Estimation of *Diospyros melanoxylon* Roxb. leaves production in forests of Jharkhand, India

ABSTRACT

Diospyros melanoxylon Roxb. leaves used in manufacture of indigenous traditional cigarette, called as bidi, contributes to social economic livelihood of rural and tribal people in India generating a source of subsidiary occupation and supplementary income apart from providing significant revenue to state forest departments. However, a reliable, scientific and statistically sound estimate of its production is essential to obtain optimal revenue and livelihood opportunities in the sector. Thus, the present study was carried out to quantify production of *D. melanoxylon* leaves in the state of Jharkhand on a scientific basis. Collection of *D. melanoxylon* leaves being a time-bound seasonal activity, field survey and data collection was planned by dividing the state into in five administrative zones namely Palamu, Hazaribagh, Giridih, Singhbhum and Ranchi divided into 45 MFP ranges comprising of 295 lots and 686 collection units. The focus of sampling was estimation of number of plants in a fixed area i.e. plant density, number of pluck able leaves per plant, number of total pluckable leaves per plant, and plant growth geometry. A novel sampling strategy designed as Stratified Cluster Line Transect Quadrat Random Sampling comprising of essential elements of sampling strategy and vegetational survey methods with line transect of 100m x 10m and quadrate of 5m x 5m. In all, 52% collection units from all lots of entire MFP ranges were surveyed. Three permanent plots per MFP range were also maintained to evaluate the quantum of leaf harvesting throughout the collection season by collecting all pluckable leaves. The productivity of *D. melanoxylon* leaves was found around 11.50 lakh standard bags (52000 tonnes). However, realized yield in absence of pruning/pollarding and other silvicultural operation as well as the political disturbance severely hampering efficient working, may be less.

KEY WORDS: Bidi, Harvestable leaves, NWFP, Standard bags, Yield

1. INTRODUCTION

Diospyros melanoxylon Roxb. (Coromondel Ebony, Tendu) leaves contributes to social economic livelihood of rural and tribal people in India generating a source of subsidiary occupation and supplementary income. The leaves are rolled instead of paper for making

indigenous traditional cigarette known as *bidis* which constitute financial lifeline providing significant revenue to state forest departments and seasonal income and employment to 7.5 million people in 12 states of the country during the agricultural off-season summer months when they have no other form of employment.

The species belongs to the family Ebenaceae, endemic to the Indian subcontinent, extends from the north Indian sub- Himalayan tracts to the Indus plains, Gangetic plains, Madhya Pradesh and eastern coast up to Coromandal in southern India in both moist and dry deciduous forests. It is a medium sized tree and bears leathery leaves and round fruits. The bark, fruits and leaves possess medicinal properties. *D. melanoxylon* is the most widely distributed and tolerant species and grows in poor denuded soils, hot and dry hill slopes, stony soils with quartzite, shale and sand stone and also heavy clay. However, it attains best growth and development on loose, porous soils in cool and moist sheltered valleys where it tends to be gregarious (Gupta 1992). It also occurs naturally on land that has become largely barren as a result of biotic interference such as firewood collection, logging, grazing and fires. *D. melanoxylon* manages to survive on these lands, because it is highly adaptive and responds to disturbance such as ground fires and root damage by sprouting new root suckers (Ghosh et al. 1976).

Leaves of many other plants like *Butea monosperma*, *Shorea robusta* etc. also find use as bidi wrappers in different parts of the country but for unmatched attributes such as the smooth texture, agreeable flavour, ease in rolling, resistance to decay and capacity to retain fires *D. melanoxylon* leaf is considered the most preferred in bidi manufacture. Collection of leaves from around the middle of April to the middle of May, over a period of around six weeks is labour-intensive enterprise in which whole families are engaged receiving wages according to the number of bundles. Process of leaves collection (plucking, drying, preparing of bundles and packaging) is a very sensitive and critical and should be dealt in well-organized manner, otherwise losses the quality and render them unfit for processing and making bidis. Leaves are plucked in a very short period before the onset of monsoons and dried up quickly to avoid development of cracks or fractures. After plucking leaves are stored, spread on the ground for nearly 8 days in a layer for drying in the sun and the tied in bundles of 50 to 100 leaves, (locally called as Pola, Pulla, pudas, gaddies, or bidas). The dried leaves are sprinkled with water to soften them and then filled tightly in jute bags and exposed to direct sunlight for 2 days. On an average, 107 man days are required for collection (including drying and packing) of one tonne of leaves (Gupta and Guleria 1982).

