Asian Journal of Conservation Biology, July 2025. Vol. 14 No. 1, pp. 47 –59 AJCB: FP0261/84301
ISSN 2278-7666 ©TCRP Foundation 2025 https://doi.org/10.53562/ajcb.84301

Research Article

Production and Improvement of Highland Bamboo (*Yushania alpina*) Resources Utilization in Dawro Zone, Ethiopia

Bekele Tona Amenu[1*], Getahun Shanko Mamo[1]

[1]*Department of Natural Resource Management, Wolaita Sodo University Dawro Tarcha Campus, P. O. Box 01, Tarcha, Ethiopia*

(Received: January 26, 2024; Revised: February 14, 2025; Accepted: March 11, 2025)

ABSTRACT

Highland bamboo (*Yushania alpina*) is a perennial, multipurpose, and fast-growing plant that significantly supports local livelihoods. This study, conducted in the Dawro Zone of SNNPRG, Ethiopia, aimed to enhance the utilization of bamboo resources. A cross-sectional survey design employing both qualitative and quantitative approaches was used, with multistage sampling techniques. Site preference showed a strong positive correlation with bamboo production, with a correlation coefficient of .917**. Factors such as site condition, agro-ecology, bamboo species, plantation technique, and tilling frequency were positively correlated with production. Discussions with stakeholders highlighted the need for scientific management to improve production. Traditional products crafted from bamboo include mats, tables, chairs, beehives, and baskets, mostly sold directly to consumers. However, the production remains limited, with poor processing techniques and no formal training provided. Bamboo diseases are poorly managed, with uprooting being the only mitigation strategy. There is no use of commercial fertilizers, and the bamboo market chain is hindered by inadequate infrastructure. Scientific intervention is essential to enhance bamboo utilization in the Dawro Zone.

Keywords: *Yushania alpina,* Production, Resourses, Dawro

INTRODUCTION

N.T.F.Ps are not only crucial to ecosystem but valuable to the live hood of communities NTFPs are known to general substation, to generate foreign exchange and are increasingly being regarded as valuable communities around in the world, our perception and evaluation of NTFPs are changing due to an alarming rates of deforestation and decrease the yield of NTFPS and in come from them (Kigomo, 2007)

Bamboo is one of the NTFPs, and is one of the world's greatest renewable natural resources, which yields a multitude of products and services of high economic value to humankind; in addition, it also plays a vital role in conserving ecological stability and biodiversity. Bamboos are tall perennial, arbores cent grasses, belonging to the sub-family Bambusoideae of the family Poacea. Almost 75 genera and more than 1500 species of bamboo and still more with incorrect names are found in the world (Ohrnberger, 2002).

The morphology of bamboo belongs to the tribe of bamboo belongs to the trivet CF bamboo so idea of the plant family of Poacea which called giant grass. It is the most relatively fast growing species attaining stand maturity with five to seven years and the infrequently flowering of 15 – 40 yrs then dies (Kigomo, 2007, FAO, 2005)

The set of pure bamboo forests in Ethiopia is the largest in Africa; it covers more than one million hectares, and makes up 67% of the total bamboo resources in Africa, and more than 7% of the world total (Kassahun, 2003). The two recorded natural species of bamboo which grow in Ethiopia are *Yushania alpin-a*Known as Highland bamboo, and *Oxytenanthera abyssinica*(A. Rich) Munro known as Lowland bamboo (Luso Consult, 1997; Kassahun, 2003). Bamboos are the most freely and readily available resources for the communities living within and around the natural bamboo forests of Ethiopia (Kassahun, 2003).

[*]*Corresponding Author's E-mail: bekelet20007@gmail.com*

However, despite the availability of the resource in large quantities and at low cost, its uses have been limited to traditional applications such as hut construction, fencing, and to a lesser extent, the production of handicrafts, furniture, containers for water transport and storage, baskets, walking sticks, agricultural tools, beehives, household utensils and various other artifacts (Kassahun, 2003). Even at regards its low-level traditional applications, there is still little baseline information on the situation of bamboo as a source of livelihood (Ensermu *et al*., 2000). Bamboo, like other NTFPs, receives little attention (Ensermu *et al*., 2000; Kassahun, 2003). However, there is little research and information on the extent of bamboo domestication, on the management of the domestic stocks and on its role in household livelihoods in Ethiopia.

The habitat distribution is largely governed rain fall, temperature, Altitude and soil. The most bamboos require temperature of 8 0c – 36 0c of a minimum of 1000 mm annual RF high atmospheric humidity for good growth and development. They mostly grow or exist in most valleys, sheltered depression a long stream and lower hill slopes but occasionally occur in higher slopes and hill slopes usually mixed with or under tree species in open canopy (Kassahun, 1000)

In Ethiopia only species of bamboo are growing and both are endemic to Africa (kassahum, 2000). These species are *Yushania alpina* K. schum (high land bamboo) and *Oxytenenthera abyssinica* /Aiorichmuaro or lowland bamboo. In Ethiopia, it has covered one million hectare of *Y.alpina*.K. and low land bamboo resources which cover about 68% of the African bamboo coverage and more than 7% of the world total coverage of bamboo resource (Luso-consult, 1997).

