Bamboos in rural farming systems in the Terai and Midhills of Nepal

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Bamboos are an important component of rural farming systems of the Terai and Midhills of Nepal. They are mainly grown in homesteads and degraded lands, and help sustain livelihoods of many rural people that include socially and economically disadvantaged groups. Very few species can match them in terms of uses, as they are flexible, easy to bend and split into small pieces with superior strength. They can be used for house construction, furniture, woven products, small household utility items, and leaves fodder bank to be used during the scarcity and in dry season. New bamboo shoots provide valuable source of nutrients for human consumption along with some medicinal uses. Rural households' interest towards bamboo growing has considerably increased in recent years. The perceived scarcity of forest products, fast growing nature of bamboos and its potential as a source of income has made it like a cash crop, particularly in areas having good infrastructure such as roads and transport services. Based on the detailed socioeconomic study conducted on bamboos in eastern Terai and Midhills and author's long association with bamboo and socioeconomic research and literature review, this paper provides information on its role in rural farming systems; trends of bamboo growing in relation to farm size; biomass production; its characteristics as a farm crop; existing trends of utilisation and management practices, problems and constraints associated with bamboo planting in Nepal.

Keywords: Bamboos, Rural Farming Systems, Terai, Midhills, Uses, farmlands, Farm size, forests.

Terai and Midhills are the most densely populated parts of Nepal (306 and 155 people/km^2 respectively). Of the total population (23.15 million), 55% and 37.71% of the people live in the Terai and Midhills, where as they cover only about 9.53 million ha (64%) of the land (CBS, 2002; Task Force, 2003). As a result, there is a greater pressure on the farming systems of both the Terai and Midhills to meet the household needs.

Farming systems in the Midhills are in fact based on strategies to manage forest pasture and arable land simultaneously in an integrated fashion to obtain essential items of food, shelter and clothing. The hill farmers in Nepal have traditionally practised many types of agroforestry (Fonzen and Oberholzer, 1984; Thapa *et al.*,1989; Denholm, 1991). The farmers who cultivate land for crop production also raise livestock and depend upon tree resources for the support of both components (Mahat, 1987; Thapa, 1994). The combination and interactions of climate, topography, altitude, social organisation, religious belief and access to land and markets in the Midhills has given rise to a wide variety of farming systems and great variances within them (Gibbon and Schultz, 1989; Thapa, 1994) which in turn has resulted in several agroforestry practices. One of the agroforestry practices employed by farmers is the planting and protecting of trees and bamboos on agricultural land.

The hot, flat Terai, the northern part of India's Gangetic plain, is almost different from the Midhills. Its soil is a thick layer of alluvium deposits in contrast to the generally shallow soil of the Midhills. The Terai, previously an endemic malarial area, now absorbs an ever-increasing stream of hill migrants and has led to increasing pressure on the already limited Terai forests (Wallace, 1988). Forestlands in the Terai were cleared in the past to resettle the people of hill origins (Adhikari, 2002). The hills have clusters of trees and clusters of people with strong communities and there are a large number of community-managed forests. In the Terai, the division between people and trees is more often linear as traditional villages are in the

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south and forests are in the north bordering hill districts. In the Terai, leaf fodder is not so important as in the hills. The Terai farmers use more agricultural residues for fuel and to feed their livestock. The forests are a more important source of fuelwood in the hills than in the Terai. There is less forest in the Terai, however villagers have greater access to energy sources such as kerosene. The land in the Terai can be more productively used to grow crops, and using dung for fuel affects agricultural output less because chemical fertilisers are more readily available. Commercial production of timber and bamboo is more important in the Terai than in the hills.

This paper is based on author's experience in bamboo research in Nepal, literature review and the findings of the detailed socioeconomic study conducted in eastern Nepal. The objective of the paper is to analyse the role of bamboos in farming systems and its potentiality for sustaining rural livelihoods in the Terai and Midhills of Nepal. This paper gives brief account of bamboos, its comparative advantage in terms of growth, its arrangement in rural farm landscape. The relationship between farm size and bamboo growing (case study from eastern Nepal), socioeconomic characteristics of bamboo as a farm crop, recent utilisation trends and the role its development can play in sustaining rural livelihoods are also discussed.