The annual national production of *D. melanoxylon* leaves is 4.5 lakh tonnes/year (FSRI 2010). According to the All India Bidi Industry Federation, about 550 billion pieces of bidi, rolled by 10 million people are sold every year in India (Chavan et al. 2016). Bidi is widely smoked in the Indian subcontinent and is gaining popularity globally, especially in USA, Germany, Middle East, Eastern Europe and Japan. In fact Bidi industry has a vital role in rural welfare and in promoting rural economy (Rathore 1970). Throughout India *D. melanoxylon* leaves extraction and bidi making are estimated to provide 106 million person days of employment in collecting activities and 675 million person days in secondary processing.

Despite immense potential of revenue generation and socio-economic upliftment of rural population residing in forest fringe areas limited efforts have been taken up to systematically assess *D. melanoxylon* leaf production and accurate estimates are difficult to find. For better decision-making, management and regulation, it is important that rigorous estimates for *D. melanoxylon* leaves (and bidis) are accessible (Lal 2012). Accurate national estimation has not been recorded as different units (standard bag unit, metric ton, quintals, $m^{3)}$ are used in measuring *D. melanoxylon* leave plucking or extraction in different states and illicit trading of leaves also exists leaves (Sabar et al. 2016). As management intervention *D. melanoxylon* bushes are coppiced near the ground to induce new flush of leaves during February–March of each year, which gives soft, pliable and fairly developed good quality leaves after 40-50 days of the coppicing (Kerketta et al. 2018). Pollarding also provides good quality of leaves, but it takes longer time for the leaves to regain and hence is not always preferable (Kerketta 2016). The leaves collected from large trees are stiff and brittle not suitable for rolling (Desarkar 1963). Collection of leaves from coppiced/pollarded bushes makes it further difficult to estimate leaf production from forest areas.

Jharkhand has 29.76 % forest cover which accounts for 3.4% of the total forest cover of the country (ISFR, 2021). It is one of the foremost *D. melanoxylon* leaf productive states along with Madhya Pradesh, Chhattisgarh, Odisha, AP, Gujarat and Maharashtra. *D. melanoxylon* leaves, collected from the forest areas of all the districts, constitute one of the most important non timber forest produce of Jharkhand with relative abundance of 5.14% (ISFR 2021). A reliable and scientific estimate of *D. melanoxylon* leaves production in the state is essential to obtain for optimal revenue to the forests departments, as also advocated by Gupta (1994). Thus, the present study has been exercised to address the issue and attempted to provide a scientific estimate of *D. melanoxylon* leaves production in Jharkhand.

2. MATERIALS AND METHODS

Present study seeks to estimates the potential production of *D. melanoxylon* leaves therefore the data collection process for fulfilling the study objectives included the process of site selection from target population and collection of pertinent information that is number of leaves on the individual selected sites and number of yielding plants. Sampling frame was made based on the available information. Sample size and the sampling units were decided on the basis of the variability in the system under study as well as with the ecological practices for collection of number of saplings with the logic to account all sort of micro variations including climatic environment within the zones, besides available man power (Cochran 1977). The stratification criterion was the collection units in five administrative divisions in Jharkhand *viz*. Palamu, Hazaribagh, Giridih, Singhbhum and Ranchi on the basis of past production records of Jharkhand Forest Development Corporation Limited, Ranchi.

