“My new Province is a land of bamboo groves;

Their shoots in spring fill the valleys and hills.

The mountain woodman cuts an armful of them

And brings them down to sell at the early market.

Things are cheap in proportion as they are common;

For two farthings I buy a whole bundle.

I put the shoots in a great earthen pot,

And steam them over the boiling rice.

Their purple nodules broken, they suggest an old brocade;

Their white skin gleams like new pearls.”

- PO CHU-I, Translated by WALEY (1929)

Bamboos are the arborescent plants of global interest since beginning of civilization because of their distinctive life form, ecological importance, multifarious uses and other values they have for humans. Today bamboo helps more than 2 billion people meet their basic needs. It is considered as a cheap, widespread, renewable, productive, versatile, easily accessed, environment-enhancing resource. It has great potential to improve life, especially in the rural areas of the developing world (Sastry, 2008). Bamboos are gaining increased attention as an alternative crop having multiple uses and benefits. It provides human beings with various living resources. They are intermingled with the tradition and culture of rural and tribal populations and are an integral part of their cultural, social, and economic conditions from times immemorial (Tewari, 1988; Madhab, 2003). It is cheap and abundant to meet the vast needs of human from the 'child’s cradle to the dead man’s pier'. So many sayings are associated with Bamboo like ‘The Cradle to Coffin Plant’, ‘The Poor Man’s Timber’, ‘Friend of the People’, ‘Green Gasoline’, ‘The Plant with Thousand Faces’, ‘The Green Gold’ and so many others. In Indonesia it is said, 'without bamboo land dies'.
‘Bamboos are all things to some men and some things to all men’. Presently bamboo is not only 'Poor man’s timber' but also 'rich man’s delicacy'. In ancient time, narrating importance of Bamboo Confucius once said ‘man can live without meat, but will die without bamboo’. Eight hundred years ago Pou-Sou-Tung, a Chinese poet, wrote ‘A meal should have meat, but a house must have a bamboo. Without meat we become thin; without bamboo we lose serenity and culture in itself’. The Vietnamese epitomize the closeness of the bamboo in their proverb ‘the bamboo is my brother’. However, bamboo is so familiar, ever present and commonly available that it has long been taken for granted and overlooked. Only in recent years long neglect has given way to the beginning of serious attention. The resurgence of interest in bamboo as a substitute for tropical timber and the recent developments may be called ‘Golden revolution’ (analogue of ‘Green revolution’) to address global wood security (Jiang, 2007).

The origin of the word bamboo is not very clear. Some believes that it is derived from Indian word Mambu. Mambu is Malay word for ‘bamboo’. According to Marden (1980), an ancient Chinese dictionary called ‘Erh Ya’ mentions bamboo by names ts’ao. Ibn sina called ‘Prince of Physician’ born in Bokhara, Persia (now Iran) in 1980 codified all knowledge of medicine. He mentions word Tabaxir in his book ‘Cannon of medicine’. In Arabic Tabaxir means milk, juice or liquid condensed. In the same book he referred the word Mambu ascribed to present day bamboo. In 16th century a noted Portuguese physician Garcia de Orta established at Malabar Coast (presently Goa) wrote the book ‘Coloquios dos simples e drogas da India’ in 1653. The book mentions word Saccar Mambu derived from the word acucar de Mambu. Acucar is a Portuguese word for sugar and Mambu Malay word for Bamboo. Bauhin in 1623 in his famous book used the word Arundo from India. He mentions that Taxbir is derived from Mambu.
Importance and utilities of bamboo (sataparva) have been mentioned in the Arthasastra of Kautilya also. Kautilya’s observations and instructions on bamboo are scattered in dissertations on different adhikarana (topic). It is divided into adhyaya (chapter) and prakarana (sections) which are chronologically numbered. Kautilya considers bamboos as distinct class of plants and names the class Venubarga (2.17.25). He classifies the same into – venu, utaja, cimaya, capa, satina, kantaka and bhalluka. He declares the bamboos as a source of wealth (Kupya) and mentions that the Superintendent of Wealth (Kupyaadhyaksa) should along with other sources of wealth, look after this unique source also (2.17.35). For cultivation, he suggested to use bamboo cuttings (2.24.41). According to him, the open ends of the cuttings should be smeared with honey, fat and ghee before sowing (Sensarma, 1993).

