thickness of 5 mm and then dried at a temperature of 45°C using oven drier for 40 h.

Moisture content

The moisture content of the bamboo shoots were determined by drying of the samples in an oven at $105 \pm 2^\circ\text{C}$.

Fat extraction

The bamboo shoots were extracted with hexane in a Soxtec apparatus (a product of Germany) and the average reading of six replicate for each location were taken (Greenfield and Southgate, 2003).

Ash determination

A sample of the bamboo shoots was first heated on a burner in air to remove its smoke, and then burned in a furnace at 550°C. The ash content was expressed as a percentage ratio of the weight of the ash to the oven dry weight of bamboo shoots.

Nitrogen content

Nitrogen analysis was undertaken using Kjedhal Distillation Apparatus. The amount of nitrogen was calculated by the amount of acid added that change the colour of the distilled solution. The protein content was calculated using the nitrogen conversion factor (NCF) of 6.25 (Anonymous, 1998).

Mineral content

Ash obtained from samples of bamboo shoots were dissolved in concentrated sulfuric acid. Then the solution was used for the determination of the studied minerals by Atomic Absorption Spectrometer except for Phosphorous. Wet ash method was used for the determination of Phosphorous. Finally the amount of Phosphorous was determined using UV-VIS spectrometer at 400 nm wave length (AOAC, 2000).

Statistical analysis

Results were expressed as the mean of three replicates. A one-way

Table 1. Mean nutritional values of *Arundinaria alpina*.

Components	Location		
	Injibara	Masha	Tikur Incheny
Nitrogen (%)	5.83 ^a	6.22 ^a	4.15 ^b
Fat (%)	1.1 ^a	0.64 ^b	1.5 ^a
Moisture (%)	93.3 ^a	93.0 ^a	91.9 ^a
Ash (%)	15.6 ^b	17.1 ^a	14.2 ^c
P (ppm)	9660 ^a (0.97%)	9903.33 ^a (0.99%)	7113.33 ^b (0.71%)
K (ppm)	90833.33 ^b (9.08%)	97716.67 ^a (9.77 %)	85350.00 ^c (8.54%)
Ca (ppm)	2440.00 ^a (0.24%)	2853.30 ^a (0.29%)	1633.33 ^b (0.16%)
Mg (ppm)	1890.00 ^a (0.19%)	1850.00 ^a (0.19%)	1386.67 ^b (0.14%)
Fe (ppm)	72.67 ^b	147.00 ^a	41.67 ^c
Mn (ppm)	25.33 ^a	28.33 ^a	11.00 ^b
Zn (ppm)	107.00 ^b	210.67 ^a	97.67 ^b

Means with similar letters for comparison between different sites are not significantly different at $p = 0.05$.

analysis of variance (ANOVA) was used to compare the mean using the least significant difference at 5% level.

RESULTS AND DISCUSSION

In Masha and Assosa areas where the bamboo shoots emerge between April and June the indigenous communities use it as a food during spring season of the year. The shoots are immediately picked within the first week of their development as they have a growth rate of up to 1 m per day for some species (Anonymous, 2004). Before serving, the shoots are boiled and drained the first water to reduce the bitterness or the toxic chemicals of the shoots which could be the cynogenic glycosides (Hunt and Feng'e, 2000; Agatemo, 2009; Choudhury et al., 2010, 2012).

In both shoot samples Ethiopian bamboo species the fat extract has a light yellow colour. The bamboo shoots of *A. alpina* were low in fat content with an average of 1.09% on dry weight basis (dwb). The statistical analysis of the fat content showed that the samples of Masha site was lower in fat content which differ significantly from the contents of the samples of the other two locations (Table 1). The average fat content of the lowland bamboo shoots collected from Assosa, Dhedhessa and Pawe sites was 1.44% on dwb. The average fat content of shoots collected from Pawe area was significantly different from those of the other two locations. The low fat content in bamboo shoots is also reported by others and this is one of the reasons that make the bamboo species as a preferred food items (Choudhury et al., 2010, 2011).

The mean ash content of highland bamboo shoots collected from the three sites range from 14.20 to 17.10% dwb. The ash content of the highland bamboo shoots was significantly varied with locations. The lowest ash amount of the shoot was 14% dwb and the highest was 18% dwb for samples of Tekur Incheny and Masha,

respectively. The high amount of ash reveals the mineral richness of the biological material which serves as a source of mineral elements required in the nutrition. Whereas the average ash content for the lowland bamboo shoots collected from Assosa, Dhidhessa and Pawe were 11.17, 12.03 and 11.63% dwb, respectively. The lowest ash content in the lowland bamboo was obtained from Assosa (10.87% dwb) and the highest was obtained from Dhidhessa (12.38% dwb) areas. The ash amount of the lowland bamboo from Dhidhessa site showed a significant difference from that of Assosa sample (Table 2). High amount of ash also reported on bamboo shoots of *Fargesia yunnanensis* (Wang et al., 2009). High ash content of biological material is also observed in barks and annual crops, indicating that it is a phenomenon for fast growing plants, which can accumulate high amount of mineral materials in the growing season (Raveendran et al., 1995; Azarov et al., 1999). Similar with the BSs of *Bambusa balcoa*, *Bambusa polymorpha*, *Dendrocalmus hamiltonii*, *D. strictus*, *D. gigantus*, *Phyllostachys praecox* the ash content of the studied species are high but their mineral contents depend on the species, location and season of harvesting (Zhang et al., 2011; Choudhury et al., 2011). The high amounts of ash content in the bamboo shoots enable them to hold the macro- and micro-elements making them preferable.

The average nitrogen content of the bamboo shoots of *A. alpina* from Tekur Incheny, Injibara and Masha areas were in the range of 4.15 to 6.22% dwb. The lowest amount was 4.15% dwb and the highest was 6.22% dwb from Tekur Incheny and Masha areas, respectively. The nitrogen content of the bamboo shoots from Tekur Incheny site was low and significantly different from those of the other two locations (Figure 1). The average nitrogen content in *A. alpina* bamboo shoots are 8 to 10 times richer than the 1st to 3rd year old culms of Masha area (Embaye et al., 2005). Such high variation in nitrogen

Table 2. Mean nutritional values of *Oxytenanthera abyssinica*.