2.1 Sampling strategy

The focus of sampling was estimation of number of plants in a fixed area i.e. plant density, number of pluck able leaves per plant, number of total pluckable leaves per plant during collection period and plant growth geometry. This three pronged planning addressed the respective estimates together with verification of estimates. In view of the vast area which includes practically all *D. melanoxylon* producing regions in the state of Jharkhand a novel sampling strategy designated as *"*Stratified Cluster Line Transect Quadrat Random Sampling*"* was devised and employed under the study which includes essential elements of statistical and vegetational survey methods having line transect of 100m x 10m and quadrats of 5m x 5m (Fig. 1). From each area, a cluster of units was randomly selected. The clustering approach facilitated the efficient monitoring and proper management besides logistic issues (Cochran 1977). From each cluster, a line of 100m (line transect) were drawn by selecting a point randomly through systematic sampling. Samples were drawn after regular interval from this point by considering both sides of line alternatively at the interval of 30 m distance. In all, for each unit, at least 15 samples were selected.

2.2 Sampling for estimates of saplings/plants

Information pertaining to the number of *D. melanoxylon* plants were collected from randomly selected sites through the line transects sampling by laying quadrats of fixed area (5m x 5m). On both side of transect line, all the plants falling within the distance of 1 m were counted. Further at each point at a distance of 10 m towards the direction of line, a quadrat of 5 x 5 m were selected both side, alternatively, perpendicular to the line. Surveys were conducted to generate the primary data on different aspects pertaining to estimates of *D. melanoxylon*

leaves. Primary data were collected through sample surveys to generate the yield as the as well as other information on number of plants through the devised and tested formats.

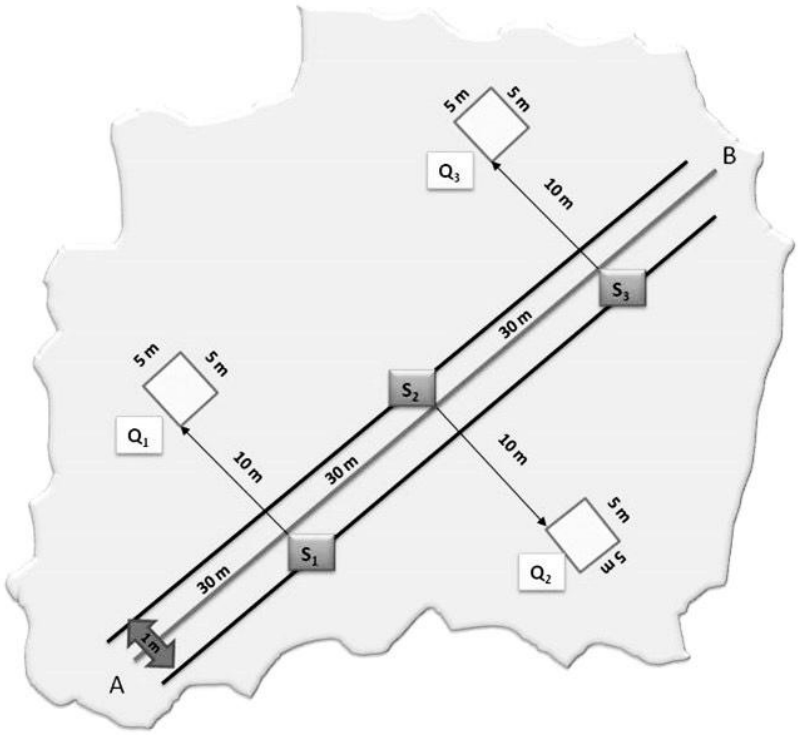

Figure 1. Representation of selection of quadrat for estimates of plants along the line transect. A – Starting point (selected randomly); distance between A and B is > 100 m. Distance between A to S_1 and between two sampling points is 30 m. Distance between sampling point and quadrat point (perpendicular to line) is 10 m.

2.3 Estimates of actual collected yield

Information on actual realized yield (number of leaves) was collected from each selected lots/units of collection centres. Three numbers of permanent plots of 10m x 10 m quadrat were laid in each Minor Forest Produce (MFP) Range to record periodical observation on parameters. The plots were guarded and maintained during the entire collection period for counting the number of harvestable leaves per shoots from 5 at random selected plants in each permanent plot. This lead to estimation of number of plants per unit area, number of shoots per plant and number of harvestable leaves per shoots.

2.4 Estimation of number of plants per unit area

Number of transect of fixed size (100 m^2) was laid in at least one unit of each lots of different MFP ranges of all zones. Based on the number of plants in a transect, mean number of plants per unit area of the MFP unit was estimated and generalised for all area of the unit.

