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Assessing the Status, Utilization and Market value chain of Bamboo Species

(Case study from chure area of Arghakhanchi District, Nepal)

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Abstract:

Important group of non-timber forest products (NTFPs) gifted by nature to mankindwhich is also known as the "poor man's timber" or "green gold of the forest, called bamboo which are also important renewable resources which can bring people above the poverty line if grown and managed on sustainable basis. Bamboo plays an important role in the socio-economic development of the rural people, especially for the poor people. The key objective of this study was to assess the status of bamboo, its utilization and market value in the study area from which production and market value as well as to minimize the gap between the farmers and market price are identified.

Biophysical data, Key informant survey, Focus group discussion and Household survey were taken for the primary data collection, which were more precisedby information from secondary sources. Qualitative and quantitative data collected were analyzed after feeding them into computer software package like MS Excel, ARC GIS 10.5,and SPSS 20. Data analysis was carried out using various statistical tools like mean, frequency and standard deviation analysis. Some figures were also represented in different diagrammaticpatterns.

The present study reveals that, 5 bamboo species are found in study area, which supports in products like doko, nanglo, chalno, dalo, bhakari, racks, dustbins, photo frames, flower vase and decorative items made from Tama bans (*Bambusanepalensis**)*** is high as compared to other species. Similar utilization of *B. nepalensis* has been reported from the Mid-hills and the Terai of eastern Nepal and in central and western Nepal.*Bambusanepalensis*has the highest diameter, height and basal area. Similarly, diameter, height and basal area growt,h performance of this species is very good. Though *Phyllostachys nigra* has lowest diameter, height and basal area, growth performance of *Phyllostachys nigra* is good.
Infrastructure development, Marketing system, introduction of modern tools and technology, Skill development program knowledge of people was found to beimproved.

Key words: *NTFPs, Marketing system, utilization, modern tools and technology*

INTRODUCTION

Bamboo is a group of plants that belong taxonomically to the subfamily of Bambusoideae under the family of Gramineae. Under 87 genera of bamboo, approximately there are 1500 species of bamboo worldwide (Ohrnberger 1999; Li and Kobayashi 2004). China is recognized as the richest bamboo resources in the world in terms of number of species, area and reserve of bamboo as it has over 500 species of bamboo in 39 genera. China has long been known as the "Kingdom of Bamboo"(Ben-Zhi et al., 2005). Bamboo forest is an important forest type in tropical and sub- tropical areas, with a total area of 22 million hectares at present (Zhou 1999; Lei 2001; Liu 2001). Although total area of forest have drastically decreased in many countries, bamboo forest area has progressively increased(Ben-Zhi et al., 2005). Bamboo is known as one of the fastest growing plants in the world, as its growth rate ranges from 30 to 100 cm per day in growing season. It can grow to a height of 36 m with a diameter of 1-30 cm (United Nations 1972). According to C. M. A. Stapleton (1990) bamboos play an important role in many Asian ecosystems, both naural and man-made, especially in montane areas such as the Himalayas. Bamboos are of great importance in forest as well as rural areas. In forest areas they provide useful products as well as valuable wildlife habitats and annual harvesting without large machinery minimize environmental disturbance. Bamboos cultivated in rural areas supports subsistence agriculture through the provision of animal fodder and manure, fencing and tools which reduces pressure on forest and grazing areas. In steep or eroding areas, pachymorphs rhizomes stabilize the soil and reduces soil erosion.

C. Stapleton(1994)reported that bamboos are widely distributed throughout Nepal, but they are more common in the eastern half of the country, from Dhaulagiri to the Sikkim border. Varities of genera and species of bamboo as well as large number of bamboo clumps can be grown in higher rainfall areas such as Pokhara and Illam.Temperate and sub- alpine genera which are more common in Tibet and Bhutan can be found at altitudes of up to 4,000m in eastern Nepal. Tropical species from Malaysia and Burma extend into the Nepalese terai. Bamboos are found in private land, common land, natural forest, and riverbank as well as in roadside areas. Marginalized people are full of skills to weave varities of bamboo products which are necessary for subsistence farming system but don't have sufficient land to cultivate agricultural crops and also don't have their own bamboo clump. Varities of bamboo have varities of uses as they have different capacity in flexibility and durability.They are found in the natural forest in association with other species, but they are very much planted around villages and on private land (Shrestha, 1998). Bamboo is also widely spread outside forests, including farmlands, riverbanks, roadsides and urban areas. Bamboo is one of the fastest-growing plants on earth, gaining approximately 121 cm in 24 hrs (Ueda, 1974). It has ability to grow on marginal and waste lands, rapid growth habit, low cost extraction, low-cost processing, multi-functionality-make them important for subsistence and income needs of rural communities, especially those with few alternative resources or employment opportunities. It is quickly changing its image from the 'poor man's tree' to a high-tech, industrial raw material and substitute for wood.

Bamboo is an important group of non-timber forest products (NTFPs) gifted by nature to mankind (Handique et al., 2010). It is also known as the "poor man's timber" or "green gold of the forest" (Kanglin et al., 2000).Bamboo is one of the important renewable natural resources and backbone of Nepal's rural culture.In Nepal, bamboos are found in almost all its parts–natural or cultivated with twelve genera and more than fifty-three species (Stapleton, 1994; Karki et al., 1995; Das, 1999; Joshi and Amatya 1999; Das, 2004). Mainly the bamboo species found in Nepal are *Dendrocalamusstrictus, Bambusa nutans, B. Balcooa, B. tulda, B. nutans, Dendrocalamusgiganteus, D. hamiltonii and D. hookeri*. The natural range of bamboo species extends from Terai (flat plains) to the high mountains (50-4000m) (Jackson, 1987; Das, 1988; Stapleton, 1994). Bamboos are abundant in Eastern, Central and Western parts of Nepal. Far western regions are yet to be explored.

Varities of bamboo have varities of use based on their durability and flexibility. Culms can be used entire, split into sections, crushed into panels, or split and then woven.(Jackson, n.d.)Reported that the culms of Bambusa and Dendrocalamus species are used entire for strong rafters, pillars and fence posts. After splitting they are used for roof lattices, floors, ceilings and walls. Some Dendrocalamus species (especially *D. hamiltonii*) are used for weaving. Bambusa species and other Dendrocalamus species are

less flexible and so not as good for this purpose. Culms of Drepanostachyum and Arundinaria species are more important for weaving as the outer layers produce more flexible and durable material than can be obtained from Dendrocalamus or Bambusa species. Woven products include baskets, mats and trays used for collecting, sorting, transporting and storing agricultural products.Bamboos are important renewable resourceswhich can bring people above the poverty line if grown and managed on sustainable basis (Das, 2002; Poudyal and Das, 2002). There is a great demand of bamboo in rural area for construction materials. Bamboo craft makers, rural as well as urban enterprises are equally demanding bamboo for manufacturing various bamboo articles. Bamboo craft makers prepares bamboo articles in assistance with simple basic tools. Bamboo based entreprises helps in upliftment of socio-economic status of poor and under privileged in Nepal. It is estimated that about 3.3 million farming families are somehow involved with bamboo sub-sector either as producers or as users of bamboo- based products (Pant, 2006). Development and encouragement of cottage industries based on bamboo contributes to the upliftment of household economy of poor people. Further, it contributes to the national and regional economy (Poudyal, 1992; Karki et al., 1995; Sherchan et al., 1996). But due to limited government support, lack of policy, disorganized market and limited skills, bamboo based economy contributes only 1-2% to the national economy (Karki et al., 1998).

Bamboo is of great importance to people of both the Terai and hills. Farmers make practically everything they need from bamboo, except the ploughshare. Because of its fast growth, versatility, light weight, strength and straightness they are used for a wide variety of purposes. In the hills, bamboos are grown in the gullies and on the edge of terraces. 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. The tree species are mainly grown for fodder and fuelwood. The houses in the hills may last 60-80 years but require major maintenance every 25-30 years. However, bamboo is being used more frequently for minor repairs.

MATERIALS AND METHOD

Study area/Site description

The study was carried out in 3 wards (Powera, Rikot, Mandre) of Sitganga Municipality of Arghakhanchi district.