Components	Location		
	Assoa	Dehdhesa	Pawe
Nitrogen (%)	3.30 ^a	3.99 ^a	2.96 ^a
Fat (%)	1.5 ^a	2.2 ^a	0.6 ^b
Moisture (%)	91.65 ^a	92.57 ^a	92.54 ^a
Ash (%)	11.17 ^b	12.03 ^a	11.63 ^{ab}
P (ppm)	5686.67 ^c (0.57%)	6166.67 ^b (0.62%)	7453.33 ^a (0.75%)
K (ppm)	66285 ^b (6.63%)	70283.33 ^a (7.03%)	71533.33 ^a (7.15%)
Ca (ppm)	933.33 ^c (0.09%)	1200.00 ^b (0.12%)	1460.00 ^a (0.15%)
Mg (ppm)	1903.33 ^a (0.19%)	2020.00 ^a (0.20%)	1986.67 ^a (0.20%)
Fe (ppm)	33.67 ^c	45.00 ^b	88.00 ^a
Mn (ppm)	19.67 ^a	19.33 ^a	18.67 ^a
Zn (ppm)	71.67 ^c	88.33 ^b	106.67 ^a

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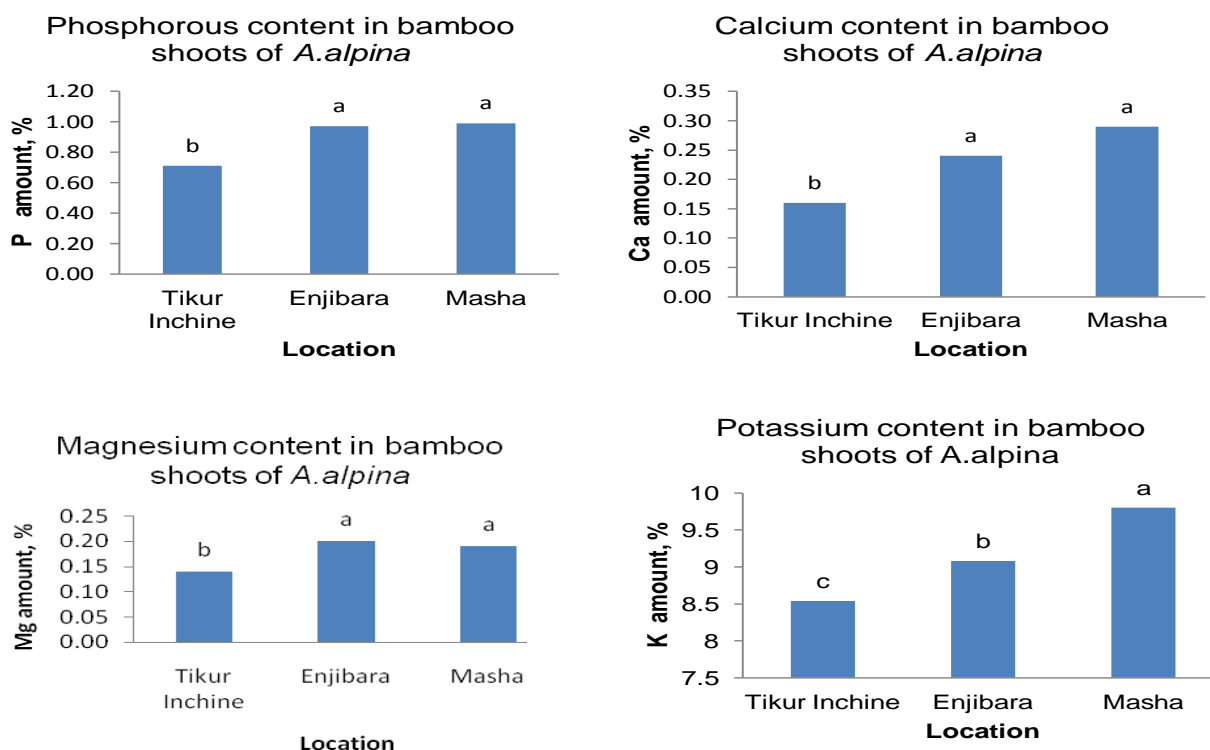


Figure 1. Mineral contents in bamboo shoots of *A. alpina* from different locations. Bars with the same letter are not significantly different at $p = 0.05$ level.

content is attributed to the active and fast growing stage of the plant which requires more nitrogen in the chlorophyll make up, cell differentiation of the growing bamboo shoots and biosynthesis of nitrogen containing compounds. The average nitrogen content for lowland bamboo shoots was 3.29, 3.99 and 2.95% dwb for samples from Assosa, Dhidhessa and Pawe areas, respectively. There was no significant difference in nitrogen content between the lowland bamboo shoots

collected from the three locations. When the nitrogen content in the shoots multiplied by the factor 6.25 the total protein amount ranges between 2.88 and 4.13% of the fresh BS which is in the range of other BS of Asian species (Wang et al., 2009; Choudhury et al., 2010, 2011).

The average phosphorous content of the *A. alpina* bamboo was 0.71, 0.97 and 0.99% for samples collected from Tekur Incheny, Injebara and Masha sites,