Bamboo belongs to the family Poaceae under sub family bambusoideae. Bamboosoid grasses comprise both woody bamboo whose culms are lignified and herbaceous bamboos. Depending upon morphological features, many classification systems of bamboo have been proposed since time immemorial. The first Ruprecht in his monograph, published in 1839, says that the first mentions of bamboos occur in the works of Ctesius, in the letter from Alexander the Great to Aristotle and in the Natural History of Pliny. The first writer to write on Indian bamboos was Van Rheede, who in his ‘Hortus Malabaricus’ described two kinds of bamboo. These two are now identified as Bambusa arundinacea and Ochlandra rheedi. Periodically regular attempts have been made to study bamboo taxonomically. Most of the recent classification systems (Dransfield and Widjaja, 1995; Li, 1997; Soderstrom and Ellis, 1987) placed 67 genera of woody bamboos in nine sub tribes. Bamboo taxonomy poses certain difficulties for science, owing to the plant’s often long flowering cycles, thus taxonomists still debate the total number of bamboo species and genera.
Bamboo is widely distributed in tropical, subtropical and mild temperate zone. Bamboo occurs naturally in four of the five continents (except Europe) of the world and is found mainly in the wide belt between the Tropics of Cancer and Tropics of Capricorn, as well as the adjacent temperate and subtropical areas. The distribution of bamboo extends from 51° N latitude in Sakhalin island of Japan to 47° S in South Argentina.

Bamboo is spread in over 1250 species under 75 genera in the world with 136 species under 23 genera in India (Upreti and Sundriyal, 2002; Sharma, 1980). There are many reports regarding number of genera and species of India. According to Seethalakshmi and Muktesh Kumar (1998) that there are 128 species under 18 genera known from India. According to the latest report from International Network on Bamboo and Rattan (Anon., 2005) India is having 205 species belonging to 23 genera. According to Remualdo (2006), about 80% of the world bamboo resources are found in Asia. China is the leading country with 39 genera and around 500 species and a plantation area of 5.0 million ha. (Fan et al., 2006).


India is reported to be the largest producer of bamboo in the world after China with area of about 8.96 million ha and out of these nearly 28% falls in the North Eastern states (Naithani, 2010). The NE Himalayan region represents 58 species belonging to 16 genera (Bhatt et al., 2005a, 2005b).
Bamboos provide food, shelter, medicine, raw materials for construction, wood substitute, and paper and pulp for industry. They are also used for making furniture, handicrafts, containers, tool handles, poles, musical instruments, bows and arrows, boats, rafts, fishing poles, and so on. There are more than 1500 different documented traditional uses of bamboo (Shrestha, 1999). At present, there are more than 3000 companies around the world engaged in the production of various bamboo-based products such as panels, flooring, pulp, charcoal, edible shoots, and other daily-use articles (Xuhe, 2003).

There is a growing realization that the potential of bamboo in our country has not been tapped to its fullest. Bamboo is being 're-discovered’ in India as its attributes and utilities are increasingly recognized. Presently in India it is being used in various segments like wood substitutes and composites, utility and craft products, charcoal, activated carbon, gasification for rural and decentralized energy needs, edible bamboo shoots for dietary requirements etc. The National Mission on Bamboo Application has demonstrated commercial viability of bamboo based gasification system. The leaves have been used as fodder for livestock. It is also a very important food for the giant pandas in China. In addition, due to their characteristic growth habits, particularly its interwoven system of rhizomes and roots that performs the function of cohesion, bamboos have enormous potential for alleviating many environmental conditions such as soil erosion control, water conservation, land rehabilitation, carbon sequestration and sewerage treatment. In addition Bamboos fix significant amount of atmospheric carbon (Ben-zhi et al., 2005; Fan et al., 2006, Zhang and Zhou, 2006).

It is estimated that the bamboo markets excluding markets for bamboos in paper/pulp production and unprocessed bamboo supplied to construction industries and other uses, have a combined value of 6.8 billion US $ per annum and traditional bamboo products like handicrafts, blinds,
chopsticks, bamboo edible shoots account for almost 95% of this value (Smith et al., 2006). The emerging markets with newer industries, particularly wood substitutes have been pioneered by Asian producers and include flooring, panels and non-traditional furniture. According the Smith et al., (2006), these represent the largest growth opportunities for bamboo.

Bamboo shoot is a new emerging bamboo culm progressively formed from latent buds on rhizomes. It is also known as ‘juvenile shoot’ or ‘bamboo sprout’. The shoots of some of the species are edible. The young shoots are tightly clasped with overlapping sheaths that have to be removed to extract the edible part. Shoots usually develop every year with the beginning of the monsoon season, during which the shoots are harvested. The typical shooting season of a species rarely exceeds 2 months (Chongtham et al., 2011).