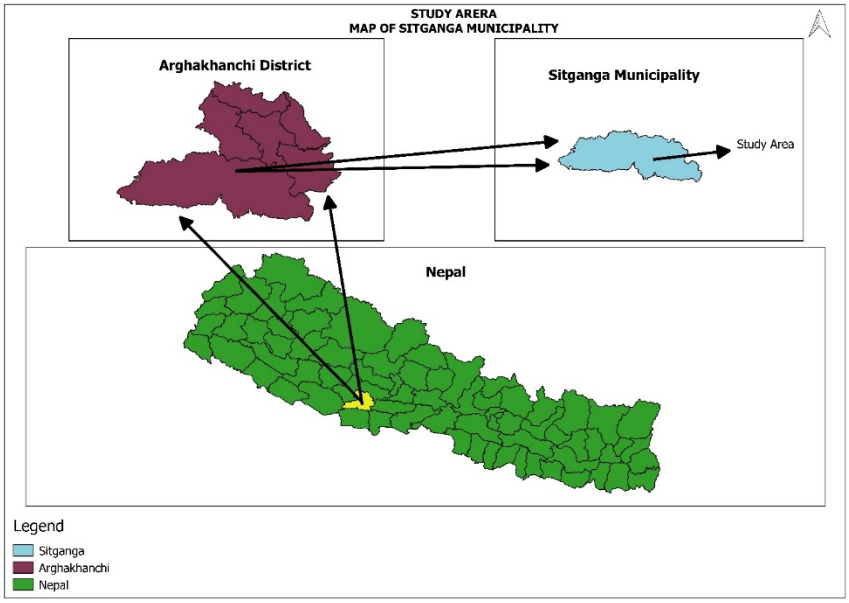


Figure 1: Map of study area

District information

The study area is located in province no. 5 of Arghakhanchi district. This district is located in the middle physiographical zone of Nepal. Its headquarter lies on Sandhikharka and it is surrounded by Palpain the east, Gulmi in the north, Kapilbastu in the south and Pyuthan in the east. Out of the total area, 40% of the area is forested. The GPS coordinates for Arghakhanchi are 28000'1.80‘‘N latitude and 83014'28.80‘‘E longitude. Sitganga municipality the major forest area in Arghakhanchi district. Other land use type are agricultural and cultivated land, rivers and streams, bush/shrub, rock cliff, barrenland, pond, builtuparea,etc.(Table 1)

Table 1: Land use statusof Sitganga Municipality

Land use	Area (ha)
Forest	47594.4
Cultivation	10900.5
Bush/shrub	1349.0
River/Sand	1167.9
Rock cliff	179.2
Barren land	111.7
Grassland	20.2
Pond	3.0

Source: DFO Arghakhanchi 2074/07

Arghakhanchi district lies between 305m to 2515 m above mean sea level. The district can be broadly divided into two physiographic regions i.e. 68%Mahabharat hills and 32%Churia hills. Because of the topological structure, the Churia hills made mostly of soft lime stones and the Mahabharat region made of Phyllite, Schist, Quartzite, limestone etc. Climatic variation in the district ranges from tropical to temperate. Tropical and subtropical climate exists in the southern part of the district whereas the temperate predominates the northern part. The district can be divided into three seasons: Hot, rainy and cold season. Hot season exists between March to June with the temperature up to 40°C. This season is the

fire occurring season. Monsoon i.e. rainy season starts from July to September. The average rainfall in the district is 2,200 mm. Cold season exists between December to February with the temperature decreases up to 6.5°C. According to the census 2068, the total population of Arghakhanchi district is 1,97,632 which includes 86,266 male and 1,11,366 female. Annual population growth rate of the district is 0.53%. Total family number in the district is 46,835 with 4.22 members per family. Average population density of the district is 166 people per square km. Total population of Sitganga municipality is 43373.

Forest resources

Forest covers 62.05% of the total land area of the district. Majority of the forest area is dominated by Sal (*Shorearobusta*) forest. Saj (*Terminalia elliptica*), Bajh (*Quercusleucotrichophora*), Katush (*Castanopsistribuliodes*), Rhododendron (*Rhododendron ferrugineum*), Uttis (*Alnusnepalensis*), Chuire (*Aesandrabutyracea*), Koiralo (*Bauhinia variegata*), etc.are also available in district.(Table2)

Table 2: Status of forest according to local units inSitganga municipality(Source:DFO 2074/075)

Vegetation type	Sitganga
Chir pine forest	4469
Chir pine broad leaved forest	
Hillsal forest	35721
Lower temperate oak forest	156
Lower tropical sal and mixed broad leave	3435
Schimacastanopsis forest	3813
Total forest in local level	47594
% of forest cover (compare to district forest)	64.29
% of forest cover (compare to local level)	78.20

Data Collection

For the data collection both Primary and Secondary data collection methods were used.

a) Primary Data collection

1. **Biophysical data**:

Altogether, 45 bamboo clumps were selected randomly and the height of bamboo culm and its diameter was measured and recorded. Culm diameter was measured at two sides (north-south and east-west) perpendicular to each other. Number of culms in clump, number of culms by age (young: <1 year, middle aged: 1-3 years and mature: >3 years) culms were counted from a plot (1 m × 1 m) laid out at the central part of each clump. Number of new shoots (emerged in 2019 rainy season), dry culms and culms cut were recorded. GPS point at each clump measure was taken to prepare map. Some ground information including the soil and existing vegetation in and around the measured clump was taken. Species of bamboo (local and scientific names) clump was measured and the owner of the bamboo clump was also noted.

2. Socio-economic data:

Key Informant Interview: Key informant interview was carried out with people who have more knowledge about this topic such as DFO Office, skilled persons who prepares articles, middle man or traders, business entrepreneurs, personnel from cottage and small scale industries office and farmers. Questionnaire was done with the key informants to get information about status, production and utilization of bamboo, farmers and market price, demand and supply situation of raw materials and bamboo products.

Focus Group Discussion: Out of 14 wards of Sitganga municipality, focus group discussion was carried out in 3 wards. Three wards were selected after the discussion with sub-divisional officer, locally elected representative, and local knowledgeable people to knowhigh, medium and low bamboo stocking ward.In each ward twofocus group discussion was carried out with selected forest user group members such as women, poor and indigenous people who were engaged in bamboo plantation activities. Thebamboo dependent farmers were also the focus group, so discussion with the key farmers (at least 10 farmers in each ward) was done. Checklist of questionnaire for the selected CFUGs and bamboo

dependent farmer's communities was also prepared and questionnaire was done related to the objectives and problems cited above.

Household Survey: Household survey was organized in 3 selected Wards havinghigh, medium and low density after focus group discussion.Household was selected purposively based on the availability of bamboo.Questionnaire survey was done to know the status of bamboo and bamboo articles prepared in bamboo industriesas per the attached questionnaire.

Firstofalldraftquestionnaire(Annex1)wasprepared,andpre-testingofquestionnairewas donewithlocalpeople.Finalquestionnairewasthenmodifiedincludingtheresponsesfrom pre-testing. Household for survey was selected using random sampling method. The formula proposed by Cochran, 1977 was used to determine the sample size.

$$\mathbf{n} = \frac{Nz^2p(1-P)}{Nd^2+z^2p(1-P)}$$

Where,

n = sample size
N = total number of households
Z = confidence level (at 95% level Z = 1.96)
p = estimated population proportion (0.5, this maximizes the sample size)
d = error limit of 5% (0.05)

N	**1818**	population size
P	**15%**	expected incidence (sample size as % of population size)
D	**0.05**	required level of precision (accuracy)
Z	**1.96**	c = 1.96 for 95% confidence, or 1.645 for 90% confidence

formula result = 176.86

therefore n= **177**

Out of the total 1818 households, (632 in Mandre, 734 in Powera, 452 in Rikot 452), 177 households were selected as sample units. Sample unit was designed according to the formula proposed by Cochran, 1977, with involvement of all household ranking of people. Based on sample unit 59 household were selected in each ward. After knowing the key person related to objective, Snow ball sampling sampling method was designed to select the household. Detailed face-to-face questionnaire survey was conducted. This survey was carried out visiting selected households to acquire relatively detailed information on the demographic representation of users, socio-economic status of users, involvement as well as interest of householdsonbamboo production ,impactcontributionrelatedinenhancingthecultivation fortheir livelihood improvement instudy area.

snowball sampling or **chain sampling**, **chain-referral sampling**, **referral sampling**

It is a **nonprobability sampling** technique where existing study subjects recruit future subjects from among their acquaintances. Thus the sample group is said to grow like a rolling snowball. As the sample builds up, enough data are gathered to be useful for research. This sampling technique is often used in hidden populations, such as drug users or sex workers, which are difficult for researchers to access. As sample members are not selected from a sampling frame, snowball samples are subject to numerous biases.