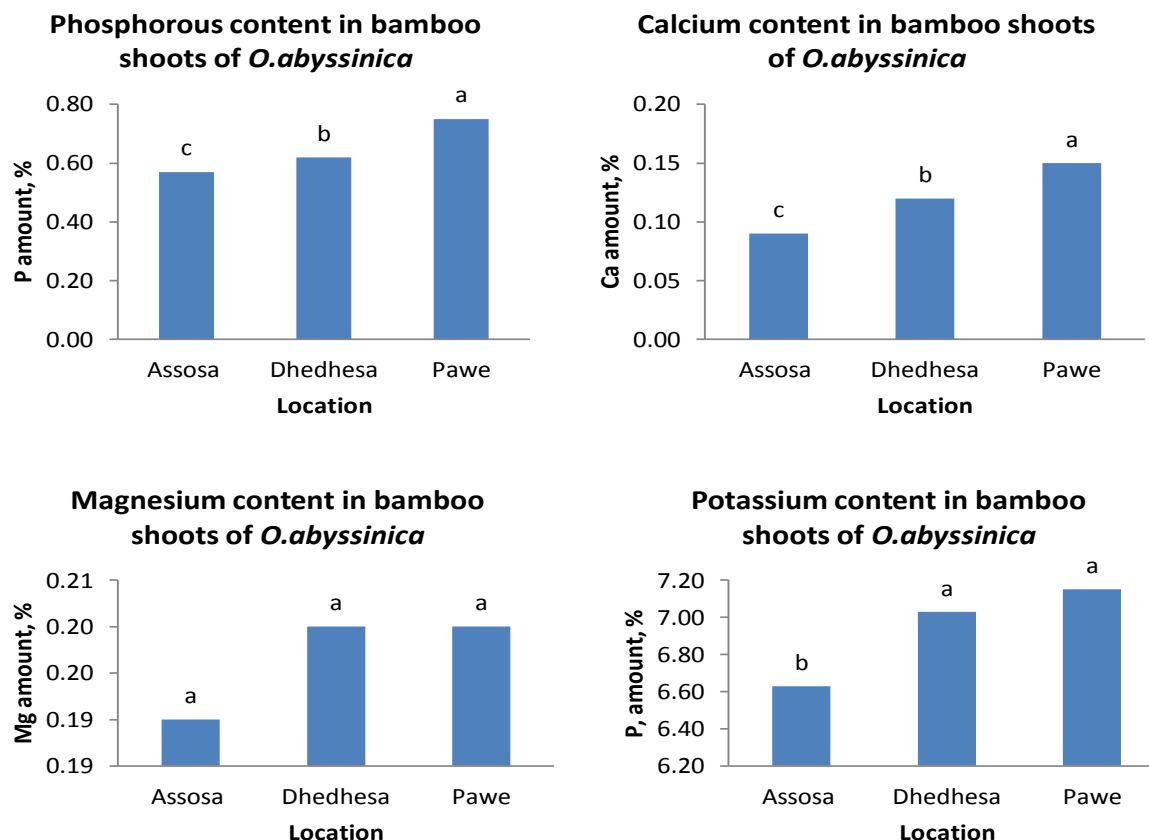


Figure 2. Mineral contents in bamboo shoots of *O. abyssinica*. Bars with the same letter are not significantly different at $p = 0.05$ level.

respectively. The phosphorous amount in the highland bamboo shoots from Tekur Incheny was significantly different from Injebara and Masha locations with its low content. Similarly, the average phosphorous content of the samples of lowland bamboo shoots of Assosa, Dhidhesa and Pawe were 0.57, 0.62 and 0.75%, respectively. The result of phosphorus content indicates strong differences between all the three locations. The phosphorous content of BSs of *A. alpina* and *O. abyssinica* is much higher than those of *Bambusa* and *Dendrocalamus* species (Choudhury et al., 2010, 2011).

The average calcium content of the bamboo shoots of *A. alpina* was analyzed and found the lowest content in the samples of Tekur Incheny site which was statistically different from those of Injebara and Masha areas. The average calcium contents were 0.16, 0.24 and 0.29% for bamboo shoot samples of Tekur Incheny, Injebara and Masha areas, respectively (Table 1). The low calcium content of the samples of Tekur Incheny is related to the low ash content of the sampled material. The average calcium content of the lowland bamboo shoot samples of *O. abyssinica* collected from Assosa, Dhidhesa and Pawe areas were 0.09, 0.12 and 0.15%, respectively. There was significant difference between the sites in average calcium content the lowest calcium content in

the samples of Assosa area (Table 2). In both studied species, the calcium content accounts for less than 1% of the mineral content unlike the perennial plant wood which consists more than 50% (Fengel and Wegner, 1984; Azarov et al., 1999).

The average magnesium contents of *A. alpina* bamboo shoots collected from Tekur Incheny, Injebara and Masha was in the range of 0.14 to 0.19%. The highland bamboo shoots of Tekur Incheny site exhibited lowest amount which was significantly different from those of Injebara and Masha locations as indicated in Figure 1. On the other hand, the average magnesium content in the shoots of *O. abyssinica* collected from Assosa, Dhidhesa and Pawe areas was in the range of 0.19 to 0.20% with no significant difference between locations (Figure 2). The amount of magnesium in these bamboo shoots were 10 fold higher than the leafy vegetables of *Amaranthus spinosus*, *Hibiscus species*, *Solanum macrocarpon* consumed in Northern Ghana (Amagloh and Nyarko, 2012) and equal to *Eragrostis tef* an Ethiopian staple food called “Injera” made of it (Seyfu, 1997; Parish, 2006).

The average potassium contents in the bamboo shoots of *A. alpina* were 8.53, 9.08 and 9.77% for the samples of Tekur Incheny, Injebara and Masha areas respectively.

The statistical analysis for the average potassium content showed significant differences among all three sites. Whereas the average potassium content in *O. abyssinica* bamboo shoots collected from Assosa, Dhidhessa and Pawe areas were 6.63, 7.02 and 7.15%, respectively. The average potassium content of the samples of Assosa site was found to be lower and significantly different from those of the other locations. There are also reports which reveal similar high amounts of potassium in bamboo shoots of other species (Shanmughavel and Francis, 2003; Choudhury et al., 2011). In general the bamboo shoots exhibit higher amount of potassium than *A. spinosus*, *Hibiscus species*, *Solanum macrocarpon* leaves consumed in Ghana (Amagloh and Nyarko, 2012) and higher amount than teff (*Eragrostis tef*) grain (Seyfu, 1997; Parish, 2006).