Yushania alpina is only high land bamboo which synonyms to Arudinaria, found in high land of Ethiopia which distributed in south and south western part mainly Mesha, reach Bonga, Tiliku and Tinishu Gesha forest, Hagereselam, Bore, Jima, on Bale mountain b/n 2400 to 3600 m.a.s.l. at Jibat Mountain.

In Dawro zone there is a surplus resource of bamboo and the current study mainly aimed at studying how to improve the utilization of bamboo in Dawro which is being done traditionally and transported up to national level market without any value addition.

Although Ethiopia is well known in bamboo resources, the use of this resource is usually limited to traditional house construction, fences, and some rudimentary furniture and household utensils (Kalbessa et al., 2000; INBAR, 2006). In Ethiopia there is new bamboo products under development, e.g. thermal modified panels (Starke, 2014), bamboo flooring and ceiling panels from Adal (personal communication) or the establishment of production of cement bound bamboo fiber board (plant in Asosa), but up to now all developments do not create significant impact on the bamboo culm production. This shows that despite their potential, Ethiopian bamboo resources are continued to be utilized and managed on a low level (INBAR, 2007).

In the study zone many community use highland bamboo extensively use building material and use a diversity of traditionally housing design. However, modernization the decreasing availability if bamboo resource increased rural population, due to conversation of bamboo to other crop and lack of adequate processing skill trend operation management skill. There is a global demand of bamboo a wood substitute for several constructions and furnishing application.

Bamboo resources are often poorly managed and high conversation of the area to other crop products due to low awareness of bamboo management and advantage. Additionally although there is huge potential of bamboo in Dawro zone, there is no way in which its resource is fully or partially processed or value addition. The resource is being transported to regional and national market in totally raw form.

To assess the way to Improvement of Highland bamboo (*Yushania alpina*) Resources Utilization in Dawro Zone

- To assess marketing system of bamboo in Dawro and to identify key opportunities and bottlenecks
- To identify existing and new bamboo products that can be exported to regional and international markets.
- To provide practical and technical support to enterprises and individuals how to produce value added bamboo products.
- To give concrete recommendations for upscaling new and existing bamboo products.

1. What are the ways that people of Dawro use the resources of bamboo?
2. What are the materials that people of study area use to prepare bamboo products?
3. What improvement does it require to modernize the utilization of bamboo in Dawro zone?

MATERIAL AND METHODOLOGY

Description of study Area

Dawuro is a zone in the Ethiopia south Nation Nationalities and peoples Regions state /SNNPR/. It located at about 497 km in southern western of Addis Ababa, the capital of Ethiopia and 280 km to Hawassa, the regional capital S.N.N.P.R 140 km of South East of Jima city, 177 km west to Woilata Sodo city. It is 714 North latitude, and 35 S, east of longitude. Administrative center or capital town of Dawuro is Tarcha. Dawuro besided on the north by Gojeb river which defines boundary with Oromia Regions on the north east by Hadiya and KambataTembaro on the east by Wolaita. The Omo river (Gibe III) hydroelectric plant project defines its eastern and southern boundaries on the south by Gamo-Gofa, and on the west by konta special woreda (district).

Demographics of the zone

Based on the 2007 census conducted by the central statistical Ages of Ethiopia (CSA) the zone has a total population of 489,577 of whom 249,763 a ramen and 240,314 women which area of 4,814,575 square kilio meters. And a total of 89,915 House hold were accounted in Dawuro, the ethnic group larges are Dawuro, and Hadiya. Dawurtso is spoken language in ethnic group Hadiya, Kambata, Tembaro, some of Afan – oromoorigic regions bonders the protestant, Ethiopian orthodox Christianity and traditional religion (ESA, 2007) and The zone composed ten district namely Maraka, Mari-Mansa, Tocha, Kachi, Essera, Gena-Bossa, Zaba-Gazo, Loma-Bossa, Disa and Tarcha Zuria.

Research Design

To conduct this study, the cross-sectional survey design with the application of both qualitative and quantitative approaches was employed. The study involved a multi-stage sampling, i.e. a combination of purposive, stratified, and simple random sampling procedures to select the study area and sample households.

Sample size

The sample size was decided based on sample size determination formula, which is given a care to have the sample size of the study to be as representative as possible in accordance with the time and budget billed. Having this into consideration, out of total households in the selected the following or Slovene's formula adapted from Israel (1992) was used.

$n=N/1+N\ (e)^2$ where; N= the total population that had been studied

n= the required sample size

e= the precision level which is = (±5%) Precision Levels Where Confidence Level is 95%.

As a result 300 households were selected.