Tools used in measurement

Instruments	Use
GPS	To record the coordinates of the study sites
Diameter tape	To measure the diameter of bamboo
Clinometer	To measure the height of bamboo

b) Secondary data collection

Bamboo related published and unpublished documents, literature and journals were used for secondary data collection. Others necessary data were collected by reviewing documents related to the objectives such as research papers, case studies, journals, published and unpublished reports and articles from different libraries. Research publications on bamboo was studied and reviewed from the library of different academic and non-academic organizations like INBAR, ABARI, Ministry of Forests and Environment, etc. Furthermore, website was also used to get the essential information about bamboo.

Data analysis

Statistical data were entered and analyzed using SPSS. Flow chart, pie chart and bar diagram were prepared using Microsoft Excel 2010. Arcmap 10.5 was used to prepare map of study area and to show different bamboo locations. This all were used for completing of the study. They were used for different applications and purpose as summarized in the Table.

Table3: Software and tools used in the study

S.N.	Software's Name	Specific application
1.	Arc GIS 10.5	Geospatial analysis
2.	MS Word	Thesis Writing
3.	Microsoft excel 2010, SPSS	Flow chart, Bar diagram, Pie-chart, Statistical analysis

RESULT AND DISCUSSION

Result and Discussion

Characteristics of respondents and Ethnic composition

The characteristics of respondents were categorized based on ethnic composition, age composition, literacy and occupation status of the respondents of Sitganga Municipality which has been presented below:Brahmin is the most dominant ethnic group of Sitganga Municipality followed by Chhetri and Magar in the second and third position as shown in figure below:

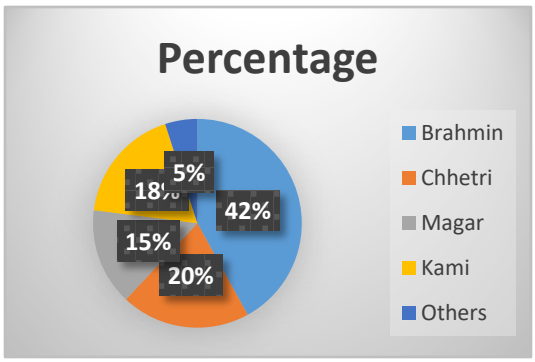


Figure 2: Ethnicity of Sitganga Municipality

Age composition of the respondents and literacy rate

Respondents of different ages were involved in study for more realistic information. Maximum number of respondents were from age groups of 20-35 years (42%) followed by age group of 51-65 (31%), age group of 36-50 years(20%) and age group of 66-80 years (7%).Education level of respondents were categorized into four groups that were illiterate, primary education (class 1-7), secondary education (class 8-10) and higher education (above SLC). Education status of respondents are shown in figure below.

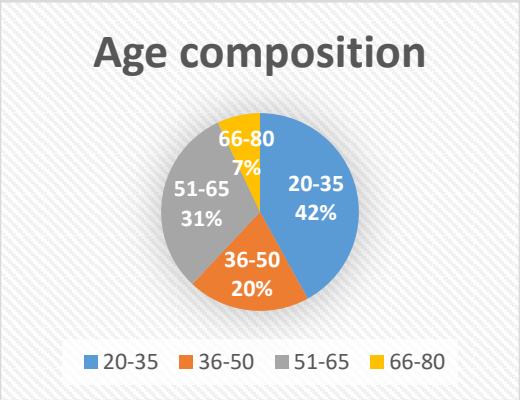


Figure 3: Age composition of respondent

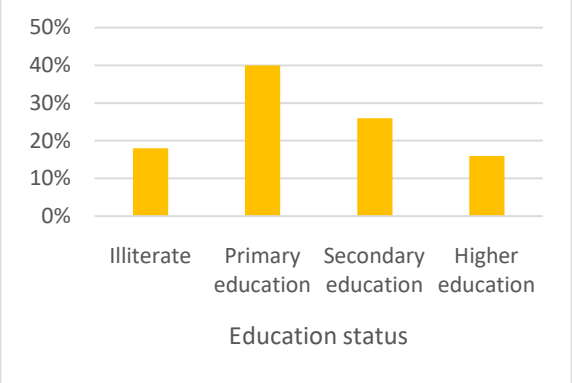


Figure 4: Literacy rate of respondents

Occupation status

Most of the respondents were involved in agriculture (55%) followed by agri-business (20%), services (10%) and others (15%).

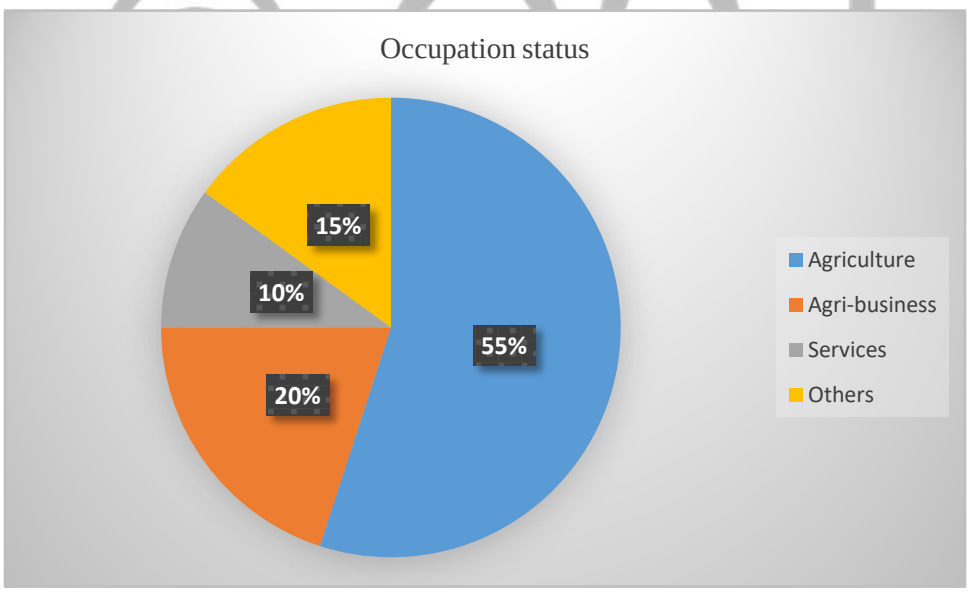


Figure 5: Occupation status of respondents

Status of available bamboo species in study area

Availability of bamboo species in high in Mandre (Ward 1) followed by Powera (Ward 14) and Rikot (Ward 13). Among 5 bamboo species found in study area, Tama bans (*Bambusanepalensis*) was found in highest number followed by Dhanu bans (*Bambusabalcooa*), Taru bans (*Bambusa nutans*), Lyas bans (*Dendrocalamuspatellaris*) and Nigalo (*Phyllostachys nigra*)as shown in figure 6.