Facts about bamboos

Bamboos prefer well-drained soil and humid conditions for its growth and occur both on private farmlands and natural forests of Nepal. Even though they belong to family of grasses, they are categorised as tree (*rukh* in Nepali) by rural people in Nepal. More than 50 species are reported in Nepal, most of which are indigenous (Das, 2003). They are generally categorised into two classes by local people: 1. *Bans* (big size bamboo species of 4cm or above diameter) 2. *Nigalo* (small-size bamboo species of 4cm or less diameter). *Nigalos* are mostly found naturally in forests of Nepal, generally between 1200-4000 masl, but more commonly in 2000-3000 masl. Many species of *nigalo* are also cultivated in Midhills for making woven products. *Bans* are also found in natural forests but are mostly in degraded condition due to overexploitation. They are widely cultivated from Terai (flat plains) - 2200masl in the Midhills, mainly for construction and variety of other uses. In the Terai, some exotic species of *nigalo* type bamboos are grown on smaller scale. The eastern half of Nepal has greater biodiversity of bamboos as climate is more favourable for its growth than the other half of the country.

Bamboos in Comparison to fast-growing Tree Species

Bamboo occurs either as an understorey mixed with a large number of tree species or in pure stands. Volume and yield also varies with stand composition and species. Sustained yield is 5-20 tonnes/ha from plantations. Higher yields can be obtained on good soils with the application of fertiliser and scientific management (Liese,1986; Hsiung,1987). Large yields often occur in alternative years (McClure,1966; Liese, 1986). Annual biomass productions of some fast-growing tree species are compared with bamboo in Table 1. The mean annual increment (MAI) of medium or large-sized bamboos is as high or higher than that many of the fast-growing tree species. In

Table 1. Annual biomass production in green weight of some fast growing species and bamboos

Species	Local Name	Country	Origin	MAI t/ha/year	Remarks
Alnus nepalensis	Utis	Nepal	Nepal	4.3-6	
Bambusa nutans subsp cupulata	Mal Bans	Nepal	Nepal	20-25	Well- established clumps
Dalbergia sissoo	Sissou	Nepal	Nepal	13	
Cassia siamea	Cassia	Nepal	South-east Asia	11.1-27.2	3 year rotations
Dendrocalamus hookerii	Kalo/Bhalu bans	Nepal	Nepal	15-20	Well- established clumps
Eucalyptus camadulensis	Masala	Nepal	Australia	14-18	
Eucalyptus tereticornis	Masala	India	Australia	10.5-11.5	
Pinus patula	Patle salla	Nepal	Mexico	12	
Pinus roxburghii	Khote salla	Nepal	Nepal	9.5	
Shorea robusta	Sal	Nepal	Nepal	11.7-22.2	3 successive short rotation of 4 years

Keys: MAI= Mean Annual Increment, t/ha/year= tonnes per hectare per year
Sources: Jackson, 1987; Das, 1999; Thapa, 2002; Acharya *et al.* 2002

most cases, the wood produced from trees cannot be used for purposes, other than fuelwood or pulp and do not have multiplicity of uses as the bamboo of same age. The additional advantages with bamboo is that one should not have to replant as in case of trees for perpetuity till it flowers and biomass remains more or less the same. In case of trees, usually biomass retards after first 3 rotations (Jackson, 1999; Thapa, 2002).

Bamboo: species having multiple uses and versatility

Bamboo is of great importance to people of both the Terai and hills. There are no other species with as many uses as bamboos, except perhaps palms. Farmers make practically everything except the ploughshare in Nepal. Because of its fast growth, versatility, lightweight, strength and straightness, they are used for a wide variety of purposes. It is easy to bend and split bamboo culms into small pieces.

Bamboos are extensively used for house construction, fencing, scaffolding, woven products such as mats, baskets, trays, winnow, furniture, water supply pipes, handles for agricultural implements, and fodder for livestock (Seeland, 1980; Das, 2002).. The new shoots of some bamboo species are used as vegetables and for making pickles. They are also grown as ornamental plants in urban area. They also have medical value. Bamboos are the best species for soil conservation as they form a mat-like structure above the ground and thus prevent seepage of water into soil, which if occurs at erodible sites, will result in mass movement of soil (Howell *et al.*, 1989).

It has been ranked highest among all structural boards and is considered as good as the solid wood of high-density commercial timbers (Guisheng, 1985). Successful development of bamboo parquet has been started in Nepal with the establishment of the Himalayan Bamboo Pvt. Ltd at Hetauda in Central Nepal. Similarly, Unique Bamboo Products at Butwol in western Nepal is producing bamboo matboards. Due to the sharp increase in the price of timber, bamboos are increasingly used for construction and furniture. Bamboo furniture is getting popular since it is cheap and lighter than timber based furniture particularly in Kathmandu valley (Poudyal, 1992).