Four woredas namely Essera, Tocha, Loma-Bosa and Mareka woreda were taken as sample woredas. From each woredas 75 sample households were taken.

Data Sources and Collection

The data for this study was generated from both secondary and primary sources of data focusing on both qualitative and quantitative natures. The surveys covered the population in three woreda of Dawro zone.

a. Secondary sources: The secondary sources of information including, research journals and articles, internet sources, different agriculture and rural development office, enterprise office and administration office of woreda

b. Primary sources: Starting from on-spot observation**,** stratified multi-stage sample designing was used to select the sample. The primary sampling units was enumeration areas (EAs). Sample EAs from each domain was selected using systematic sampling that is probability proportional to size; size being number of households obtained from the 2020 population data of each kebele manager office.

The sources of the information were key informants, focus group discussants, field observation and photograph, household survey participants.

To collect the reliable data, the field study combined Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and household surveys, direct observations and transect walks.

c. Questionnaire: The research based on a survey using questionnaires. Questions applicable to this study was

selected and arranged in a manner that could yield meaningful results in a cost effective manner.

Data Analysis and Presentation

Combinations of q8ualitative and quantitative methods were employed for data analysis. Quantitative analysis was carried out by Excel 2010 and SPPS software version 20. The data was edited and coded before entering into the cells of Excel. The qualitative data, which was generated from different sources, was analyzed qualitatively, and the results of the key findings were displayed in the form of narrations, graphs, diagrams, tables, and pictures to provide evidence and to support the qualitative information.

RESULT AND DISCUSSION

Demographic information

Table 1. Descriptive Statistic

	N	Minimum	Maximum	Mean	Std. Deviation
Gender of respondents	277	1	2	1.12	.325
Education level of respondents	277	1	5	2.90	1.305
Job of respondents	277	1	4	2.06	1.295

The table 1 above shows the descriptive statistics such as total number, minimum value, maximum value, mean and standard deviation of gender, education level and job of respondents.

Frequencies

Table 2. Gender of respondents

		Frequency	Percent	Cumulative Percent
Valid	Male	244	88.1	88.1
	Female	33	11.9	100.0
	Total	277	100.0	

Source: Survey, 2021

As frequency table 2 above indicated, among respondents 244 or 88.1% were male and 33 or 11.9% were female.

Table 3. Education level of respondents

		Frequency	Percent	Cumulative Percent
Valid	Illiterate	39	14.1	14.1
	Grade 1-8	89	32.1	46.2
	Grade 9-12	53	19.1	65.3
	Certificate	52	18.8	84.1
	Other	44	15.9	100.0
	Total	277	100.0	

Among respondents, 39 or 14.1% were illiterate, 89 or 32.1% were educated from grade 1-8, 53 or 19.1% were educated from grade 9-12, 52 or 18.8% were educated up certificate and 44 or 15.9 were educated above certificate like diploma and first degree in different as result indicated. It was identified that more educated respondents have better understanding about the production and utilization of bamboo resources than that of uneducated (Table 3).

Table 4. Job of respondents

		Frequency	Percent	Cumulative Percent
Valid	Farmer	160	57.8	57.8
	Merchant	5	1.8	59.6
	Enterprise	48	17.3	76.9
	Other	64	23.1	100.0
	Total	277	100.0	

The job of respondents was summarized in the table above. Among respondents 160 or 57.8% were farmers. The farmers of study area produce different annual and perennial crops among which bamboo is one and much known in study area. Five/5/ or 1.8 % were merchants, 48 or 17.3% were enterprises and 64 or 23.1% were others workers (Table 4).

Site preparation for Bamboo

Table 5. Statistics

		How do you prefer site for bamboo plantation?	Do you think site preference affects production of bamboo?	Which kind of site do you prefer for bamboo?	How do you prefer site/ farm?	Which device do you use for bamboo production?	How many times do you till your farm for bamboo?	Which agro-ecology agrees to bamboo?
N	Valid	277	277	277	277	277	277	276
		0	0	0	0	0	0	1
Mean		1.30	1.20	1.25	1.28	2.32	1.30	1.14
Std. Error of Mean		.037	.024	.033	.039	.028	.031	.021
Median		1.00	1.00	1.00	1.00	2.00	1.00	1.00
Mode		1	1	1	1	2	1	1
Std. Deviation		.613	.402	.556	.648	.474	.513	.345
Variance		.376	.162	.309	.420	.225	.263	.119
Skewness		1.912	1.491	2.189	2.059	.684	1.417	2.115
Std. Error of Skewness		.146	.146	.146	.146	.146	.146	.147
Kurtosis		2.326	.225	3.670	2.578	-1.259	1.054	2.489
Std. Error of Kurtosis		.292	.292	.292	.292	.292	.292	.292
Range		2	1	2	2	2	2	1
Minimum		1	1	1	1	1	1	1
Maximum		3	2	3	3	3	3	2

The table 5 indicates general statistics of how site is preferred for bamboo plantation in study area, total respondent was 277 in number, and the table showed mean, minimum, maximum, range, standard deviation and the like.