The mean iron content in the *A. alpina* bamboo shoots of all the three sites was significantly different from each other with 41, 75 and 145 ppm for samples collected from Tekur Incheny, Injebara and Masha sites respectively. The iron content in the bamboo shoots of *A. alpina* in Masha area is 2 to 5 folds higher than those of the other locations. The average iron content in *O. abyssinica* bamboo shoots collected from Assosa, Dhidhessa and Pawe were 33.67, 45 and 88 ppm respectively. The analysis for iron content for lowland bamboo shoots was significantly different from each other. The iron content of the bamboo shoots of *O. abyssinica* from Pawe area is 2 to 3 folds higher than the other locations. The iron content in the two bamboo shoots is higher than the leafy vegetables used in Northern Ghana and almost equal to the amount in teff (*Eragrostis tef*) grain (Seyfu, 1997; Parish, 2006; Amagloh and Nyarko, 2012).

Conclusion

The analysis of bamboo shoots of *A. alpina* collected from the three locations showed that the bamboo shoots collected from Tekur Incheny area was the lowest in all analyzed mineral content. The lowland bamboo shoots of *O. abyssinica* except for the magnesium, all samples differ in their content of mineral elements and the bamboo shoots from Assosa area showed the lowest values. Analysis of both shoot samples of bamboo species nutrient elements were in the order of $K > N > P > Ca > Mg$ for *O. abyssinica* bamboo shoots and $K > N > P > Mg > Ca$ for the *A. alpina*. In general the result of this study and the experiences of southwest Ethiopia strongly indicate the great potential of bamboo shoot for food security mechanism of the country.

ACKNOWLEDGMENT

The author thank the Ethiopian Agricultural Research Institute for its Financial support, and the offices of Rural

and Agricultural Development of the districts targeted for materials, to his assistants Ato Kinfe Tesfaye and Ato Ayeshem Tebeje and also extend his thanks to the anonymous reviewers for their valuable and constructive comments on previous version of this paper.

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Full Length Research Paper

Forest degradation and livelihood of local communities in India: A human rights approach

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Accepted 29 July 2013

India's current forest and tree cover is estimated to be 78.29 million ha, constituting 23.81% of the geographical area of the country. As per the India State of the Forest Report (ISFR) 2011, forest cover has declined by 367 sq. km compared to the forest cover in the preceding ISFR in 2009. The National Forest Commission report 2006 indicated that around 41 per cent of total forest in the country is already degraded, 70 per cent of the forests have no natural regeneration, and 55 per cent of the forests are prone to fire. In the forested landscapes of India, the livelihoods of the people, especially the indigenous communities, living close to forest and within the forests are inextricably linked to the forest ecosystem. People depend on the forest for a variety of forest products for food, fodder, agriculture, housing, and an array of marketable minor forest produces which can potentially degrade forest if harvested unsustainably. People living in these forest fringe villages depend upon forest for a variety of goods and services. These includes collection of edible fruits, flowers, tubers, roots and leaves for food and medicines; firewood for cooking (some also sale in the market); materials for agricultural implements, house construction and fencing; fodder (grass and leaf) for livestock and grazing of livestock in forest; and collection of a range of marketable non-timber forest products. Thus, this increasing degradation of forest is hampering the basic human right to life and livelihood of the local communities, especially the indigenous community whose life is closely linked with the resources and environment amidst which they live.

Keywords: Forest degradation, human rights, local communities.

INTRODUCTION

More than 1.6 billion people around the world depend on varying degrees on forests for their livelihoods – not just for food but also for fuel, for livestock grazing areas and for medicine. At least 350 million people live inside or close to dense forests, largely dependent on these areas for subsistence and income, while about 60 million indigenous people are almost wholly dependent on forests (World Bank, 2006). FAO (2002) defines forest degradation as: The reduction of the capacity of a forest to provide goods and services. Perceptions of forest degradation are many and varied. For example, a manager who replaces a natural forest with a plantation

to supply desired wood products is unlikely to perceive his forest as degraded. On the other hand, his plantation is less capable of providing many of the goods and services that a fully functioning natural forest would provide on the same site, because of the reduced biodiversity, generally associated with plantations.

In a recent survey, Lund (2009) found more than 50 definitions of forest degradation, formulated for various purposes. FAO (2009) shows that many such definitions are either very general or their focus is on the reduction of productivity, biomass or biological diversity. Definitions that refer to multiple-use forests or multiple forest benefits

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may consider forest values comprehensively but are more difficult to apply universally in a consistent and transparent way. Nevertheless, the general definition of forest degradation given above provides an adequate umbrella at the international level and a common framework for developing more specific definitions for particular purposes. It is also compatible with an ecosystem-services approach. Forest degradation involves a process that negatively affects the characteristics of a forest such that the value and production of its goods and services decline. This change of process is caused by disturbance (although not all disturbance causes degradation), which may vary in extent, severity, quality, origin and frequency. Disturbance may be natural (e.g. that caused by fire, storm or drought), human-induced (e.g. through harvesting, road construction, shifting cultivation, hunting or grazing) or a combination of the two. Human-induced disturbance may be intentional (direct), such as that caused by logging or grazing, or it may be unintentional (indirect), such as that caused by the spread of an invasive alien species (FAO, 2009). As per the India State of the Forest Report (ISFR, 2011), forest cover has declined by 36700 ha compared to the forest cover in the preceding ISFR in 2009. Tree cover outside forest areas is assessed to be 9.7 million hectare, and is experiencing an increase over the last few assessments, indicating a rise in green cover in non-forest land in the country.

Forest degradation is a serious environmental, social and economic problem. Quantifying the scale of the problem is difficult, because forest degradation has many causes, occurs in different forms and with varying intensity, and is perceived differently by different stakeholders. The International Tropical Timber Organization (ITTO, 2002) estimated that up to 850 million hectares of tropical forest and forest lands could be degraded. The Global Partnership on Forest Landscape Restoration (GPFLR, undated) suggested that more than one billion hectares of deforested and degraded forest land worldwide are suitable and available for restoration.

India's current forest and tree cover is estimated to be 78.29 million ha, constituting 23.81% of the geographical area of the country (ISFR, 2011). Forest cover alone amounts to 69.20 million ha, against the recorded forest area of 76.95 million ha. Of the total forest cover, 12.06% is very dense forest (more than 70% crown density), 46.35% is moderately dense forest (40% to 70% crown density), and the remaining 41.59% is open forest (10 to 40% crown density).