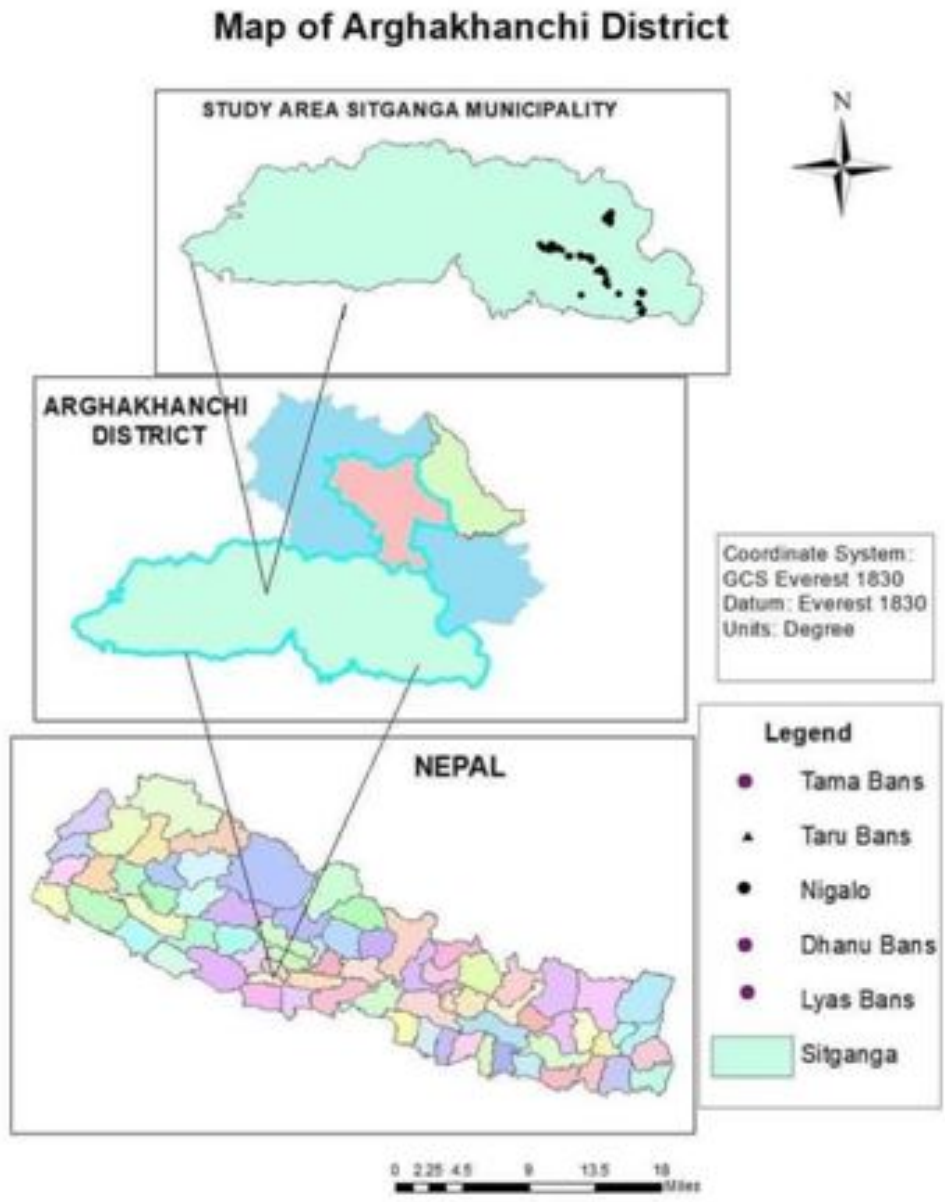


Figure 6: Map of study area with available bamboo species

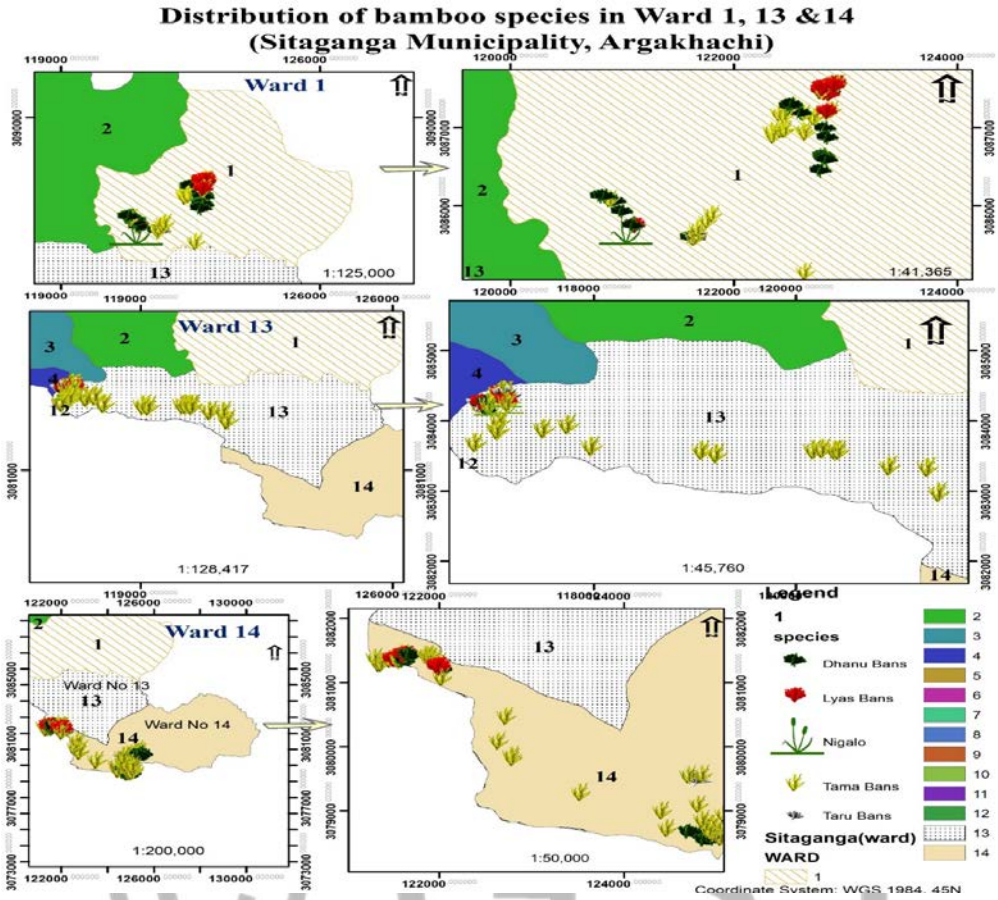


Table 4: Bamboo species found in study area

Local Name	*Scientific name*	Importance
Dhanu Bans	*Bambusabalcooa*	Pachymorph rhizomes are suitable for soil conservation. Leaves are used as fodder. Good for posts or scaffolding.
Taru Bans	*Bambusa nutans*	Pachymorph rhizomes are good for soil conservation. Leaves are used as fodder.
Tama Bans	*Bambusanepalensis*	Young shoots are edible, leaves are used as fodder.Good for posts or scaffolding. Pachymorphs rhizomes are suitable for soil stabilization. Good for weaving
Lyas Bans	*Dendrocalamuspatellaris*	Use forWeaving, Leaves are used as fodder.
Nigalo	*Phyllostachys nigra*	Young shoots are edible. Leaves are used as fodder. Roots are suitable for soil stabilization.

Table5: Presence and absence of bamboo in ward

Spp	Ward no 1 (Mandre)	Ward no 14 (Powera)	Ward no 13 (Rikot)
Bambusanepalensis	Presence	Presence	Presence
Bambusabalcooa	Presence	Presence	Presence
Bambusa nutans	Presence	Presence	Presence
Dendrocalamuspatellaris	Presence	Presence	Presence
Phyllostachys nigra	Presence	Absence	Presence

Diameter distribution of bamboo species

The study showed that, diameter of *Bambusanepalensis* was highest followed by*Bambusabalcooa*, Bambusa nutans and *D. patellaris. Phyllostachys nigra* has the lowest diameter among 5 species. Diameter of *Dendrocalamusnepalensis* varied from 7 to 8.1cm and *Bambusa nutans* from 6.15to7.26cm. Similarly, minimum diameter of *Bambusabalcooa* was 6.12cm and its maximum diameter of 7.62cm was recorded. *Dendrocalamuspatellaris* has minimum diameter of 4.13cm and maximum diameter of 4.48cm.*Phyllostachys nigra* has the minimum diameter of 2.48cm and maximum diameter of 2.53cm as shown in table 6.