Arrangement and purpose of bamboos and trees in the Terai and Midhills Farm Landscape

In the Terai, bamboos are grown near the house at the bund of homegardens. Pure stands of bamboos known as *bansbitti/bansbari* (bamboo garden) are managed by rich landowners (Das, 1999). The land is usually rainfed without irrigation. In many cases, the homegarden also consists fruit trees such as mango (*Mangifera indica*), Katahar (*Artocarpus heterophyllus*), Lichi (*Lichi chinensis*), Nariwal (*Cocos nucifera*), Supari (*Areca catechu*) and fast growing tree species such as sissoo (*Dalbergia sissoo*), bakaino (*Melia azederach*), kadam (*Anthocephalus cadamba*) and *Poplar* sp. Tree growing is not so closely interlinked with the production of agricultural crops as in the Midhills. The trees, including bamboos are considered more as a source of income than in the hills where it is just to meet household requirements. Surplus bamboo and tree products have good markets and are considered similar to bank savings. Livestock graze both on the nearby national forests if exist and on the farmland during the fallow season. The paddy, wheat straw and other agricultural residues are commonly fed to the livestock. Unlike in the hills, a negligible amount of tree fodder is used to feed livestock (Kanel, 1995).

In the hills, bamboos are grown in the gullies and on the edge of terraces in such a way that soil erosion due to heavy rain and wind damage can be minimised. The fruit and fodder trees are also grown in combination with food crops or at the edge of homestead (*bari*) land. The minimum effect on production of food crops is also considered. Bamboo forms a mat-like structure on the ground and prevents soil erosion. The hill farmers also manage bamboo clumps for fodder as a reserve, especially for the dry season (March-May) when fodder is scarce. In general, farmers grow more than one species of bamboos in their land. The bamboo which produces edible shoots are planted very close to home to prevent its theft.

Existing trends of bamboo growing in Nepal

Bamboos can be seen growing everywhere in the rural as well as the urban parts of Nepal. Levels of bamboo growing vary significantly with wealth (Das and Seeley, 1996). The richer households in general have planted more bamboos than poorer households. In

eastern Nepal, both in the Terai and Midhills, bamboo plantation is more common than other regions of Nepal. The scale of plantation gradually reduces westwards. The older village settlements in the Terai and Midhills all over Nepal have more bamboos than newer settlements.

In Terai districts of Central Nepal such as Saptari, Siraha, Dhanusha, where there is virtually no natural forests, bamboos are grown on a large scale by households (Das, 1992). Districts such as Jhapa, Morang, Sunsari, Sarlahi and Mohottari, where only moderate amount of natural forests, bamboos the commonest species on the farmlands. In the Terai of the Far-Western Region of Nepal, there are less bamboo plantations, which may be due to abundance of natural forests.

In the Midhills, bamboos are abundant in those villages where only a small percentage of natural forest exists. Districts such as Dhankuta, Ilam, Sankhuwasabha and Kaski have higher density of bamboo plantations. In places where there are large areas of forest left or villages near to the forests, have smaller numbers of bamboo clumps in comparison to those villages, which are farther from the forest. Bamboos are also seen in abundance in those areas, which are accessible to markets and have good transportation facilities. Bamboos clumps in these areas are better managed in comparison to those, which are inaccessible to markets.

Farmers in the Terai mostly grow bamboos that can be used for house construction. Bamboos from extensively managed bamboo clumps are sold in the market and are largely used by both the urban and rural poor for house construction, fencing and also for scaffolding. Bamboos are also exported to India where there is a greater demand. Even branches are used or sold by farmers in the Terai, for making walls of houses and fencing (Das, 1992).

Bamboos in the Midhills and High Mountains are managed for multiple uses e.g. *D. hamiltonii* (Tama bans) and *D. hookerii* (kalo/bhalu bans) which have many uses such as in construction, weaving, fodder and new shoots as food. In the Midhills, farmers grow *nigalo* for weaving whereas for construction purposes and fodder they usually grow *bans* (Das, 1992). The role of bamboo in soil conservation in the Midhills is also important. Bamboos occurring in natural forests are also exploited but rarely for commercial purposes.