Forest cover in the country has more or less stabilized since the 1980s. As per the estimates of the Forest Survey of India (2011), forest cover has increased marginally from 64.08 million ha in 1987 to 96.2 million ha in 2011. The enactment of proactive forest conservation policies and changes in management approaches from 'timber' to 'forest ecosystem' during the last few decades

have curbed deforestation, and promoted conservation and sustainable management of forest (Forest conservation act, 1980). The enforcement of The Forest Conservation Act, 1980 enabled the regulation of widespread diversions of forestland for non-forest uses, and hence put a check on deforestation. The changing priorities of the forest department from revenue generation to conservation-oriented forestry and the practice of doing away with clear felling of trees has resulted in a significant decline in the rate of deforestation and degradation on forest ecosystem. However, forest degradation of natural forest due to several factors remains a major concern of forest management.

Rationale of the study

The multiple benefits of the forests include use values and non use values. Forests are generally undervalued. Moreover forests can contribute significantly in poverty alleviation (moef, India). It encompasses the economic use of forest, including the management of forest resources for production, the role of forest development in poverty alleviation and the impacts of forest research and development. Before and after independence forests contribution was significantly noticed in the way of getting valuable timber, Non Timber Forest Product (NTFP) and other material goods. The present paper is analytical and has been analyzed on the basis of the reports of the national and international organs related to forest degradation. The paper tries to assess the problem of forest degradation and its adverse effect on the local communities of India including the village communities dependent on the forest for their livelihood.

Forest degradation in India

The forest degradation is quite evident from low level of growing stock in India forest and declining trend of dense forest in the country. The growing stock per ha of forest area as per both in 2009 and 2011 ISFR is estimated to be around 58.46 m³ per ha of forest area. This is far below the global average of 130.7 m³/ha and the south and Southeast Asian average of 98.6 m³/ha for the corresponding period (FAO, 2010). More than 40% of the forest in country are degraded and under-stocked (Aggarwal et al., 2009, Bahuguna et al., 2004). The National Forest Commission report 2006 indicated that around 41% of total forest in the country is already degraded, 70% of the forests have no natural regeneration, and 55% of the forests are prone to fire (MoEF, 2006). As the trend of change in dense forest is concerned, it has remained very moderate as compared to changes in open forest (Table 1). For some assessment years, the change has been negative to the preceding assessment too. For instance, the moderately

Table 1. Change in forest cover 1991-2011.

State of the forest report year	Dense (40% and above crown cover) forest (km ²)	Open (10 to 40% crown cover) forest (km ²)	Total forest cover (km ²)
1991	385008 (60.64)	249930 (39.36)	634938
2001	395169 (60.43)	258729 (39.57)	653898
2011	404207(58.41)	287820 (41.59)	692027
Change from 1991-2011	385008 - 404207	37890	57089

Figures in parenthesis are the percentage of total forest cover. *Source:* Various issues of State of the Forest Report.

dense forest has declined by 93600 ha from 2005 to 2007. However, the forest cover assessment exercise hardly reflects the extent of forest degradation and it is often difficult to compare the data in this regard due to lack of standardized methodologies (Davidar et al., 2010).

Factors affecting forest degradation in India

Forests and the benefits they provide in the form of food, income and watershed protection have an important and often critical role in enabling people around the world to secure a stable and adequate food supply. Forests are important to the food insecure because they are one of the most accessible productive resources available to them.

- i. Critical livelihood–forest linkage of a huge forest dependent population (Davidar et al., 2010)
- ii. Demand and supply gap of forest products, resulting in exploitation beyond its carrying capacity (Aggarwal et al., 2009)
- iii. Forest fires, over–grazing, illegal felling, and diversion of forest land (both permitted and illegal for non-forest uses due to competing land use demand for developmental and other uses (Davidar et al., 2010; Aggarwal et al, 2009; MoEF, 2009, 2006).

In the forested landscapes of India, the livelihoods of the people living close to forest and within the forests are inextricably linked to the forest ecosystem. People depend on the forest for a variety of forest products for food, fodder, agriculture, housing, and an array of marketable minor forest produces which can potentially degrade forest if harvested unsustainably. Field based studies assessing the pattern of collection of these forest products and its impact on local forest found that local livelihood dependence results in degradation (Davidar et al., 2010; Tripathy et al., 2008; Arjunan et al., 2005; Sagar and Singh, 2004; Maikhuri et al., 2001; Silori and Mishra, 2001). Hence, the livelihood concerns of the millions of poor people living in and around forest contribute to forest degradation along with other factors. Forest survey of India (FSI) also made a comprehensive

assessment of the production and consumption of forests in India.

The low productivity of forest coupled with ever-increasing demand for forest products due to India's huge and increasing population contributes to the degradation of forest (Gulati and Sharma, 2000). The development concerns in general and the rapidly growing economy has implications on forest cover and the land use pattern of the country (MoEF, 2009). The forests are also subject to several other anthropogenic pressures like over grazing, shifting cultivation, and vulnerabilities to forest fire and so on (World Bank, 2006; Bahuguna and Upadhyay, 2002).

Heavy forest degradation in tribal areas of India

India's forest cover decreased by 36700 ha between 2007 and 2009, and it was primarily tribal and hilly regions that were to blame, according to the Ministry of Environment and Forest (MoEF, 2009). The report showed some areas of progress. Among the 15 states that increased their forest cover in the period are Orissa and Rajasthan. In Punjab, the nation's grain bowl, enhanced plantation activities and an increase in agro-forestry practices contributed to the highest gain in forest cover with 10000 ha. But those gains were outdone by large-scale deforestation elsewhere. The state that really jumps out in the report is the southern state of Andhra Pradesh, which lost a whopping 28100 ha of forest cover, contributing 76.5% of the net decline in forest cover nationally (MoEF, 2006). The report attributes the drastic loss of forest cover in states such as Andhra Pradesh, West Bengal and Orissa to harvesting of Eucalyptus trees in forests and felling of trees in encroached areas. The Forest Rights Act of 2006 primarily protects the rights of forest-dwelling communities to occupy land in forests for habitation or cultivation. Many environmentalists have argued that the law facilitates deforestation, while tribal rights activists have argued that it provides necessary protection to traditional forest dwellers.