Bamboo shoots are not only delicious but are also rich in nutrients and rank among the 5 most popular healthcare foods in the world. Bamboo shoot forms an essential ingredient in dishes of many countries. In India shoot is one of the ‘food from the forests’ and widely relished by tribes of North East, Central, Eastern and South India especially of Western Ghats. The popularity of Chinese restaurants worldwide gives an opportunity for people in many countries to taste this bamboo vegetable. The bamboo shoots are named mostly on lingual or community base. In Chinese it is called *zhu’sun jian*; in Korean it sounds like *juk sun*. Similarly in bamboo shoot consuming countries, different names have been given. In shoot consuming states of India also different names have been given for fresh bamboo shoots, dried bamboo shoots and fermented bamboo shoots. In Jharkhand fresh bamboo shoots are called ‘*karil’*, crushed and fermented as ‘*Sandhana’* and the dried as ‘*harua’*.

Moisture content in fresh shoot is about 90% (ERG, 2004) and 78 to 94.7% moisture are very common in shoots of our country (Chongtham et al., 2011; Bhatt et. al., 2000b). The edible
content of a newly harvested shoot is usually 25 to 30%, small shoot yielding species have lower edible part. Studies from NE India (Singh, 2006) with a large number of species have indicated higher proportion of edible part (45 to 74%).

Bamboo shoots are low in calories, high in dietary fibre, and rich in various nutrients. The main nutrients in bamboo shoots are protein, carbohydrates, amino acids, minerals, fat, sugar, fibre and inorganic salts. The shoots have a good profile of minerals, consisting mainly of potassium (K), calcium (Ca), manganese (Mn), zinc (Zn), chromium (Cr), copper (Cu), iron (Fe), plus lower amounts of phosphorus (P), and selenium (Se). Fresh shoots are a good source of thiamine, niacin, vitamin A, vitamin B6, and vitamin E.

Bamboo shoots not only have nutritional but also medicinal value. In China and South East Asia since long it is being used as medicine. Its medicinal value is also recorded in the book *Compendium of Materia Medica*, a pharmaceutical text written during the Ming Dynasty (1368 to 1644). According to archaic Chinese medicinal books, such as ‘Ben Chao Qu Zheng’, ‘Ben Jing Feng Yuan’, ‘Yao Pin Hua Yi’ and ‘Jing Yue’, it is proclaimed to be beneficial to human health, by promoting motion and peristalsis of the intestine, helping digestion, and preventing and curing cardiovascular diseases (CVDs) and cancers. Modern research has revealed that bamboo shoots have a number of health benefits, from cancer prevention and weight loss to lowering cholesterol level, improving appetite and digestion. It is also low in sugar and therefore can be used by persons on sugar-restricted diets.

Most bamboo species produce edible shoots. According to Fu and Banik (1995), over 500 species can produce edible shoots. The main monopodial species used commercially in China is *Phyllostachys pubescens*, known colloquially as ‘Moso’. Singh (2006) listed 50 native bamboo species used for edible purpose from North East (NE) India. In Central and Eastern India, tribal
collect bamboo shoots from natural bamboo forests having mostly pure patches of *D. strictus*. Pandey *et al.*, (2012) have listed some more species.

The INBAR (International Network on Bamboo and Rattan) has selected six species which are most suited for the development of bamboo shoot industry in India. These are: *Bambusa balcooa, Dendrocalamus brandisii, D. giganteus, D. hamiltonii, D. strictus* and *Melocanna baccifera*. (Nath *et. al.*, 2008)

No concerted effort has so far been made for documentation of duration of shoot season, the shape and dimension of the harvested shoot and the productivity from the mainland India. Shoot season in different countries varies depending largely on climatic condition, geographical locations and genetic variability. In Central and Eastern India, shoots emerge during rainy season. In NE states, the season begins at the onset of monsoon i.e., May-June and continues till early September-October.

Like Bamboo as timber, bamboo shoot has also both global and national market. According to Smith *et al.* (2006), the current global bamboo shoot market is 1.5 million US$ out of total world bamboo market of 6.8 billion US$, excluding markets for bamboo in paper/pulp production and unprocessed bamboo supplies to domestic construction industries and other uses. As per 2000 estimate (ERG 2004), the total world trade for bamboo shoot has been estimated at Rs. 3,200 to Rs. 3,400 crores and in volume 300,000 tons. The quantum of Chinese shoot export was 150,000 ton valued at Rs. 1,200 crores. In volume terms China’s shares of total export was at almost 50 %. In spite of large resource base India imports a very small quantity from Thailand.