2.5 Estimation of number of shoots per plant

Number of shoots from 10 plants from each transect of fixed size (100 m^2) was recorded from each sampled unit of each lots of different MFP ranges of all zones. Based on the number of shoots of different plants in a transect, mean for number of shoots per plant of the MFP unit was estimated. The mean number of shoots per plant of the un-sampled MFP unit was estimated based on the means of sampled units at the vicinity.

2.6 Estimation of number of harvestable leaves per shoots

The data of harvestable leaves were recorded by daily/periodic monitoring depending on situation, of each shoots of five plants marked for the purpose in three permanent plots of each lot. The monitoring of five plants from each permanent plot was ranged from more than 30 - 45 days of the leaves collection season in the respective locations. Based on the observation of 15 plants during the harvestable period, the average number of leaves per shoot was estimated. The SE was also estimated to obtain the upper limit and lower limit of the total production of harvestable leaves. This average number of leaves per shoots was used for estimation of total leave production in the MFP lot.

2.7 Total leave production in the lot and units

The total leaves production per transect was estimated by the products of number of plants multiplied by number of shoots and harvestable leaves as per defined methodology. This was extrapolated to the per hectare basis by multiplying 100 (1 ha = 10000 m^2). The pulla (bundle) was estimated based on the standard number of leaves (1 pulla = 50 leaves). This was further converted into standard bags (1 bag = 1000 pulla). The total production of bags was estimated after considering the area of lots from various forest records of Jharkhand. Where actual area could not be obtained for all units/lots, based on the premises that *D. melanoxylon* generally prefers open areas occupying vicinity of the forest areas/ fringes, the proportion of open forest was considered from the Forest Survey of India (FSI) data for the respective districts.

3. RESULTS AND DISCUSSION

The present study was carried out to quantify production of D. melanoxylon leaves in the state of Jharkhand on a scientific basis. Collection of leaves being a time-bound seasonal activity, field survey and data collection was planned by dividing the state into in five administrative zones namely Palamu (divided in to Daltonganj and Garhwa), Hazaribagh, Giridih, Singhbhum and Ranchi divided into 45 MFP ranges comprising of 295 lots and 686 collection units. In all, 52% collection units from all lots of entire MFP ranges were surveyed. Three permanent plots (10m x 10m) per MFP range were also maintained to evaluate the quantum of leaf harvesting throughout the collection season by collecting all pluckable leaves from 10 at random selected plants comprising total of 1350 plants. The total area surveyed for estimation of the production was approximately 1200000 m^2 in the state which has many regions affected by insurgency.

Table 1. Estimate of *D. melanoxylon* leaves production in different zones of Jharkhand.

S. No.	Zone	Area under *D. melanoxylon* (Ha)	Standard bags per Ha	Number of Standard Bags	Production in tons*
1	Daltonganj	105718.90	1.45	152981.08	6884.15
2	Hazaribagh	451450.45	0.65	292099.70	13144.49
3	Singhbhum	192104.00	0.73	140548.20	6324.67
4	Giridih	259330.80	0.69	178436.53	8029.64
5	Garhwa	188650.45	1.09	207182.80	9323.23
6	Ranchi	252428.98	0.73	184367.60	8296.54
	Total	1449683.58		11,55,615.93	52002.72

* Considering 1 Standard Bag Unit= 45 kg

The findings suggest that the productivity of *D. melanoxylon* leaves is around 1155000 standard bags (1 Standard Bag Unit = 1000 bundles of 50 leaves each; weight 45 kg) with average of 0.89 standard bags/ha. However, realized yield may be less in absence of pruning/pollarding and other silvicultural operation as well as the political disturbance severely hampering efficient management and extraction. Overall per ha yield recorded to be 0.69 (lowest in Giridih zone) to 1.45 (highest in Daltonganj zone). For evaluating precisely, the Palamu Division has been partitioned into Daltonganj and Garhwa region and accordingly the estimate has been made. Hazaribagh and Garhwa were the most productive zones. The total production of *D. melanoxylon* leaves of 11.6 lakhs standard bags (52003 tons) in the Jharkhand may be used for further planning of development in the state (Table 1).