Table6: Statistics of diameter distribution of bamboo

Species	**Mean ±SE**	**SD**	**Minimum diameter(cm)**	**Maximum diameter(cm)**
Tama bans (*Bambusanepalensis)*	7.39±0.03	0.27	7	8.01
Dhanubans(*Bambusabalcooa)*	6.81 ±0.07	0.45	6.12	7.62
Taru bans (*Bambusa nutans)*	6.42±0.12	0.40	6.15	7.26
Lyas bans (*Dendrocalamuspatellaris)*	4.33±0.03	0.18	4.13	4.83
Nigalo (*Phyllostachys nigra)*	2.92±0..009	0.024	2.48	2.53

Height distribution of bamboo species

Height distribution of bamboo varies from species to species. Minimum height varied from 20.1m for *Bambusanepalensis*, 20m for *Bambusabalcooa* and 16.91m for*B. nutans*. Similarly for *Dendrocalamuspatellaris* and *Phyllostachys nigra* minimum height variation was 4.18m and 3.18m respectively. Study showed that maximum height of *Bambusaneplensis, B.balcooa*, and *B. Nutans* was 23.6m, 22m and 17.36m respectively. Maximum height of 5.96m and 3.21m of *Dendrocalamuspatellaris* and *Phyllostachys nigra* was recorded which is shown in table 7.

Table7: Statistics of height distribution of bamboo

Species	**Mean ±SE**	**SD**	**Minimum Height(m)**	**Maximum Height(m)**
Tamabans(*Bambusanepalensis)*	22.03±0.10	0.84	20.1	23.6
Dhanubans(*Bambusabalcooa)*	21.13±0.10	0.63	20	22
Tarubans(*Bambusa nutans)*	17.18±0.05	0.17	16.91	17.36
Lyasbans(*Dendrocalamuspatellaris)*	5.04±0.10	0.56	4.18	5.96
Nigalo(*Phyllostachys nigra)*	3.72±0.005	0.014	3.18	3.21

Basal area of Bamboo species

Study showed that *Bambusanepalensis* has the highest basal area followed by *Bambusabalcooa,Bambusa nutans* and *Dendrocalamuspatellaris. Phyllostachys nigra*has the lowest basal area among the 5 species as it has lowest diameter and height. Maximum basal area of *D. nepalensis, B. balcooa, B. nutans, D. patellaris*and *P. nigra* was 201.46cm², 182.32cm², 165.76cm², 73.25cm² and 20.09cm² respectively. Similarly, minimum basal area of *B. nepalensis, B. balcooa, B. nutans, D. patellaris* and *D. nigra*was 153.86cm², 117.60cm², 118.76cm², 53.55cm² and 19.31cm² respectively.

Table8: Statistics of Basal area of bamboo

Species	Mean ±SE	SD	Minimum BA(cm²)	Maximum BA(cm²)
Tamabans(*Bambusanepalensis)*	172.01±1.57	13.00	153.86	201.46
Dhanubans(*Bambusabalcooa)*	146.32±3.21	19.55	117.60	182.32
Tarubans(*Bambusa nutans)*	129.93±5.14	17.07	118.76	165.76
Lyasbans*(Dendrocalamuspatellaris)*	58.99±1.00	5.20	53.55	73.25
Nigalo(*Phyllostachys nigra*)	23.055±0.14	0.38	19.31	20.09

Average age of bamboo species

*Bambusanepalensis*and *Phyllostachys nigra*with minimum age of 1 year was found in the study area. Similarly, *bambusabalcooa* and *D. Patellaris*with minimum age of 2 year was found. *Bambusa nutans* was found with minimum age of 10 years. Study showed that maximum age of *B. nepalensis, B. balcooa, B. nutans,* and *D. patellaris* was 21, 22, 16 and 10 years respectively. P. nigra was found with maximum age of 2 years only this is because P. nigra was completely disappeared after massive earthquake in 2072. New culm of this species started to appear from last 2 years.

Table9: Statistics of average age of bamboo species

Species	Mean ±SE	SD	Minimum age(years)	Maximum age(years)
Tamabans(*Bambusanepalensis*)	10.07±0.52	4.34	1	21
Dhanubans(*Bambusabalcooa)*	10.25±1.02	6.23	2	22
Tarubans(*Bambusa nutans)*	13.36±0.74	2.45	10	16
Lyasbans(*Dendrocalamuspatellaris)*	19.70±0.39	2.38	2	10
Nigalo(*Phyllostachys nigra*)	1.66±0.18	0.49	1	2

Diameter and Height growth of bamboo species

The diameter growth of *Bambusanepalensis* was highest followed*Bambusabalcooa,Phllyostachysnigra*and *D. patellaris*. In comparison to other species, diameter growth performance of *Bambusa nutans* was poor though it has higher diameter. The present result indicates that site condition for *Bambusa nutans* is not good and it should not be planted without site improvement. Diameter growth of *B. nepalensis, B. balcooa, B. nutans, D. patellaris* and *P. nigra* ranges from0.33-7.22cm, 0.32-3.58cm, 0.38-0.63cm, 0.41-2.41cm and 1.24-2.53cm respectively .Study showed that,height growth of *Bambusanepalensis* was highest followed by *B. balcooa, P.nigra* and *D. patellaris*. Maximum height growth of *bambusa nutans* was poor as compared to other species. The result indicates that site condition of *B. nutans* was not good.Minimum height growth of *B. nepalensis, B. balcooa, B.nutans, D. Patellaris* and *P. nigra* was 1.014m, 0.92m, 1.075m, 0.41m and 1.60m respectively. Maximum height growth of *B. nepalensis, D. balcooa, P. nigra, D. patellaris* and *B. nutans* was 20.1m, 11m, 3.18m,2.60m and 1.73m respectively.

Basal area growth of bamboo species

Study showed that basal area growth of *B. nepalensis* was highest followed by *B. balcooa, P. nigra* and *D. patellaris*. Maximum Basal area growth of *B. nutans* was only 1.27cm² as it has very low diameter. It was found that basal area growth of *B. nepalensis, B. balcooa, B. nutans,D. patellaris* and *P. nigra*ranges from 0.34-163.68cm², 0.33-40-24cm², 0.46-1.27cm², 0.55-18.31cm² and 4.82-20.09cm² respectively.

Table 10: Statistics of basal area growth of bamboo

Species	Mean ±SE	SD	Minimum BA Growth (cm²)	Maximum BA Growth (cm²)
Tamabans(*Bambusanepalensis)*	23.56 ±2.6	22.23	0.34	163.68
Dhanubans(*Bambusabalcooa)*	24.90 ±3.58	21.82	0.33	40.24
Tarubans(*Bambusa nutans)*	10.18±0.82	2.72	0.46	1.27
Lyasbans(*Dendrocalamuspatellaris)*	13.09±1.70	8.86	0.55	18.31
Nigalo(*Phyllostachys nigra*)	14.87 ±36.44	8.86	4.82	20.09

Utilization of bamboo

Bamboos are commonly used in western part of Nepal for preparing bamboo products like Doko (Basket for carrying loads), Nanglo (flat and rounded plate), Chalno (Sieve), Dalo (Basket for storage purpose),Bhakari (grain storage) racks, dustbins, photo frames, flower vase. Besides crafts making they are used for scaffolding, weaving into panel for making house, wall, tying roof, fencing, soil conservation and road stabilization. Many of the bamboo species produces edible shoots which are very popular as food and pickle. Farmers use bamboo leaves as important source of fodder.

Bamboo species preferred among the respondents

After HHs survey it was found that, use of bamboo products like doko, nanglo, chalno, dalo, bhakari, racks, dustbins, photo frames, flower vase and decorative items made from Tama bans (*Bambusanepalensis)* was high as compared to other species. Similar utilization of *B. nepalensis* has been reported from the Mid-hills and the Terai of eastern Nepal and in central and western Nepal by Das (1999, 2004) and Poudyal (2006) as cited in (Bajracharya et al., 2013).Though *Bambusabalcooa, Bambusa nutans*can be used for soil conservation, scaffolding and weaving into panel for making house wall, use of *Bambusanepalensis* is high as it is dominant species of study area. (C. Stapleton, 1994) reported that poles of *Bambusa nutans* are used for carrying corpses to the funeral pyre.