Tribal districts showed a 67900 ha loss in forest cover. Most of the north-eastern Indian states, which have hilly terrain and are inhabited by many tribal groups, showed

significant reduction in forest cover. These are areas where shifting cultivation, a practice where plots of fertile land are cultivated and then abandoned, is commonly practiced. The communities clear additional land as they move from one area to the next (MoEF, 2009).

Livelihood of the forest dependent communities

India has a huge population living close to the forest with their livelihoods critically linked to the forest ecosystem. There are around 1.73 lac villages located in and around forests (MoEF, 2006). Though there is no official census figure for the forest dependent population in the country, different estimates put the figures from 275 million (World Bank, 2006) to 350- 400 million (MoEF, 2009). People living in these forest fringe villages depend upon forest for a variety of goods and services. These includes collection of edible fruits, flowers, tubers, roots and leaves for food and medicines; firewood for cooking (some also sale in the market); materials for agricultural implements, house construction and fencing; fodder (grass and leave) for livestock and grazing of livestock in forest; and collection of a range of marketable non-timber forest products. Therefore, with such a huge population and extensive dependence pattern, any over exploitation and unsustainable harvest practice can potentially degrade forest.

Moreover, a significant percentage of the country's underprivileged population happened to be living in its forested regions (Saha and Guru, 2003). It has been estimated that more than 40% of the poor of the country are living in these forest fringe villages (MoEF, 2006). Apart from this, a significant percentage of India's tribal population lives in these regions. Several field based studies have documented the adverse impact of such dependence pattern on the forest quality. The forest fringe communities not just collect these forest products for their own consumption but also for commercial sale, which fetch them some income. The income from sale of the forest products for households living in and around forest constitutes 40 to 60% of their total income (Bharath Kumar et al., 2010; Sadashivappa et al., 2006; Mahapatra and Kant, 2005; Sills et al., 2003; Bahuguna, 2000). A study (Saha and Sundriyal, 2012) on the extent of Non Timber Forest Product use in north-east India suggest that the tribal communities use 343 NTFPs for diverse purposes like medicinal (163 species), edible fruits (75 species) and vegetables (65 species). The dependence for firewood and house construction material is 100 and NTFPs contributed 19 to 32% of total household income for the communities under study (Saha and Sundriyal, 2012).

Forests are not only a source of subsistence income for millions of poor households but also provide employment to poor in these hinterlands. This makes forests an important contributor to the rural economy in the forested

landscapes in the country. The widespread poverty and lack of other income generating opportunities often make these people resort to over-exploitation of forest resources. The collection of firewood for sale in the market, though it is illegal, is also extensive in many parts of the forested regions in the country and constitutes the source of livelihood for 11% of the population (IPCC, 2007). However, many other forest products have been sustainably harvested by local communities for many years, and are a constant source of household income.

Agriculture and livestock are two other major sources of livelihoods in the forest fringe villages, which in turn depend extensively on the forest for various inputs. People rear both bovine and ruminant livestock and forests and other local common land are the major source of grass and tree fodder. Open grazing in the forest is the conventional rearing practices for forest fringe communities and this has adverse impact on growing stock as well as regeneration capacity of forest when there is over grazing due to more livestock.

Reducing emissions from deforestation and degradation (REDD)

Deforestation accounts for an estimated 17% of global greenhouse gas emissions-more than the global transport sector (IPCC, 2007). The burning and clearing of tropical forests is responsible for the majority of these emissions, due to their high carbon stocks and the rate at which they are being lost: approximately 13 million hectares per year (FAO, 2005). Reducing emissions from tropical deforestation is therefore a necessary component of any strategy to avert catastrophic climate change. In addition to regulating the climate, standing forests provide many other important ecosystem services to society. These include provisioning food, fuel and water; regulating floods and the spread of disease; stabilizing soil and maintaining plant pollination; and conserving cultural and aesthetic values.

However, because the values of these ecosystem services are not reflected in the prices of the commodities that often drive forest clearing (soy, beef, oil palm, timber), farmers, companies and governments-seeking immediate financial gains-often decide that forests are worth more cut down than standing. A new approach to battling tropical deforestation, commonly referred to as 'REDD', seeks to provide positive incentives to tropical countries for forest conservation. The basic idea of Reduced Emissions from Deforestation and Forest Degradation (REDD) is to make standing forests more attractive than agricultural and timber products by valuing the carbon in forests for its climate regulating benefits. Given the livelihood linkage of forests in many developing countries, forest conservation imposes several direct and indirect costs. Hence, any financial mechanism to compensate some of these costs by

developed countries would encourage sustainable management of forest in developing countries.

Decentralized forest management through devolution of power to local communities is one of the important components of the sustainable management of forest under REDD+ regime. Since, 75% of forest-based income is from NTFPs (MoEF, 2009) the NTFP enterprises can contribute significantly, to livelihood enhancement in forested areas. In addition, the two main barriers recognized in NTFP management are lack of sustainable harvesting practices and problems of NTFP productivity.

REDD: Possible problems of the indigenous people

Like many other options in climate change mitigation, the implementation of REDD is not free from the disadvantages or opportunities and risks, particularly to the indigenous people. Considering the differences in forest management and systems from one place to another, some potential areas of concern that the implementation of REDD might negatively impact indigenous people include the following.

Loss of access to forest

There are concerns among indigenous peoples that their rights on land and territory will be disturbed by the establishment of some protected areas as a response to REDD (Fry, 2008:177). These concerns are reasonable because of experiences in the past that indigenous peoples often conflict with the governments and private companies for access and manage the forest. Worse than access restriction issue, REDD may also lead to the eviction of the indigenous people from their area. This is contrary to The United Nations Declaration on rights of indigenous people that has assured the right of indigenous people to their land and access to it. Article 26 of the declaration stated that "Indigenous peoples have the right to own, use, develop and control the lands, territories and resources that they possess by reason of traditional ownership or other traditional occupation or use" (UNDRIP, 2007).