Table 6. How do you prefer site for bamboo plantation?

		Frequency	Percent	Cumulative Percent
Valid	Traditionally	218	78.7	78.7
	Advice of DAs	36	13.0	91.7
	Both of them	23	8.3	100.0
	Total	277	100.0	

During data collection, the respondents were asked to tell how they prefer site for plantation of bamboo and 218 or 78.7% of respondents replied that they use traditional way to plant bamboo. That means they use their indigenous knowledge to prefer site where they plant bamboo. As the response of 36 or 13% of respondents indicated that DAs (development of agents) give professional advice where bamboo to be planted and 23 or 8.3% of respondents replied that they use both the advice of DAs and traditional approach to prefer site for the plantation of bamboo (Table 6).

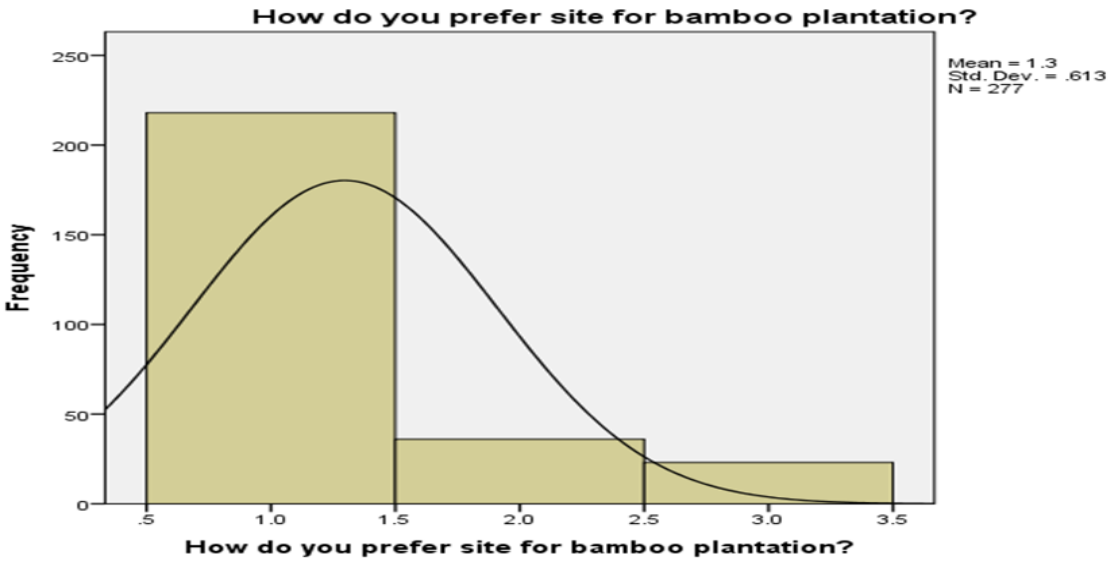

Figure 1. Histogram Showing How Site was Preferred

Table 7. Do you think site preference affects production of bamboo?

		Frequency	Percent	Cumulative Percent
Valid	Yes	221	79.8	79.8
	No	56	20.2	100.0
	Total	277	100.0	

As indicated in table 7 site preferences affects the production and productivity of bamboo as the result of this study indicated. 221 or 79.8% of respondents said that bamboo production and productivity depends on the suitability of site. This result was related others study undergone before like Chen, Chung and Ramm (Figure 1) . Bamboo stand yield in a site is a function of locality /environment and stand structure. The locality class is determined by the soil and topography of the stand. The most important soil factors are the soil mineral and moisture (Chen, 2000; Chung and Ramm, 1990). The soil mineral and moisture of valleys and plain land, hillsides and ridges and soil texture created on these land features are different. The topography of the stand has significant but indirect effect on bamboo stand yield. The conditions of the topography such as the altitude, aspect, slope and physical properties such as texture and moisture holding capacity have considerable effect on bamboo growth (Kleinhenz and Midmore, 2001). Howevere, there is no well defined research on the topography, gradient, drainage and soil texture preferences of *Y. alpina* in Ethiopia.

Table 8. Which kind of site do you prefer for bamboo?

		Frequency	Percent	Cumulative Percent
Valid	Fertile	226	81.6	81.6
	Unfertile	34	12.3	93.9
	Stony	17	6.1	100.0
	Total	277	100.0	

Source: Survey, 2021

As any plant, bamboo needs fertile soil to give good result. This was indicated by the respondents as table showed, 226 or 81.6% respondent that they prefer fertile soil to plant bamboo so as to gain surplus products. During direct interview with researcher team many owners of bamboo said, they plant bamboo around string water, or swampy area which contains huge moisture (Table 8).

Table 9. How do you prefer site/farm?