Bamboo growing in relation to farm size in eastern Nepal

The study is based upon a detailed socioeconomic study in 13 VDCs of eastern Nepal (Figure 1). The VDCs selected in the Terai of Morang districts were Dangraha, Sidhraha, Lakhantai, Tetariya, Motipur and Banigaon. They are mainly composed of *Tharus*, one of the oldest and dominant ethnic groups, in the Terai of Nepal. The seventh village in Morang district, Kerabari, is close to national forest. The six VDCs selected of mixed ethnicity in the Midhills of Dhankuta were Ankhisalla, Hattikharka, Pakhribas, Murtidhunga, Parewadin and Bhirgaon. The study randomly selected grower and non-grower households of each wealth rank and RRA/PRA tools were used to collect the information.

About 20-25% of the households in six Tharu villages were *Sukumbasis* (landless people) who do not have any land or occupy less than 0.05 hectare of unregistered land. In Kerabari, about 5% of the households were landless. In the Midhills villages, less than 2% of the households (4 households) were landless. The study found that land distribution is skewed, so smallholders predominate both in the Terai and the Midhills. Population growth over the years has brought intense pressure on the land use system resulting in frequent fragmentation and has led to reduced *per capita* land availability.

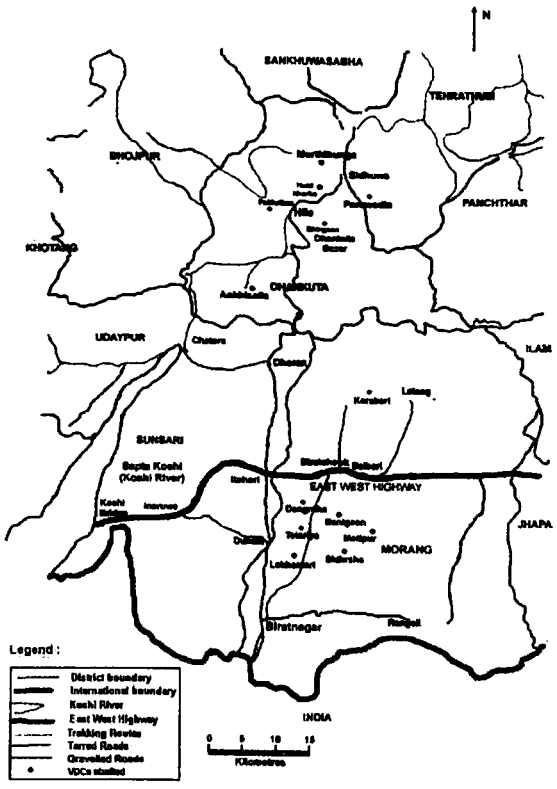

Fig.1: Location of Study VDCs in eastern Nepal

As bamboo growing is a land-based activity it was expected that households with more land would show more interest in bamboo planting. The increasing trend of adoption with size of landholding was also evident from the cross-tabulation. The Chi-square test revealed that there is a strong association between bamboo growing and farm size for both the Terai and the Midhills (Terai,Chi-square = 57.772, P-Value = 0.000; Midhills, Chi-Square = 51.990, P-Value = 0.000). The situation is not very different in Kerabari. Table 2 shows that, in general, as the farm size increases so do the number of bamboo clumps on the farm (see also Fig 1). On average the number of bamboo clumps is greater in the Midhills than in the Terai. The number of clumps on farms in Kerabari does not vary much. The reason may be that most of the settlement is recent and the average land-holding is smaller than in the Terai and the Midhills.

Characteristics of bamboo as a farm crop, and its socioeconomic implications

Growth Habit

New shoots start to emerge from the soil mostly at the beginning of the rainy season. The new shoots emerge with full diameter and reach full height within 60-120 days. During the growing season shoot elongation continues day and night. A culm of *Phyllostachys bambusoides*, Japan's commonest bamboo, grew almost four feet in 24 hours (Chaturvedi, 1986).

Land and gestation period: Bamboo can utilise small vacant spaces like field terraces, bunds, homesteads, gullies and stream banks where crops are not generally grown. It can also be grown on marginal and degraded lands where annual crops can be grown only after a great deal of investment. It can be planted on arable lands either on field boundaries or as intercrops without completely replacing the annual crops and alternatively in blocks as woodlots. The opportunity costs may vary in each case. It is assumed that farmers with small landholdings may find it difficult to spare arable land for bamboo, despite the promise of high profits, as the return from annual production of crops will go down. Bamboo has an advantage over other fast growing tree species such as masala (*Eucalyptus camadulensis*), utis (*Alnus nepalensis*) and sissoo (*Dalbergia sissoo*) because of a shorter maturation period. In some sense, it also behaves in the manner of agricultural crops as the sustained annual production of culms is achieved without any further establishment cost for a very long period until it flowers (Chaturvedi, 1986; Das, 2002). It is generally assumed that a long rotation length also increases uncertainty about yield and market price.