The high production of *D. melanoxylon* leaves per unit area in Daltonganj may be attributed to better soil and climatic conditions besides other reasons, including low anthropogenic disturbances due to insurgency. The probable causes of low productivity in the Hazaribagh and Giridih may be attributed to inefficient crop manangemnt and high anthropogenic pressure as observed during the survey. The zonal share of standrad bag was 13%, 25%, 12%, 16%, 18% and 16% for Daltenganj, Hazaribagh, Dhalbhumgarh, Giridih, Garhwa and Ranchi.

Approximately 8 million standard bags (360000 tons) of leaves worth millions of revenue are collected annually throughout the forest of India. *D. melanoxylon* plants occupy open forest area and degraded land on the forest margins close to the forest-fringe villages rather dense forests offer enormous potential for generation of employment. Process of *D. melanoxylon* leaves collection (plucking, drying, preparing of bundles and packaging) is a complex work which needs to be done in a well-organized manner in the common standard protocol adapted by all states of India. On an average, 107 man days are required for collection (including drying and packing) of one tonne of leaves which is substantial in providing gainful employment during agricultural off season to people living in vicinity of forests and/or collection centres.

Present estimation suggests that Jharkhand has the potential of around 15 % collection of *D. melanoxylon* leaves in India. However, a large portion of the *D. melanoxylon* leaf potential remains untapped due to improper silvicultural management of the species e.g. bush cutting, tending and cleaning, setting up of fire before collection, improper running/ closing down of collection units (called Phanis) etc. An assessment of *D. melanoxylon* leaves collection (realized yield) in the Jharkhand in 18 years (2002-2019) reveals that collection has always been well below the fixed notified yield (*i. e.* 795875 standard bags) by the Jharkhand Government except in some years e. g. 2007, 2012 and 2017 (Fig. 2). The average of realized yield (%) in all these years has been 59.37% only. The realized % yield has exhibited a highly variable trend- the lowest (21.9 %) in 2019 to highest (96.6%) in 2012. These steep fluctuations in the realization of *D. melanoxylon* leaves collection are beyond rationale. Seasonal variations might have imparted some role. However, other factors like insurgent activities and trade malpractices in many regions of state have also significantly affected leaf collection or its reporting. Concrete steps as mentioned below should be taken to deal with such activities.

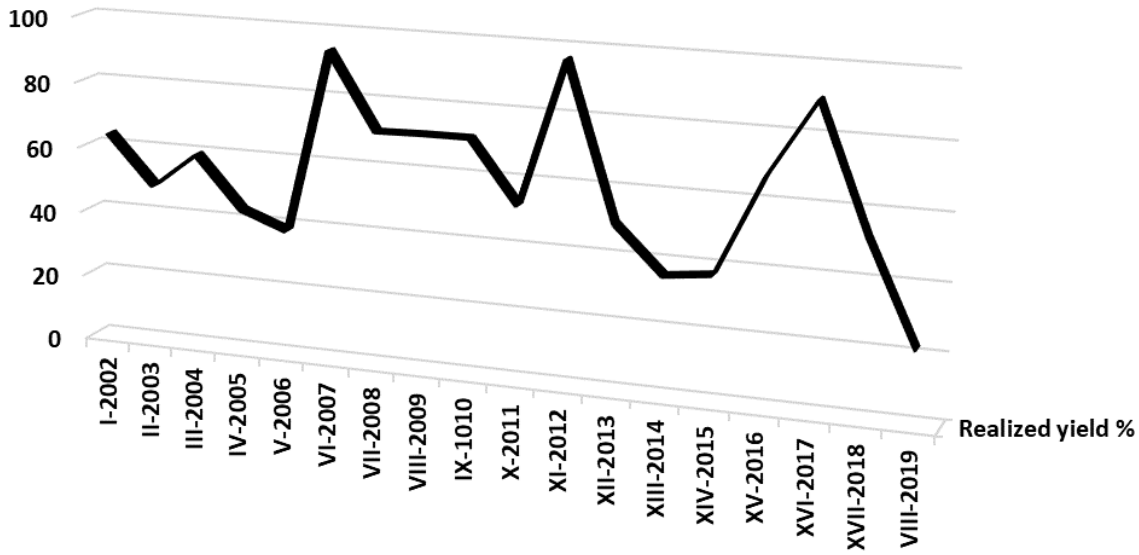

Figure 2. Realized yield (%) from 2002-2019 of notified yield potential is 7, 95,875 standard bags of *D. melanoxylon* leaf in Jharkhand (based on data of JFDC Ltd.).