Supply chain of bamboo

A supply chain is a network between a company and its suppliers to produce and distribute a specific product to the final buyer. This network includes different activities, people, entities, information, and resources. The supply chain also represents the steps it takes to get the product or service from its original state to the customer. A supply chain involves a series of steps involved to get a product or service to the customer. The steps include moving and transforming raw materials into finished products, transporting those products, and distributing them to the end-user. The entities involved in the supply chain include producers, vendors, warehouses, transportation companies, distribution centers, and retailers. Supply chain management is a very important part of the business process. There are many different links in this chain that require skill and expertise. When supply chain management is effective, it can lower a company's overall costs and boost profitability. If one link breaks down, it can affect the rest of the chain and can be costly which is highlighted through the chart given below.

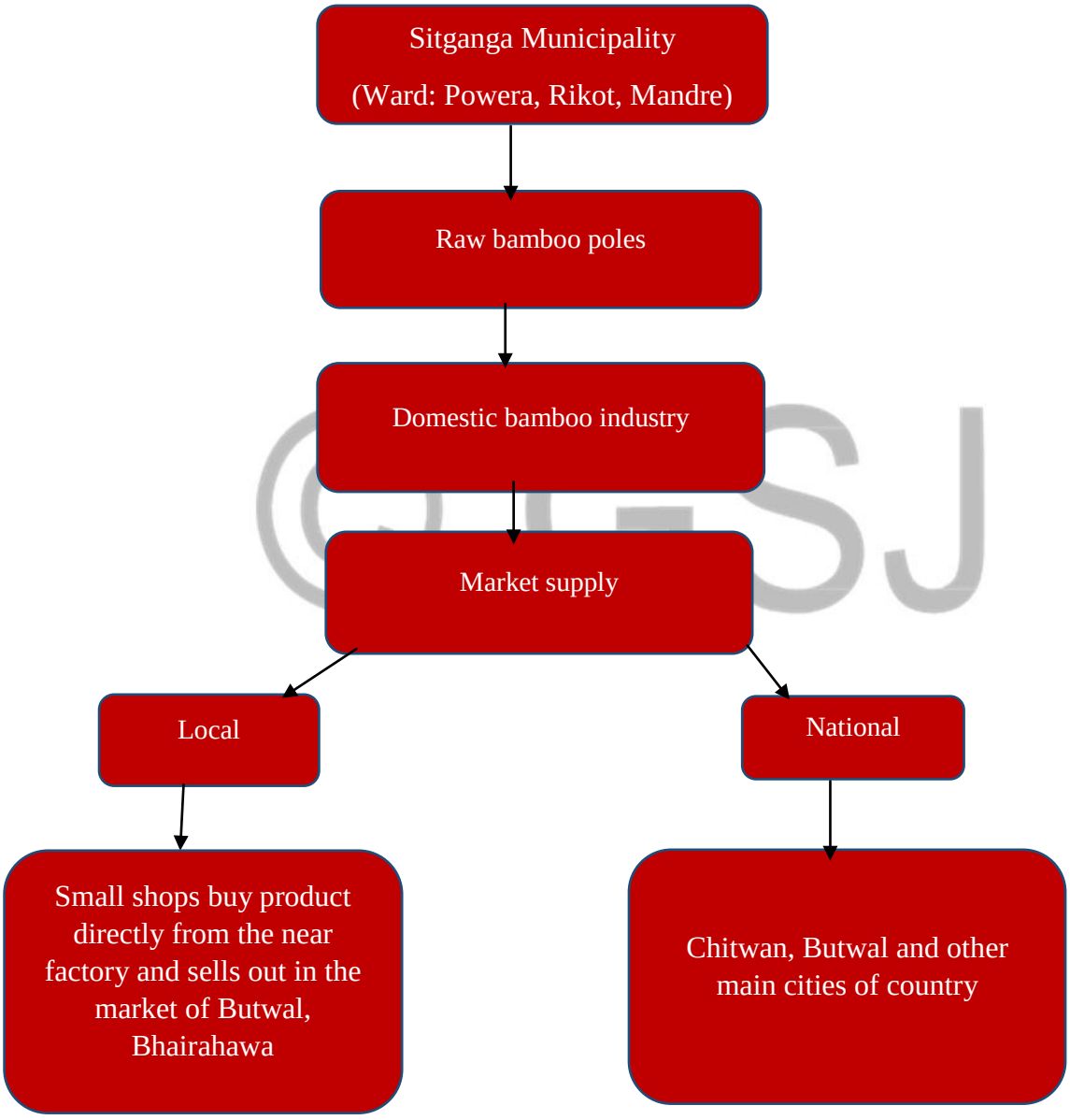


Figure 7: Supply chain of bamboo

Value chain map of bamboo

The value chain map is presented below. The linkages are shown vertically from bottom to top. The left hand block lists the major function of the chain, which includes production, collection, trading, processing, trading, and retailing. During mapping, actors involved in this sector are listed and mapped according to their respective functions. Then the institutions supporting this sector directly or indirectly are listed as enablers. The value chain map provides a graphic representation of bamboo product as it moves from production to consumers, passing through different stages and processes.

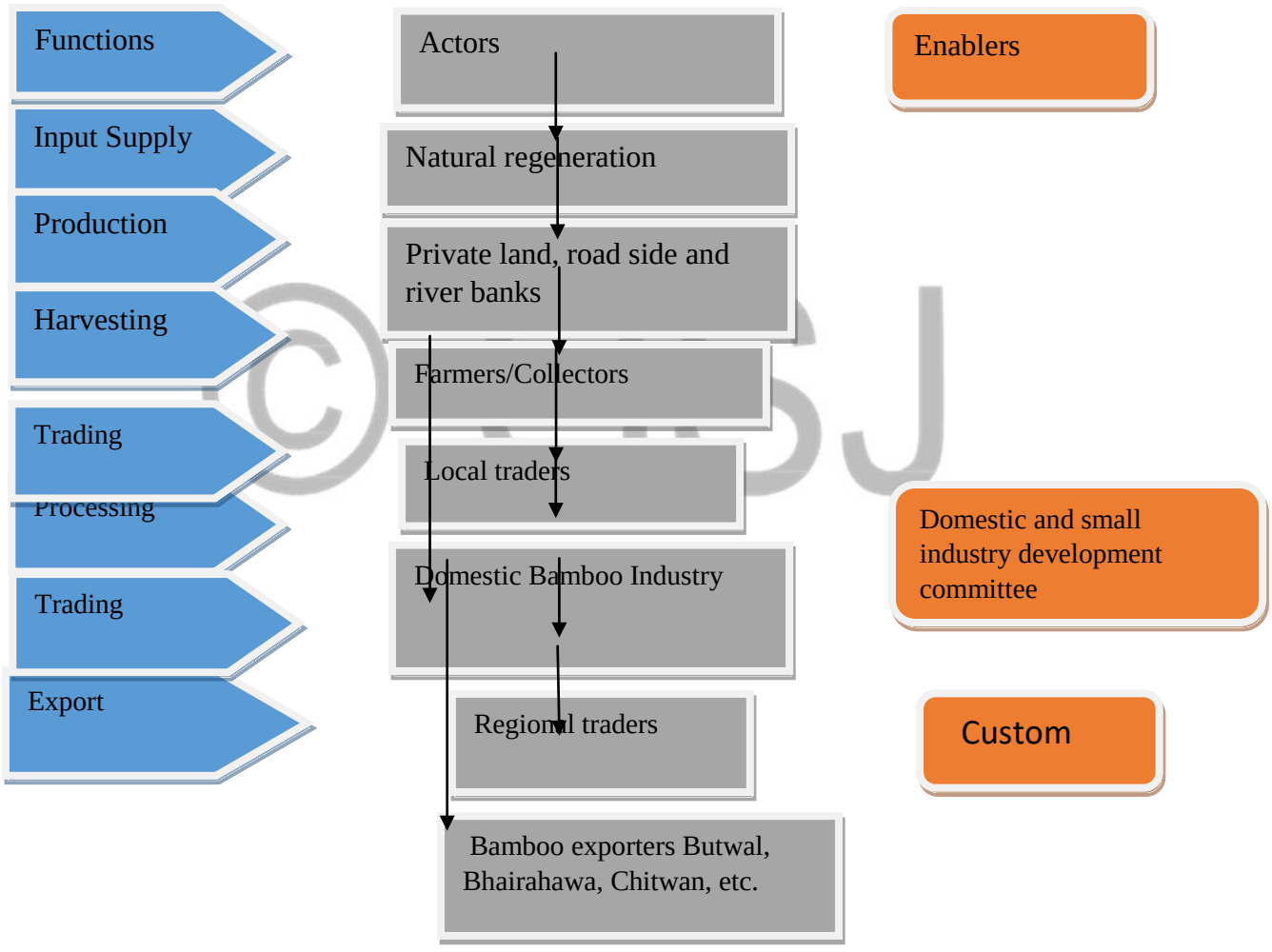


Figure 8: Value chain map of bamboo

Producers:

Bamboos are cultivated by the farmers of Sitganga municipality in private land, river bank, roadside and nearby their houses. Bamboo is one of the important source of livelihood for the farmers of Sitganga Municipality. After survey it was found that, most of the producers sell their bamboo culm to the middle man. But in some cases, bamboo producer or cultivator themselves they are engaged in manufacturing

bamboo products. When producer themselves they are engaged in manufacturing bamboo products they can get maximum benefit as compared to selling bamboo poles to the traders.