		Frequency	Percent	Cumulative Percent
Valid	Traditionally	229	82.7	82.7
	As DAs advice	18	6.5	89.2
	Both	30	10.8	100.0
	Total	277	100.0	

Farmers of study area most of the time do not use modern and scientific knowledge to prefer site where to plant bamboo. As table above indicated 229 or 82.7% respondents responded that they prefer site of plantation traditionally. Researchers interviewed heads and experts of agriculture and natural resources management office of study districts why the farmers were not supported by experts to prefer site, to plant and generally to manage bamboo products and they answered as there was no detail scientific approach that agricultural experts know. But for future support and development of they are preferring manuals by accessing from internet and discussing with university instructors and they requested polytechnic college of Tarcha for scientific support (Table 9).

Table 10. Which device do you use for bamboo production?

		Frequency	Percent	Cumulative Percent
Valid	Machine	1	.4	.4
	Hand tool	187	67.5	67.9
	Both	89	32.1	100.0
	Total	277	100.0	

As the table above indicated that 187 or 67.5% of respondents said that they use local hand tools to produce bamboo in to different usable forms. As different data sources indicated craftspersons manufacture several traditional products from bamboo culms by using indigenous crafting skills and simple tools. Their main products were mats, tables, chairs, traditional beehives and baskets. Craftsperson sold their products at directly to consumers, without intermediaries. Most of the time the craftspersons produced bamboo products for their stock and only sometimes they produced upon request (Amenu BT, 2020). In Dawro, types of the bamboo production materials were extremely low. Despite the fact that bamboo processing is based on a longstanding traditional knowledge, the performance of the craftsperson in the study area was poor. The lifetime of the products is short not more than a couple of month, due to poor working quality and lack of treatment against borers and fungi. High wastage of raw bamboo material was observed during study. There is lack of efficient utilization (high wastage) of bamboo culms by craftspersons. By removing the upper and bottom part of the culm, rural craftspersons used only around 1/3 (middle part) of the whole bamboo culm (Table 10).

Table 11. How many times do you till your farm for bamboo?

		Frequency	Percent	Cumulative Percent
Valid	Twice	200	72.2	72.2
	Three times	70	25.3	97.5
	Four times	7	2.5	100.0
	Total	277	100.0	

Source: Survey, 2021

Most respondents about 200 or 72.2% said that they till the land two times to plant bamboo. That means low tilling frequency compared with other perennial crops such coffee, mango and etc. respondents were asked to tell the reason why they do not till land as many times as other and the said that bamboo simply survives in their locality (Table 11).

Table 12. Which agro-ecology agrees to bamboo?

		Frequency	Percent	Cumulative Percent
Valid	High land	238	85.9	86.2
	Mid land	38	13.7	100.0
	Total	276	99.6	
Missing	System	1	.4	
Total		277	100.0	

High land bamboo prefers highland area to grow well. As result indicated, 238 or 85.9% of respondents said highland agro-ecology is well preferred for bamboo production. This result was supported by the study of PROTA and Philip which say *Arundinaria alpina* is restricted to high elevations (2200-4000 m altitude) and is the characteristic and definitive dominant of Afromontane bamboo vegetation (PROTA, 1989; Philips, 1995). It also occurs in abandoned fields and it can form extensive pure stands. Afromontane bamboo vegetation occurs in cool growing conditions, with average annual temperatures of 14–17°C. Average monthly maximum temperatures are 13–32°C, and average monthly minimum temperatures range from –4°C to 11°C, implying that some populations tolerate frost (Table 12).

Bamboo plantation and farm follow up

Table 13. How many times do you till your farm for

		Frequency	Percent	Cumulative Percent
Valid	Twice	200	72.2	72.2
	Three times	70	25.3	97.5
	Four times	7	2.5	100.0
	Total	277	100.0	

Site preparation play very prominent role in any agricultural activity. In bamboo plantation, farmers of study area prepare site before plantation, as we can see from the table above, among total respondents 200 or 72.2% responded that they tilled their farmer twice to plant bamboo, 70 or 25.3% of respondents said they tilled three times and only 7 or 2.5% of respondents responded as they tilled four times to plant bamboo (Table 13).

Table 14. Which agro-ecology agrees to bamboo?

		Frequency	Percent	Cumulative Percent
Valid	High land	238	85.9	86.2
	Mid land	38	13.7	100.0
	Total	276	99.6	
Missing	System	1	.4	
Total		277	100.0	

Source: Survey, 2021

As result in table 14 indicated, highland or 'dega' in study area above 2200 m altitude is preferred for bamboo. This result was in to the study of PRATO *Arundinaria alpina* is restricted to high elevations (2200-4000 m altitude) and is the characteristic and definitive dominant of Afromontane bamboo vegetation (PROTA, 1989; Philips, 1995).

Table 15. Which species of bamboo do you have?