The present exercise provides a way to facilitate path by providing actual shares of *D. melanoxylon* production and therefore, policy planning may be exercised in advance to tackle the loss of revenue to state exchequer and hence facilitate for development. This important forest resource of Jharkhand which at present contribute to rural livelihoods on a subsistence level, could play a much bigger role in economic growth and poverty alleviation. This represents a significant opportunity to expand forest productivity and attain growth potential (World Bank 2007). The study further advocates for the crop management practices for better yield and reduce the anthropogenic disturbances. The anthropogenic disturbances and pressures may be reduced through better planning of development by implementing the income generating programmes for inclusive growth of the region.

It is worth to mention that the purview of the present investigation was quantitative and not qualitative. Thus, the lower yield at the areas with known superior quality leaves should not be equated with higher standard bags in lower quality leaves in other areas. The situation warrants further investigation based on qualitative parameters. This estimation exercise is the first in the entire country. The knowledge and conclusion obtained will serve as the precursor for evolving mechanism and strategies for future studies of the nature.

REFERENCES

Chavan SB, Uthappa AR, Sridhar KB, Keerthika A, Handa AK, Newaj R, Kumar N, Kumar D, Chaturvedi OP. 2016. Trees for life: creating sustainable livelihood in Bundelkhand region of central India. Curr Sci. 6 (25): 994-1002.

Cochran WG. 1977. Sampling Techniques. New York (NY): John Wiley & Sons.

Desarkar BK. 1963. A note on bidi leaf (*Diospyros melanoxylon*). Ind For. 89:39-45.

FSRI 2010. Forest Sector Report India. Dehradun: Indian Council of Forestry Research and Education (Ministry of Environment and Forests, Govt. of India).

Ghosh RC, Mathur N, Singh RP. 1976. *Diospyros melanoxylon*: its problem of cultivation. Ind For. 102(6): 326–336.

Gupta BN. 1994. India. Bangkok: FAO Regional Office for Asia and the Pacific. Chapter 3 Non-Wood Forest Products in Asia; p 19-48.

Gupta RK. 1992. Multipurpose trees for agroforestry and wasteland utilization. New Delhi: Oxford & IBH Publishing.

Gupta T, Guleria A. 1982. Some economic and management aspects of a non-wood forests product in India: Tendu leaves. CMA monograph No. 88. New Delhi: Oxford & IBH Publishing.

ISFR 2021. India State of Forest Report. Dehradun: Forest Survey of India. Chapter 2 Forest cover; p 18-59.

Kerketta JK. 2016. Studies on Productivity, Silviculture and Socio-economics of *Diospyros melanoxylon* Roxb. in Jharkhand [Dissertation]. Dehradun (DD): Forest Research Institute Deemed University.

Kerketta JK, Singh S, Kumar B. 2018. Effect of silvicultural treatments on quantity and quality assessment of tendu (*Diospyros melanoxylon* Roxb.) leaves. Jour Pharmacog Phytochem. SP1: 1317-1322.

Lal P. 2012. Estimating the size of Tendu leaf and bidi trade using a simple back-of-the-envelope method. AMBIO. 41:315–318.

Rathore JS. 1970. *Diospyros melanoxylon*, a bread-winner tree of India. Economic Bot. 26(4): 333-339.

Sabar B, Nayak NS, Achoth L. 2016. Tendu leaves collection in India: livelihood, rights and challenges for alternative to tobacco-evidences from five Indian states. J Governance Public Policy, 6 (1): 106-126.

Word Bank 2007. Jharkhand: Addressing the Challenges of Inclusive Development. Washington (DC): World Bank, Report No. 36437-IN.