Middle man/Intermediaries

Total 4 intermediaries were interviewed. Out of 4 intermediaries, 2 were from Sitganga and 2 were from KapilvastuTaulihawa and Gorusinge. After focus group discussion and household survey, the main intermediater were found and based on snow ball sampling second person was identified and similar chain was catched .These groups buys the bamboo culm from producers and transports them to nearby cities to sell them with higher prices. According to interview with intermediaries, they need to transport the culm to the craftmakers by trucks and other load carrying vehicles. Buying and selling price is dependent upon the species of bamboo and the distance they travelled.

Average buying and selling price of bamboo culm was recorded after interview with intermediaries. Average buying price per culm of *Bambusanepalensis* is Nrs 150, whereas selling is Nrs 250. Similarly, price of other specie as shown in table below (Table 11).

Table 11: Buying and selling price of bamboo (Intermediaries price)

Species	Buying price	Selling price	Price difference	Price difference percentage
Tama bans	Nrs 150 per culm	Nrs250 per culm	Nrs 100	66.67%
Dhanu bans	Nrs 100 per culm	Nrs 150 per culm	Nrs 50	50%
Taru bans	Nrs 80 per culm	Nrs110per culm	Nrs 30	37.5%
Lyas bans	Nrs 6 per culm	Nrs9 per culm	Nrs 3	50%

Processors/Craft makers

Out of total number of craftmakers(6) interviewed, 4 were from Sitganga and 2 from Gorusungye. Craftmakers receives bamboo culm from intermediaries, prepares crafts and sells bamboo products to the entrepreneurs. They are engaged to produce handicrafts and furniture. They use traditional equipments such as Khukuri, Knife and Sickle to make products.

The unit cost and benefit analysis of some bamboo products (Doko, Nanglo, fan, Bhakari and chalno) made by craft-makers was performed. The income from Bhakari (Nrs. 250) was more than that from other traditional craft (Table 18). However, according to the bamboo craft-makers, the demand of Bhakari was not high and uniform.

Table 12: Unit cost analysis of some bamboo products (price is in Nrs)

SN	Product	No. of labour	No of bamboo	Quantity produced	Total cost	Unit cost	Selling price	Income	Income percentage
1	Doko	1	2	1	200	200	250	50	25%
2	Nanglo	2	2	4	400	50	100	50	12.5%
3	Fan	1	1	12	420	35	50	15	3.57%
4	Bhakari	1	2	1	350	350	700	250	71.42%
5	Chalno	1	2	8	480	60	100	40	8.33%

Entrepreneurs:

Entrepreneurs get most of the bamboo products from processor/manufacturer where as some products from producers. As some of the producer themselves they are engaged in processing and selling the bamboo products. Craftmakers are not able to supply the adequate products as trader demand huge quality of products.

Out of total number of entrepreneurs (7) interviewed, 4 were from Butwal and 3 were from Bhairahawa. Average buying and selling price of bamboo products were recorded (Table 13). According to entrepreneurs, income from Bhakari was more than any other products.

Table 13: Buying and selling price of bamboo products

Types of products	Buying price (Nrs)	Selling price(Nrs)	Price difference(Nrs)	Price difference percentage
Rack	200	350	150	75%
Doko	250	450	200	80%
Nanglo	200	350	150	75%
Khurlung	40	70	30	75%
Chalno	100	165	65	65%
Muda	250	400	150	60%
Pirungla	60	100	40	66.67%
Bhakari/Mandro	700	1400	700	100%
Fan	35	60	25	71.42%

Supply of bamboo culm

Bamboo grown on private land had met the demand for bamboo culms at small-scale locally in the municipality. The stocking of bamboo was found to be higher in northern part(Mandre) than in western part (Rikot) of the District .According to the respondents, the demand for bamboo culms was found to have fulfilled only in the Mandre but not in Powera and Rikot.

Demand for bamboo culm and bamboo products

According to the farmers, demand of *Bambusanepalensis* was highest followed by *Bambusabalcooa* and *Bambusa nutans* while the demand of *Dendrocalamuspatellaris* was low. Demand of *Bambusanepalensis* was highest as it is used as multiple purpose species.

According to the entrepreneurs, the demand of bamboo products increased for handicrafts and racks but the demand of traditional bamboo products decreased. Though demanded bamboo products were made available by the entrepreneurs but their income from those products was quite low. Their income from Bhakari was more than other products but the demand of this product was very low.

Indigenous use of bamboo

Mature bamboo culms are used in Nepal in 220 ways (Poudyal, 1998). They are extensively used for house construction, for walling of huts, thatching and roofing, grain storage (Bhakari), fencing, scaffolding, furniture, woven products (such as mats, baskets, trays, and winnows), agricultural implements and tool handles (NARMSAP, 2004). Bamboo leaves are importance source of fodder for livestock. The use of bamboo leaves increases lactation and milk production (Das, 1999). They are used for high quality paper making in India, China and Bangladesh (Sharma, 1988) but not in Nepal. Although, bamboo has diverse uses in rural areas of Nepal, it was found that people of Sitganga uses bamboo culms mostly in traditional craft making such as nanglo, doko, chalno, muda which are used for different household activities.

The research conducted in eastern Nepal has found that the levels of bamboo growing vary significantly with wealth (Das and Seely, 1996). According to the research done by Karki et al. (1998), the land size is directly proportional to the amount of bamboo plantation. It is usually the rich HHs with large landholdings plant more bamboos than poor HHs with less land. Similar was the finding of this research. It was found that richer HHs have relatively more land and have more bamboo clumps whereas poor HHs have hardly 1-2 bamboo clumps in their homestead and most of the poor has no bamboo clump in their

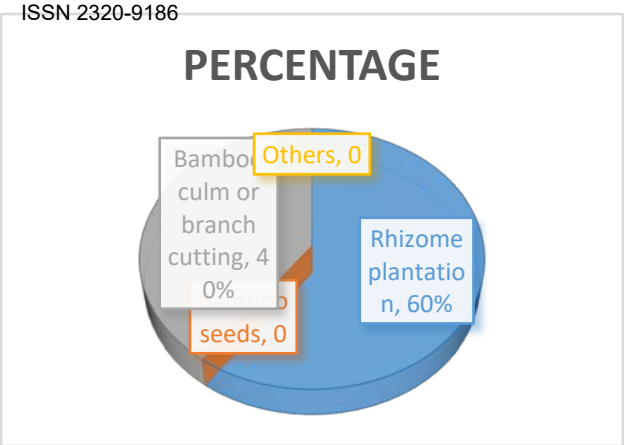
homestead land. In the study, it was found that poor people of Sitganga mainly Kami, Damai HHs are involving more on bamboo craft making than rich and medium class HHs of Sitganga.
Women are heavily involved in forest-based small-scale enterprises (FBSSE) in many developing countries (FAO, 1987; FAO, 1991). The situation is also similar in Nepal with a considerable amount of women are involved in this enterprise. Bamboo craft making is one enterprise where a considerable number of women are involved (Das, 1999). The above statements have proved the finding of this research. In Khudunabari, women are involved full time, or frequently part time especially the poor women. But the involvement of men and women depends on the labour available in their own family. Male can involve fully in their own profession like bamboo enterprise and other off-farm activities, but women can't spend full-time always because of the fact that many women are household-based family operations and care for their children. For more skilful and hardworking, men are engaged more than women.