Seedlings or planting stock: The non-availability of seed for propagation is one of the reasons behind less emphasis being placed on bamboo plantations in the past. The vegetative method presently in use by most farmers is not suitable for large-scale planting. However, the research carried out by the Department of Forest Research and Survey (DFRS) over the last 20 years shows that most of the valuable bamboo species can be successfully propagated from culm cuttings (Das, 1992). This is cost effective and can be the basis for large-scale bamboo planting in the future.

Table 2 Distribution of Bamboo (*Bans*) Clumps by Farm Size in the Terai, the Midhills and Kerabari

Farm Size (ha)	Terai				Midhills				Kerabari			
	Clump No. (mean)	HH No	Std. Dev.	Range (clump No.)	Clump No. (mean)	HH No.	Std. Dev.	Range (clump No.)	Clump No. (mean)	HH. No.	Std. Dev.	Range (clump No.)
No land	0.5	50	1.37	0- 8	0	4	0	0	0	0	0	0
0- 0.50	1.2	47	2.05	0- 9	2.77	53	4.14	0- 18	2.26	23	3.06	0- 12
0.5- 1.0	2.7	15	4.20	0- 15	8.21	47	12.45	0-59	2.00	8	1.93	0- 5
1.0- 1.5	5.8	16	6.52	0- 25	13.87	31	15.64	0-70	7.00	3	2.65	4- 9
1.5- 2.0	5.1	8	8.20	0- 24	12.50	26	6.75	3- 27	6.00	3	4.58	1- 10
2.0- 3.0	6.1	12	5.48	0- 21	24.83	29	33.47	2- 183	8.50	2	10.61	1- 16
3.0-5.0	7.6	8	11.79	1- 35	17.87	15	17.29	0- 70	N/A	0	N/A	N/A
5.0-10.0	9.3	17	12.70	1- 45	45.33	3	47.61	13- 100	N/A	0	N/A	N/A
> 10	37.5	6	31.04	1- 77	N/A	0	N/A	N/A	N/A	0	N/A	N/A

Key: HH= Household, N/A= Not applicable. Note: No households in the Midhills had more than 10 ha of land, similarly no households in Kerabari had more than 3 ha of land.

Tenure: Bamboo occurs in natural forests and other public lands in contrast to annual crops, which are grown only on private land. Even though bamboos are found in national forest, there are no strict legal restrictions applied by Department of Forests (DOF) to harvest bamboos. The DOF does restrict the farmers' harvesting tree species from their own fields in the interests of either conservation or to prevent illegal extraction from forestlands (Kanel, 1995; Das, 1999).

Processing: Bamboo can be used for making a variety of products. Bamboo culms and even branches can be used for house construction, fencing and for scaffolding and there is also a market for new bamboo shoots as food (Seeland, 1980; Das, 2002).

Labour: There may be a shortage of labour at the time of planting as it coincides with the planting of main agricultural crops when the demand for labour is high. However, it requires less labour to plant bamboos than trees and agricultural crops because of the plantation spacing (5mx5m-8mx8m) (Chaturvedi, 1986; Das, 1992).

Protection: Young bamboo plants require protection from cattle and goats. They will also need to be protected from humans if they are far from village huts.

Risk: Most farmers do not have any information about the propagation of bamboo from single node culm cuttings. Bamboo offsets with rhizomes for large scale planting may be difficult to obtain as bamboo clump owners are reluctant to provide them. Bamboo planting material is also not commonly produced by the DOF and private nurseries. The farmer has to locate the market and access to it. Bamboos are not resistant to waterlogging (Das, 1999).

Capital requirement and returns: There are higher costs to pay for bamboo planting material. Planting pits are bigger (45cmx45cmx45cm) for bamboos. They also need protection. The returns can be as high as Rs 210,000 ha (Das, 2002). The returns may vary depending on the end product, closeness to the market and access to the forest.

Bamboo *versus* Annual Crops: Bamboo has low establishment costs and provides sustained annual production of merchantable culms once it becomes well established. Unlike annual crops, it can be planted and sold in small lots and therefore the technology is a divisible one. Unlike many agricultural crops, for which irrigation is essential and fertilisers desirable, bamboo does not require any complementary investment or inputs. On the negative side as an innovation it requires access to seedlings or planting materials and market behaviour is not well known on national level (Das, 1999).