		Frequency	Percent	Cumulative Percent
Valid	Improved species	30	10.8	10.8
	Local species	226	81.6	92.4
	Both	21	7.6	100.0
	Total	277	100.0	

Source: Survey, 2021

In study area still there was no improved species as result indicated 2260 or 81.6% of the respondents said they used local species of bamboo (Table 15).

Table 16. Which plantation technique do you use?

		Frequency	Percent	Cumulative Percent
Valid	Line	50	18.1	18.1
	Without line	189	68.2	86.3
	Others	38	13.7	100.0
	Total	277	100.0	

Source: Survey, 2021

Among respondents 189 or 68.2% responded that they plant bamboo in broadcast form or without line. 50 or 18.1% planted their bamboo in line form and 38 or 13.7% planted their bamboo in other like layering. During discussion with different concerning body, even though planting without line was known method in study area, line plantation is better to than without line because, it makes management, during harvesting transportation easier (Table 16).

Table 17. How do you plant bamboo?

		Frequency	Percent	Cumulative Percent
Valid	Sleeping horizontally	121	43.7	43.7
	Erecting vertically	72	26.0	69.7
	Both	84	30.3	100.0
	Total	277	100.0	

Source: Survey, 2021

As key informants interview, observation of researchers including their knowledge about the bamboo resources indicated that bamboo planting through propagation by offsets (rhizome with the attached section of the stem) methods. But the extraction of the rhizome is difficult and inefficient, and it is difficult to collect large quantities of planting materials. As the table above indicated, 121 or 43.7% said that bamboo is planted by sleeping horizontally, 72 or 26% of respondents indicated that bamboo is planted by erecting vertically and 84 or 30 % said it is planted in both methods (Table 17).

Table 18. Have you ever trained on bamboo production?

		Frequency	Percent	Cumulative Percent
Valid	Yes	31	11.2	11.2
	No	245	88.4	100.0
	Total	276	99.6	
Missing	System	1	.4	
Total		277	100.0	

Source: Survey, 2021

Almost all respondents said that there was no training given to producer of bamboo as it can be seen from above table among respondents 245 or 88.4% replied no for the question have you ever got training about bamboo resources management. That means still production of bamboo is undergone in traditional method and to improve this training is indispensible unless it impossible to increase the product of bamboo so as to harvest huge result from small plot of land. To achieve this Agriculture and Forest Offices of study woreda took responsibility (Table 18).

Table 19. Do you use commercial fertilizer for bamboo?

		Frequency	Percent	Cumulative Percent
Valid	No	277	100.0	100.0

Source: Survey, 2021

In study area no body used commercial fertilizers to enhance production and productivity of bamboo. The study people us DAP, Urea and other commercial fertilizer for other specially annual crop but they did not it for bamboo as result in table above indicated 277 or 100% of respondents responded no (Table 19).

Table 20. After plantation, how many times do you tend the bamboo?

		Frequency	Percent	Cumulative Percent
Valid	1-2	152	54.9	54.9
	3-4	125	45.1	100.0
	Total	277	100.0	

Source: Survey, 2021

Management plays great role in enhancement of bamboo production. The application of large scale cultural operations such as removal of half cut, curved, malformed and dry bamboos and covering rhizome with soil applied on degraded *Dendrocalamus strictus* has given rise to overall production increased tremendously (30% in new sprouts) even by treatment of only a part of the area in India (Jain, 1995). Soil mounding to a depth of 10 cm has also showed significant increase in shoot recruitment of *Gigantochloa* 28 *scortechinii* bamboo in Malaysia (Azmy and Hall, 2002). Removing old stumps (degenerated bamboo rhizomes) is applied in intensively managed high-yield model stand of moso bamboo for pulp-making in China to increase culm production (INBAR, 2005).

There are only very limited research works on silviculture and management of *A. alpina* in Africa. Attempts to germinate seed of African alpine bamboo from the few seed crops in nursery beds and watered daily have germinated well in Kenya. Seedlings 2–3 cm tall transferred to soil boxes and planted out 8–12 months later, at 2 m spacing produced a stand with stems up to 12 m tall and 5 cm in diameter after 6 years (PROTA, 1989). In Ethiopia and Uganda, offsets are often planted.

Offsets used for propagation by Ethiopian farmers are single stems pruned at 8-9 nodes above the base.

In Kenya, experiments have been successful by using offsets (single stems shortened to 60 cm, with attached rhizome), clump division (groups of 5 stems shortened to 60 cm, with the parent rhizome) and 20 cm lengths of rhizome as propagules. Offsets from plants produced in the previous growing season are preferred. Stem cuttings have not produced shoots, not even after treatment with rooting compounds (PROTA, 1989; Kassa Oyicha, 1997). However, Tesfaye Hunde *et al.* (2005) indicated that culm cuttings and culm layering methods could be successfully used to propagate *A. alpina* vegetatively. Literatures on production of rooted plants from culm cuttings of A. alpina are not in harmony to each other; further study is needed to fine-tune the discrepancies (Table 20).

Table 21. Does disease occur on your bamboo?