Bamboo stocking

Study showed that, highest stock of bamboo was found in Mandre (23,078) while Powera had the medium stock of bamboo (13,349). Rikot had the lowest bamboo stock of 2,233 (Table 21). The total stocking of the middle-aged culms (16,723) and the mature culms (16,575) were nearly equal whereas that of the young ones (5,362) was comparatively quite low (Table 21). This indicates the poor management practices for bamboo. Appropriate management practices should be followed for the sustained yield of bamboo. The mature and middle-aged culms need to be urgently thinned so as to provide sufficient space for the young ones as well as the new shoots. It will provide better growth of bamboo in future as well as sufficient income to the farmers.

Bamboo planting methods and management

Among various method of bamboo plantation, rhizome planting is the most common method of bamboo propagation in the study area. Stapleton (1987) found rhizome planting as the most common bamboo propagation method which may be due to the lack of sufficient technical information to the bamboo growers (Das, 1999; 2002). 40% farmers used bamboo culm or branch cutting method for bamboo plantation. Some management practices were applied by farmers on the bamboo clump such as mounding, composting (decomposed straw and dung) and pruning during the growing stage. Few farmers (5%) have knowledge about production of bamboo plants through seeds but this method was not checked in the study area. Propagation through seed is technically sound method of bamboo propagation. According to the respondents, success rate of propagation through rhizome planting was high as compared to bamboo culm or branch cutting method. In 2071, Bandganga Sub-divisional Forest Office, Arghakhanchi has supported and encouraged local farmers to participate in soil conservation activities providing rhizomes. Rhizomes were planted in Bandganga river bank which helps in controlling soil erosion and for road embankment stabilization. Out of total number of HHs (181) surveyed, 60% people responded that bamboo plantation was done before 10 years. 30% people responded that bamboo plantation was done from last 10 years and 10% people responded that bamboo plantation was from last 5 years. Maximum bamboo plantation was done before 10 years which is shown in figure .



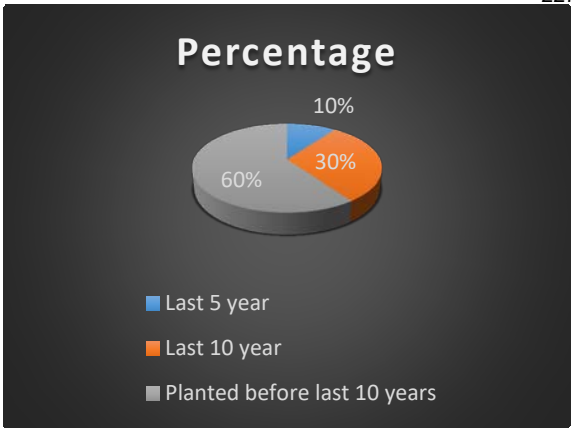


Figure 9: Bamboo plantation methodFigure 10: Bamboo plantation year

Bamboo harvesting

Favourable season of bamboo harvesting is in dry season i.e. during October-March. Bamboos should not be harvested during the summer as this is the shooting season and new shoots are easily damaged (McCracken et al., 1992)**.** Culms which are harvested at 2-3 years of age are good for making crafts whereas bamboo culm harvested at more than 3 years of age are mainly used for construction purpose. Generally, bamboos are harvested during the month of September- April due to the high use of bamboo culms **(**for making various products) in Chhath (a holly festival of the Hindus) and marriage ceremonies (Jha & Yadav, 2015). Most of the farmers had only a few bamboo clump in their homesteads and had not applied any silvicultural operations.This might be due to lack of technical knowledge at farmer's level. As a result, most of the clumps were dense leading to the very limited production of new shoots due to unavailability of space in the centre part of the clump.

Distribution of labour in bamboo enterprise:

Bamboo crafting is the traditional occupation of Dalit community who are considered to be the socially as well as economically disadvantaged ethnic group in the hilly region of Nepal. Mainly Kami and Damaiwere found to be involved in bamboo enterprise and they had been producing only traditional crafts such as Nanglo (winnow), Bhakari (large storage bin),muda, fan, doko etc. Now-a-days, such products are facing high competition with plastics and steel products, so the entrepreneurs are not getting reasonable benefits from these goods. Most of the HHs involved in bamboo cultivation had run small-scale enterprise throughout the year by utilizing their own traditional skills and knowledge by using their family members as the main labour source, sometimes exchanged and hire labour were also used. Thus, bamboo crafting had created self-employment opportunities to the family members.

CONCLUSION AND RECOMMENDATIONS

Conclusion:

- The present study reveals that, 5 bamboo species of bamboo are found in study area.
- Among 5 bamboo species, *Bambusanepalensis* is dominant species in the study area.
- Use of bamboo products like doko, nanglo, chalno, dalo, bhakari, racks, dustbins, photo frames, flower vase and decorative items made from Tama bans (*Bambusanepalensis)* is high as compared to other species. Similar utilization of *B. nepalensis* has been reported from the Mid-hills and the Terai of eastern Nepal and in central and western Nepal by Das (1999, 2004) and Poudyal (2006).
- *Bambusanepalensis*has the highest diameter, height and basal area. Similarly, diameter, height and basal area growth performance of this species is very good.

- Though *Phyllostachys nigra* has lowest diameter, height and basal area,its growth performance is good.
- Marketing system in rural areas of Nepal is inefficient and overall impact is low producer price, high consumer price and large marketing margin. The high marketing costs are also due to poor transport systems. Similar finding has been reported by A.N. Das.
- The price of bamboo culm and bamboo product is increasing day by day but the demand for traditionally used products like Nanglo and Bhakari is decreasing.
- Lack of introduction of modern tools and technology and poor market information is considered as hindrance in further progress and promotion of this traditional business in the area.
- The demand for bamboo culms from both the rich and the middle-class families for self use purpose is decreasing. The poor families are highly dependent on bamboo for their livelihood as compared to the rich and the middle-class families. Therefore, the poor people,especially bamboo dependent ones, should be supported by those concerned in pro ducing new modernmarketing products.
- The bamboo dependent people are highly vulnerable to the changing market situation, and so the stakeholders have to take quick step to support them to adapt with the new market situation

Recommendation

The following provisions should be made by GOs, DFO, local bodies ,NGOs and INGOs in order to improve the economic potential and marketing trend of bamboo in study area.

- Besides plantation of bamboo in riverbank, other aspects of bamboo like bamboo handicraft, bamboo house should be emphasized because it helps in conservation and utilization at the same time.
- Training on the new improved method of bamboo plantation and management of bamboo clumps should be provided to the bamboo producers, as most of the bamboo clumps are not managed well.
- As the number of young culms are less compared to the middle-aged and the mature ones, there is urgent need of silvicultural treatment in the clumps for sustained production of bamboo culm.
- Skill development trainings should be organized to the bamboo entrepreneurs for new varieties of bamboo products, as there is high demand of new varieties of bamboo products like bamboo skin care packging ,bamboo incense stick, kitchen items and furniture items in the market and low (decreasing) demand of traditional products.
- Product should be diversifield based on the time, new technology , new company , items should be encouraged.
- Bamboo income generation activities should be promoted by the concerned organization for rural poverty reduction.
- Should encourage bamboo entrepreneurs to manufacture the bamboo products like Hair comb, Tooth pick and Agarbatti sticks which has high demand in the market.

- Growth performance of *Bambusanepalensis* is very good and market price of this species is high. So farmers should be encouraged on plantation of *Bambusanepalensis* species.

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Declaration of Interest Statement:

DECLERATION

The piece of work entitled "Assessing the Status, Utiliation and Market value chain of Bamboo Species (Case study from chure area of Arghakhanchi District, Nepal)" is our own work, except wherever acknowledged.
We have not submitted it or any of its part to any other university for publication.There is no conflict of interest among authors for publication.

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