Problems and constraints of bamboo plantations

- Due to the long flowering cycle in bamboos, getting viable seed is difficult and has hindered large-scale planting in Nepal The traditional method of vegetative propagation is difficult to apply due to high costs and the unwillingness of owners of bamboo clumps to give or sell rhizomes as the production of new shoots is reduced in following years. Not all useful species have been successfully propagated from culm cuttings and it is not possible where water availability is limited (Stapleton,1985; Liese,1986; Das, 1992).
- As flowering in bamboos is rare, they are difficult to identify taxonomically. It causes a problem in development of proper planning and management of bamboos. If gregarious flowering occurs, then all clumps of a particular species having the same genetic base (even the newly established monoculture plantations of a bamboo species from the vegetative method) will die, irrespective of their age classes. This causes a serious problem and is considered an economic calamity, as the culms are no longer available for use. This underlines the fact that monoculture plantations of a particular bamboo species will involve risk of a serious setback (Liese, 1986).
- Bamboos prefer well-drained sandy loam to loamy-clayey soils. The optimal soil acidity lies between 5 and 6.5 (Liese,1986).
- As bamboo roots form a mat-like structure in the ground, it inhibits the growth of other plants and is therefore not suitable for intercropping.
- Congestion is a common problem in bamboo clumps, which occurs mainly due to poor management, exposure to full sunlight and irregular cutting of bamboos. Bamboo species which are thorny require regular thinning and pruning operations which are costly and time consuming manual operations (Chaturvedi,1986; Banik, 1988).
- The felling of culms is done manually and is a highly labour-intensive operation. This is because the clump forming bamboo species have culms

of different age classes and only the mature culms should be harvested (Liese,1986).

- Most forms of bamboo utilisation are exposed to attacks by microorganisms and insects. Bamboo has a low natural resistance compared with wood. The culms are susceptible to attack especially by insects (beetles, termites) and fungi (brown rot, white rot, soft rot). Untreated bamboo has an average life of less than 1-3 years when they are in contact with soil or exposed to the atmosphere (Liese,1986).

Conclusions

Bamboos are important component of rural farming system, as they play critical role in rural economy and help sustain livelihoods of many rural households that include socially and economically disadvantaged groups. Bamboos are one of the important renewable natural products that can help reduce poverty if its adoption is increased on private farmlands. The increased adoption also has other advantages such as reduced pressure on national forests and the reduced dependency of the rural farmers to meet the household needs such as timber, fodder and fuelwood. There are many positive aspects of bamboo, which underscores their some limitations mentioned above.

Analysts can always paint a rosy picture to advocate bamboo farming by suppressing some production cost items which are difficult to standardise e.g. site preparation and maintenance cost and inflating the market price of bamboo products. The widely fluctuating market price of bamboo creates a very broad range by which any sale value can always be justified. The selling price of a bamboo culm varies from Rs5 to Rs200 ($ 0.08 to 1.5) in Nepal, depending upon the location and market infrastructure in the locality (Das, 2002b). Although bamboo farming is not a new idea, it can be a powerful tool for the government to foster rural development and poverty reduction. Bamboo farming favours the development of small landholdings and the use of intensive labour suited to the Nepalese quest of eliminating poverty by improving the means of livelihood of the rural poor. Government support for the intensive development of small bamboo farms owned by small farmers and the rural poor can be a strategic move in upgrading the quality of life of rural people.

The arguments in favour of promoting bamboo planting are listed below:

- A multipurpose species, which provides building materials, food, fodder, and fuelwood.
- Provides raw materials for cottage industries, which use bamboo as raw materials for making furniture, handicrafts and woven products and thus can generate full/part time employment (Das, 2002 a).
- Bamboo shoots are largely consumed in the country and are very popular as a source of nutrition so there is potential to grow them as a commercial crop for local consumption as well as export. Thus, it can be a source of foreign exchange.
- They are highly productive even on those sites where other fast-growing tree species cannot be grown.
- Once bamboo clumps are well established (5-8 years), sustained annual production can be achieved without any further intervention for a long period of time till they flower gregariously.
- Bamboos are one of the best species for soil conservation due to their massive rhizome structure.
- They can be grown in various climatic, physiographic and edaphic zones of Nepal.
- Fast growth rate of bamboo makes it an ideal species for fulfilling the increasing demand for material for house construction and a potential species for industrial plantations, both for construction and as raw materials for making hardboards and plybamboo. The pulp and paper industry in Nepal may also use bamboo in future.
- Demand for bamboo products is increasing worldwide, and can be a driving force behind the increased coverage of bamboos in rural farming systems of Nepal.

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