	Frequency	Percent	Cumulative Percent
Yes	195	70.4	70.4
No	82	29.6	100.0
Total	277	100.0	

Source: Survey, 2021

As observation, discussion with key informants and interview result indicated there was a disease attacking the bamboo resource of study area whose name was not known by local community. As the table above showed, 165 or 70.4% of respondents said their bamboo was attached by disease and they simply uproot and remove severely attached bamboo but they did not know how to treat the disease. They said that they have not ever heard as there is treatment or medicine for the disease of bamboo (Table 21)

Bamboo Harvesting and Storage

Table 22. How long does it take for bamboo to be matured?

		Frequency	Percent	Cumulative Percent
Valid	1-2 years	85	30.7	30.7
	3-4 years	137	49.5	80.1
	5-6 years	55	19.9	100.0
	Total	277	100.0	

Source: Survey, 2021

The culm matured harvested within 3 to 4 years and the next rotation culms harvesting take place after 2 years. The average culm thickness (diameter at breast height) and length were 5 centimeters and 11 meters, respectively. This finding agreed with INBAR (2001) which reported the height of highland bamboo culm as 12-20m tall and thickness of 5-13 cm in diameter. But, cum height and thickness due to bamboo silvicultural management, soil fertility conditions, and stand density per hectare differences in the farm plots (Table 22).

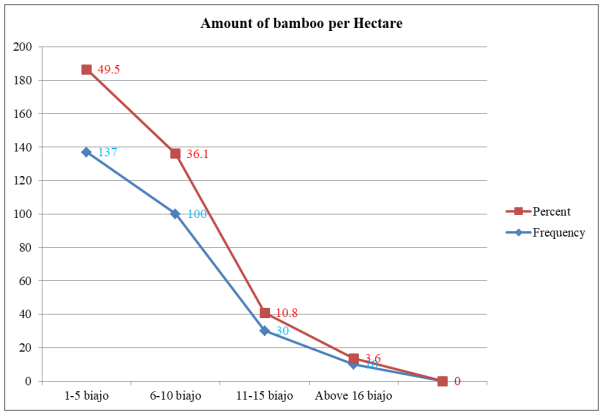

Figure 2. Amount of bamboo per Hectare

As the figure 2 above indicated, in study area 1-5 biajo of bamboo is harvested from a hectare as 137 or 49.5% of the respondents said. As key informants interview and discussion with farmers indicated that enhance production and productivity scientific intervention has to be started.

Table 23. In which season is bamboo collected?

		Frequency	Percent	Cumulative Percent
Valid	Winter/ dry	201	72.6	72.6
	Summer/ wet	16	5.8	78.3
	Other	60	21.7	100.0
	Total	277	100.0	

Source: Survey, 2021

The preferred season for bamboo collection is winter/dry season as study indicated. During discussion it was indicated that bamboo can be harvest any time when the owner desires to harvest. But winter is preferred to sell the product for merchants who

transport bamboo from Dawro to neighboring community this was due to less road infrastructure (Table 23).

Table 24. How do you transport bamboo from farm to where desired?

		Frequency	Percent	Cumulative Percent
Valid	Carefully	257	92.8	92.8
	Without care	20	7.2	100.0
	Total	277	100.0	

Source: Survey, 2021

Bamboo was carefully transported from farm site to the area where persons require, because to prevent small bamboo shoot from damage. 257 or 92.8% of respondents said as they carefully transported bamboo from place to place (Table 24).

Table 25. Do you store bamboo products properly?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	277	100.0	100.0	100.0

Source: Survey, 2021

To reduce different damage of bamboo resources, the study population properly stored the bamboo resources (Table 25).

Table 26. What is the purpose that you produce bamboo for?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fodder for livestock	10	3.6	3.6	3.6
	For sell	40	14.4	14.4	18.1
	For furniture	120	43.3	43.3	61.4
	For fire wood	19	6.9	6.9	68.2
	Others	88	31.8	31.8	100.0
	Total	277	100.0	100.0	

Source: Survey, 2021

In study area bamboo was prioduced for different purposes albeit the uitlization mechanism was traditional and with-uiot value additio. As it could be seen from the table 28, among respondents said they produced bamboo fodder for livestock, 40 respondents said for sell, 120 respondents said, they used bamboo for the formation of different furniture, 19 respondents said they produced for fire wood and the remaining 88 respondents used their bamboo different other purposes (Table 26).