Socio-cultural impact

Another thing that sometimes forgotten in the discussion of the impact of REDD to indigenous people is about its possible impact to the social and cultural life of indigenous people. As discussed earlier that indigenous people has their own culture, tradition, customs and rituals which they hold firmly. Corpuz et al. (2008:32) stated that the designation of their forest to become carbon storage and used for emission trading, not only

can obstruct the indigenous people to access the forest, but also can possibly prevent them to practice their tradition and customary system in managing the forest. Moreover, it can also prevent them to use the forest for traditional ceremony and ritual purposes.

Rights of the indigenous community

In India, the tribal population constitutes nearly 8.2% of the total population (RGI, 2001). Today, the tribal people of India and elsewhere in the world confront with the basic issue of maintaining their identity which is closely linked to the natural resources and the environment they live in. Their cultural systems ensure that the resources continue to remain as the ingredients of their day to day life for several generations but what is of concern to day is that the main-stream society in any country seems to consider those natural resources as ready raw materials for the production of consumer articles. This is where the struggle begins. The tribal areas, once largely inaccessible, have been put under man's reach by modern means of technology. The rich mineral deposits have attracted the greedy multinational corporations and entrepreneurs. In fact, the predominantly tribal areas are found to be encroached by Governmental agencies and trans-national corporations. As a result, the planners and policy makers in the name of developmental programmes often falter to take into account the interest of the tribal population and their age-old economic and cultural rights.

Environmentalists have started questioning the execution of these developmental policies which are remaining silent about issues concerning ecological balance thereby affecting the human rights of the indigenous community, particularly, their rights on environment. The tribal people of India are dealing with the basic issue that their identity is closely linked to the natural resources and the environment amid which they live.

Acquisition of lands without taking the tribal community into confidence has become a serious issue in recent years. The Land Acquisition (Amendment) Bill, 1998 targets to accelerate the rate of land acquisition and to facilitate the big business groups and multinational companies to become the ultimate beneficiaries. The tribal areas are the repositories of 80 to 85% of the country's total mineral resources, thus resulting in large scale land alienation, mass displacement, deforestation and migration of tribes to the cities and towns. Being landless and poverty stricken, the tribes migrate in considerable numbers to the cities and towns in search of a livelihood. Gradually they settle down in the city slums where the conditions of living are almost precarious. They lose their identity and are forced to cope up with a lifestyle which is unknown to them.

The sufferings of more than 1 lac scheduled tribes facing displacement and land-alienation by the "Sardar

Sarovar Project”, the “Narmada Sagar Project”, 28 major, 138 medium and 3000 minor dams have become an issue of national debate amidst agitation spearheaded by the “Narmada Bachao Andolan”. But, the trauma that many more hundreds are passing through is often forgotten. Mention may be made of the Upper Kolab and Upper Indravati dams in Orissa that have displaced more than 1 lac persons, majority among whom are scheduled tribes. The Chandil dam on the river Subarnarekha, Koel dam on the river Koel Karo in Jharkhand have evicted more than 1,03,600 tribal people and other dalits from their ancestral lands.

The depletion of forest resources adversely affects the health of the tribal community. Several studies show that the women are the worst sufferers within the tribal group. Higher rate of infant mortality, low nutritional status, low life expectancy of women and high fertility rate increases the plight of the female section.

Millions of people including several scheduled tribes live in or near the forests of India. Their sustenance depends on the forest products-major or minor. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 is an important piece of forest legislation passed in India on December 18, 2006. The law ensures the rights of forest-dwelling communities to land and other resources, denied to them over decades as a result of the continuance of colonial forest laws in India. This Act recognizes several rights including the right of ownership, community rights, right to hold and live in the forest land etc. This Act has been often misunderstood as a law to distribute forest lands to the tribal. This has drawn criticism from environmentalists and wild-life conservationists. Numerous complaints regarding the implementation of the Act have been filed. For example in September, 2010, the council for Social Development, a New Delhi based think tank, released a “Summary Report on Implementation of the Forest Rights Act”. It is to be mentioned here the International human rights law provides appropriate procedural protections especially in relation to matters such as forced evictions which directly invoke a large number of rights, recognized under the International Covenant on Civil and Political Rights and International Covenant on Economic, social and cultural Rights. In India, however, the tribal are mostly affected by forced eviction. A National Commission has been set up to study the incidents of forced evictions since the constitution came into force and make necessary recommendations for resettlement and rehabilitation to the victims of forced evictions consistent with the guarantees provided under the constitution.

In order to ameliorate the economic conditions of the forest based communities, developmental programmes like social forestry, farm forestry, forest villages are being implemented. However, in social forestry, plants having commercial value are being planted, where forest dwellers do not get minor forest produce. One major

problem today is that there is no land ceiling for plantation as a result more and more plantations is taking place in agricultural lands. And all these commercial plantations by the contractors in the tribal lands are in no way going to help the tribals. Therefore, there is a need of a national forest policy which should be more rational and humane so as to cater adequately to the needs of the tribal population.

Indigenous people attach great importance to their forests and its resources. They use their forest products in a judicious way. In fact, the planet's healthiest ecosystems tend to be found on indigenous lands. Their holistic approach to ecosystems, wild life and forests form the very basis of sustainable development. Scientists say, the huge medicinal knowledge of indigenous community may help to find answers to some of the incurable diseases like Cancer and Acquired Immuno Deficiency Syndrome (AIDS). The State should look upon the tribal community as an asset and not a liability.