Bamboo comes into production in 3 to 4 year after plantation and reaches maximum productivity in 7 to 8 year (Anon. 1997). Well managed stands of *B. bambos* and *D. hamiltonii*, may produce 33 and 53 shoots weighing 30 – 50 kg and 20 – 40 kg per clump respectively in 4 years. The yield
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of Bamboo shoot and timber also depends on species, genetic variability and its management. Even it depends on clump age structure and site factors.

Due to its multiple uses in industry and its trade, it is expanding rapidly. There is need to increase yield and develop technologies for value addition. The yield can be increased by suitable agronomic practices, choice of species and selection of sites. The application of organic and inorganic fertilizer; mulching; irrigation etc can increase bamboo shoot production.

In recent times much attention has been given on scientific research on increasing the bamboo resources by increasing the yield and area coverage. Diverse activities pertaining to bamboo research have been carried out in India. However, information on edible bamboo shoots is confined to mainly NE states. In that respect Jharkhand, the recently constituted state within the Indian federation, is the most neglected one.

Not a single effort has earlier been made to assess the bamboo resources of Jharkhand, their utilities, bamboo related livelihood support and related fields other than that by Institute of Forest Productivity, Ranchi (IFP) under the leadership of ICFRE. Bamboo research pertaining to bamboo resource survey, macro- and micro- propagation of bamboos, introduction of exotic species, establishment of ex situ conservation garden and bambusetum, management of bamboo stands, nutrient cycling, flowering inventory, etc, have recently been conducted by IFP, Ranchi. It has been reported that 14.51 % of total forest area in Jharkhand is covered with potential natural bamboo of mainly Dendrocalamus strictus. The other forest species available are Bambusa bambos and Gigantochloa albociliata. From the homesteads of the state, 10 species have been found covering 1.554 % of total geographical area. The dominant species being Bambusa nutans (Krishnamurty, 2010; Nath et al., 2012a, 2013). Dendrocalamus asper is introduced species in India. In Jharkhand it was introduced in late 1990. Commendable achievements have been made
on mass production of *Dendrocalamus membranaceus* from culm segments at seedling stage; influence of soil amendments, AM fungi inoculation, macro- and micro- nutrients on vegetative propagation with and without growth promoting substances; optimization of season, culm position and culm age for successful propagation and rhizome genesis in several species of bamboo (Nath and Das, 1995; Das *et al*., 1997; Sinha, 2009b; Sinha *et al*., 2010; 2013; Ritesh Kumar *et al*.,2010; Supriya Kumari *et al*., 2012).

Felling intensity in three year old stands of *B. bambos*, *B. balcooa* (vulki bans), *B. tulda* (Jawa), *B. vulgaris* and *D. strictus* have been studied (Nath *et al*., 2010). Inventories on flowering bamboo are not adequate in our country for ensuring seed availability and maintenance of bamboo germplasm. The flowering behaviour of *Bambusa tulda* has been studied and the effect of soil work, irrigation and manuring on seed setting in flowered clumps has been found to be positive (Suraj Kumar and Nath, 2011; Nath, 2011; Nimmy Srivastava *et al*., 2012).

In Jharkhand, species like *Bambusa bambos*, *B. nutans*, *Dendrocalamus strictus*, etc., are available both in forests and homesteads. The bamboo shoots are important food items for the people of the state. The short shoot production period may be one of the major hurdles for large scale processing and consumption. Most of the bamboo clumps are congested and lack proper management. There is absence of package and practices for extension of shoot production period from the individual species. No scientific survey has been done to assess and evaluate the potential edible species, shoot consumption pattern, its production potential, gross output, harvest and marketability.

In summation the main constraints for development of bamboo shoot sector in Jharkhand are:

i. Completely unorganized bamboo shoot market.

ii. Lack of information on bamboo shoot collection, consumption and sale.
iii. Most of the bamboo shoots collection by villagers from forest.
iv. Consumption of bamboo shoot by only a section of the population.
v. Absence of processing and packaging unit.
vi. Lack of preservation technology.
vii. Short duration of shoot emergence.
viii. Absence of any agronomic silvicultural management practices and lack of motivation.

Keeping in view all the above aspects of bamboos and edible bamboo shoot, the present study has been framed to be undertaken in Jharkhand with the following objectives.

**i. Assessment of shoot production and market potential in Jharkhand.**

**ii. To Study the influence of silvicultural management – manurial treatment, clump thinning and shoot harvest techniques on shoot emergence, duration of shoot production, shoot yield and culm growth in Dendrocalamus asper, Bambusa nutans and Dendrocalamus strictus.**

**iii. To assess the influence of grove management through organic amendments and mulching on shoot production, production period, shoot yield and culm growth and also on shoot quality of D.asper, B. nutans and D.strictus.**