CONCLUSION AND RECOMMENDATION

Conclusion

Highland bamboo is common crop in study area. Site preference affects the production and productivity of bamboo. The study population used use traditional way to prefer, to prepare and to plant bamboo. Bamboo needs fertile soil to give good result. Highland or 'dega' in study area above 2200 m altitude is preferred for bamboo. The people of study area plant bamboo around string water, or swampy area which contains huge moisture. Farmers of study area most of the time do not use modern and scientific knowledge to prefer site where to plant bamboo. craftspersons manufacture several traditional products from bamboo culms by using indigenous crafting skills and simple tools. Their main products were mats, tables, chairs, traditional beehives and baskets. Craftsperson sold their products at directly to consumers, without intermediaries. Most of the time the craftspersons produced bamboo products for their stock and only sometimes they produced upon request. In Dawro, types of the bamboo production materials were extremely low. Despite the fact that bamboo processing is based on a longstanding traditional knowledge, the performance of the craftsperson in the study area was poor. The lifetime of the products is short not more than a couple of month, due to poor working quality and lack of treatment against borers and fungi. High wastage of raw bamboo material was observed during study. Different variables affect the production of bamboo as it can be seen from above table site condition, agro-ecology, species of bamboo; plantation technique and frequency of tilling were positively correlated with production of bamboo. There was no training given to producer of bamboo in terms of production, management or utilization. Bamboo disease was occurred in study area and nobody knows how to treat it rather than uprooting and throwing. Commercial

fertilizer was not used for the production of bamboo. 1-5 biajo of bamboo is harvested from a hectare of land. Bamboo resource of study area was sold to whole sellers without any value addition and transported to neighboring zone and up to national market. Poor accessibility of infrastructure especially road access was great bottleneck for market chain of bamboo.

Recommendation

- Promote short-term training and research to enhance bamboo production.
- Establish associations for bamboo traders and craftsmen.
- Improve market infrastructure and information dissemination.
- Encourage scientific intervention in bamboo cultivation and processing.
- Provide training for quality product manufacturing.
- Conduct value chain analysis to identify and address production challenges.

Data Availability

The data used are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

ACKNOWLEDGEMENTS

We would like to offer our sincere thanks to Tarcha Polytechnic College, Essera woreda, Tocha woreda, Disa woreda, Mareka woreda and Loma-Bosa woreda Natural resource management office staff member and local communities for giving us an opportunity to pursue this research.

REFERENCES

Amenu BT. “Assessment of Socio-Economic Role of Yushania alpina in Dawuro Zone, Essera District, SNNPR, Ethiopia.”J Biodivers Endanger Species 8 (2020): 240. doi: 10.37421/JBES.2020.8.240.

Arsema, A. (2008). Value chain analysis for Bamboo originating from sledemKebele, Bale zone, master thesis Addis Ababa University, Ethiopia pp.105

Clark, L. (1997). Bamboos the center piece of the grass family. In Chapman.

Cooper, (2007). Chus. Gueo. Mountain bamboo of Latin America New plantismG (1) 51-57’

CSA, (2007). Census Statistical Agency, Ethiopia

FAO, (2005). World Bamboo Resources. A thematic study prepared in the frame Work, of a global forest Resource Assessment, 2005, Rome, Italy.

FAO, (2014). Food and Agriculture Organization of the united nations Enhancing The socio economic benefits from forests state of the world’s forests 2014, Rome Italy

FAO, (2015). Food and Agriculture Organization of the United Nations. Non-timber-forest production and Income generation, http, //WWW-fao-org/decrep/x250 elx 2n75 eoa.htm.

G.p /Eals/ the Bamboos, linnearsh society symposium series number 10, Academic press London, U.R pp.501-512.

Guitrrel, J. (2000). The development of non- traditional bamboo technologies in Costa Rica pp 2-6.

INBAR, (2015). How small Bamboo and rattan businesses can help drive new economic. Httpy/www.inbar. int/2015/04/ small and medium size bamboo unter praises KASSAHUN.E Indigenous bamboo tree forest In Ethiopian.

Kelbes, E. Bekele.T. Gebrehiwot. A. and Haderaca (2000). A socio-Economic case study of the Bamboo sector in Ethiopia. An analysis of the production to consumptions system Addis Ababa, Ethiopia

Kigomo, (8.0007). Guideline for growing bamboo Kenya forest Research institution (kefri) pp_45.

Kigomo, B.N.(l988). Distribution, cultivation, Research status of bamboo in Eastern Africa kefrteco.sermonogy, pp.l-9

Luso consult, (l997). Study on sustainable bamboo management , Addis Ababa, Ethiopia

M.C.i (2013). Millennium investment initiative Investment opportunity in Kumassi Ghana bamboo cultivation and processing, http/lwww

MCIEiconsmbio/file/(2013)/lOl Cultivation processing p.d.f

Ohrnberger, D. 2002. The Bamboos of the World. 2nded. Elsevier, Amsterdam.

Ohraherger, D. (I999). Bamboo resources of the world Engineer, Amsterdam.

Prassed, R. (I990). Bamboo resources of the oupter Himalayas and viseliks of western outer pradeghe conservation, plea for habital restoration bamboo current researcher. (J .V Ramomoja.rue R.

Singh, A.(20l2). Local bamboo utilization for rural development .Tinsley B.(20l4) Bamboo harvesting for household income generation Highland current condition and management challenges