Addressing forest degradation

Globally, there is no standard definition of forest degradation. It is a complex process and has several drivers, which pose a greater challenge to check the problem of degradation. Given the widespread dependence of a huge population on forest for subsistence livelihood, arresting forest degradation involves designing and implementing strategies that creates alternative livelihood opportunities and reduce their dependence on forest based activities. The livelihood requirement of the people fully dependent and partially on forest varies and these need to be taken into consideration while designing the strategies. Unsustainable harvesting and extraction of fuel wood will be substituted by promoting alternative livelihood and energy sources like biogas, solar energy (solar lanterns and solar street lighting), and improved cook stoves. The expansion of provisions for cleaner cooking fuels such as liquefied petroleum gas (LPG) in rural areas will help to reduce pressure on forests and enhance carbon stocks. This would save fuel wood and reduce pressure on the forests. Firewood constitutes the major source of cooking energy in India and more than 853 million people use firewood for cooking in India (FSI, 2011). As per the 2011 census, 49% of the households in the country use firewood for cooking. In some states, it is as high as 80%. The forest rich states have higher incidence of firewood use for cooking.

As the total annual volume of firewood use is concerned, it is estimated to be 216.421 million tonnes and of which 58.747 million tonnes (27.14%) are sourced from forests. There have been no estimates for the volume of firewood availability from forests and the annual availability of firewood from trees outside forests (TOF) is estimated to be 19.25 million tonnes.

Creating alternative livelihood opportunities through poverty alleviation programmes

The governments implement a series of rural development activities to generate employment for the rural poor in these forested regions and alleviate poverty. MNREGA, which ensures 100 days of employment to all poor adult population in the country, is a significant step in this regard. The effective implementation of these programmes among forest dependent communities will reduce the dependence of the local communities on forests. Provision of education to the children and other skill development trainings to youth enables these forest dependent populations to diversify their livelihood options and look beyond forest as their source of income.

Provision of infrastructure and support for improved agricultural practices as well as other natural resource based activities like apiculture would ensure better income to these poor households. Forests provide a range of marketable NTFPs like fruits, flowers, berries, tubers, resins, honey, leaves, creepers etc. that has great nutritional, medicinal, and other use values. However, many of these products fetch a good price in cities and markets but the collectors (the forest dependent) sale these to the intermediaries at abysmally lower prices. The support for marketing and value addition by creating processing facilities would not only enhance the income but also the employment opportunities in these hinterlands. Approximately, NTFP sector with annual growth rate between 5 and 15% also contributes to 75% of forest sector income.

METHODS

The present paper sought to construct through the analysis of secondary data and history of forest degradation and policies in India, and the violation of rights thereby. Published work of authors, documents of government policies, reports of Ministry of Human Resource Development, reports of United Nation, Forest and Agricultural Organization, Ministry of Environment and Forestry and Census of India have provided the secondary data.

RESULTS AND DISCUSSION

There is always an interaction between the environment in which the community lives and their practices that led to sustain their livelihood. Natural environment, surrounding the people, provides several goods, services and amenities to them, but using the environmental resources for one purpose always reduces its ability to supply them with other services. This limited natural resource base surroundings, the tribal societies being scarce and many conflicting demands placed on it from other sectors and other areas of society reduces their availability to the tribal communities and affects their livelihood. Sometimes, the outside agencies use the tribal of the locality to destroy the resources especially forest

resources by encouraging overexploitation of timber, grazing lands and crop lands. Sometimes, the people in the communities are aware of the dangers of this sort of habitat destructions but they badly can influence and arrest the exploitations. They have little knowledge and little power to influence the direction of change taking place due to broader changes in society. They could not influence the national laws, national policies, social and economic changes. They are always the sufferers from the result of the actions by the outsiders. The problem is very complex, though the paper deals with this complexity with available information, which suggests that the depletion is far less uniform. The natural resource base can be characterized as poorly suited to agriculture due to climatic, water resource, and soil conditions.

Due to several decades of non-sustainable land use practices and highly erosive monsoon rains, deforestation and accelerated soil erosion are proceeding rapidly in many parts of the plateau. The families, particularly the tribal families, that live and work in the district, often depend upon nonagricultural income generating activities to sustain the household—especially during the post Monsoon season. The majority of these non-farming activities involve low productive and low paying work. Trends with respect to the state of natural resources combined with the paucity of options for high-return non-agricultural employment make the prognosis for the future of the area, and of the families that live there, worrying. Presently, tribal indigenous lifestyle, including mode of economy, societal status, culture, polity as well, are intrinsically linked with and transformed according to the overall changes in the ecological base of their present habitats. Though no less impressive is the pattern of their spatial distribution. Moreover, two broad generalizations viz. option of the tribes to live in remote areas which are largely unfavorable to sedentary agriculture and the tribes being unscrupulously pushed into uninhabited areas by the comparatively cultured peasant groups of the villages by their general habits.

In addition, unprecedented increase in population among tribes also generates environmental degradation. So, increasing tribal population results in a tremendous stress on the natural environment of the tribes in those areas which again reduces the capacities of local environment to provide adequate support to the tribal people and the others. According to several estimates, India has traditionally been characterized as a low forest cover - low deforestation (LFLD) country exposed to significant direct-human induced deforestation and degradation in past few decades (ISFR, 2011; Ravindranath et al., 2012). Consequently, India's forests harness a large potential for livelihood based activities for the forest dependent communities, thus bridging the gap between the poor and forest based market. With such a huge population depending on forest for subsistence livelihood, the strategies for controlling forest degradation

need to be focused on reducing the dependence by creating alternative livelihood opportunities for the forest dependent communities, providing alternative technologies to reduce the gap in demand and supply of forest products and making the community adopt sustainable harvesting practices.

This provides unhindered opportunities for the poor to utilize the traditional knowledge in sustainable management of forest with the help of the forest department and the Government of India. Linking the two, REDD+, and alternative livelihood improvement activities will ultimately reduce pressure on forests producing an increase in forest cover in future. Moreover the international negotiations on REDD+ under the UNFCCC from Bali to Durban, provided a nested approach for REDD+ implementation leading to performance based system in countries undertaking REDD+ readiness activities like India, where communities will be benefited through conservation of forest ecosystem, in turn improving their livelihood and simultaneously increasing the forest cover of the country. Although, India is partially ready for implementing REDD+ mechanism, but still the benefit sharing mechanism needs to be framed properly, in order to overcome the livelihood issues in REDD+ and to conserve the degrading forest cover.

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