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Highland bamboo value chains development to enhance local livelihoods in Southern Ethiopia

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Abstract

Highland bamboo has been traditionally used in building construction, wall partitioning, ceiling, doors, windows, and roofs and has contributed in people's livelihoods. This paper focuses on pinpointing bamboo value chain, its opportunities, and challenges. Site selection and observation, review of existing knowledge, key informant interview and market assessment in the value chain, stakeholders' consultation workshop, processors workspace visit, and group discussion were performed. We found that highland bamboo is a raw material, semi-processed and processed product and sold at different locations passing through different routes based on the request and demand of the customers in the value chain. We identified different bamboo landraces in the studied areas. However, there are knowledge gaps by processors on the use of the different races for different purposes. Traders buy bamboo culms based on their sizes by giving different grades. The price of the product varied from product to product depending on the quality of bamboo raw material/culm used and the time (man-days) required to make the finished product. Local processors' capacity to produce well-finished products is affected due to lack of important machineries and tools. Therefore, introducing and promoting modern processing tools and machines through credit support systems are crucial to make processors more competitive in the value chain. Moreover, the study identified major challenges faced by bamboo growers, culm traders, and processors that have effects on bamboo value chain development. Therefore, it is important to work towards alleviating/minimizing the major challenges in the bamboo value chain considering all actors to strive towards improving the value chain.

Keywords: Highland bamboo, Value chain, Bamboo growers, Bamboo processors, Bamboo traders

Introduction

Bamboo forests are useful for the poor in the tropics, where they offer a wide range of products as a means of livelihood (e.g., Chele et al., 2012; Dai & Hwang, 2021; INBAR, 2019; Shergian & Immawan, 2015; Yun et al., 2022; Zheng & Zhu, 2021). Bamboo and its products are one of the most important traded natural commodities in the world

(Kalyan et al., 2018). Bamboo has been traditionally used in building construction for time immemorial in foundations, wall partitioning, ceiling, doors and windows, roofs and for reinforcement of cement concrete (Diwaka et al., 2017). It has contributed significant role in people's livelihood activities (Brias, 2006).

The cumulative impacts of deforestation in Ethiopia fuelled by population growth, frontiers clearing for subsistence agriculture expansion and the subsequent land degradation, poverty, forest fire, uncontrolled grazing, and poor policy implementation, have led to a net forest loss of 73,000 ha year⁻¹ equivalent to forest expansion to deforestation ratio of one in fifth (FAO, 2020). Bamboo forests are no exception to these challenges. Further, bamboo forest resources are exposed to mass flowering occurring once in 14–50 years (MEFCC, 2018), which causes mass death of the mature culms. If the naturally regenerating bamboo forests from soil seed banks are not protected from human and livestock intervention, the bamboo forest land could be converted to subsistence agriculture.

Ethiopia has one of the largest bamboo resources in Africa (INBAR, 2018a, 2018b). The promotion of bamboo plantations is important, as it helps to increase the resource base and makes bamboo a part of the farm landscape. In Ethiopia, bamboo has been used by rural people from house construction to furnishing, livestock feed and marketing to support their livelihoods (Adnew & Statz, 2007; Mekonnen et al., 2014). The existing utilization of bamboo in Ethiopia remains underdeveloped with little value addition and mainly focused on low-quality products (Kalyan et al., 2018). However, there are some initiatives, for example by Adal Industrial Plc, that have introduced modern technology to produce more technologically oriented value-added bamboo products. The raw bamboo is supplied to value-adding enterprises by smallholder farmers (EFCCC and INBAR, 2020). Durai et al. (2018) argue that lack of process upgrading, value chain governance, new market development, reliable formal supply chain and institutional innovation contributed to the underdevelopment of the sector in Ethiopia. The availability of abundant resources, rapid growth features and excellent environmental service functions mean that bamboo has great potential for commercialization (Tefera, 2015). The diverse bamboo product design options and the role of bamboo in different societal cultures in Ethiopia is not well explored to strengthen inheritance and innovation (Chele et al., 2012; Lu, 2020; Yun et al., 2022; Zheng & Zhu, 2021). Moreover, shreds of evidence show that most of the products are traditional and lack upgrading. Therefore, the objective of this research was to document opportunities, constraints, and challenges in highland bamboo raw material sourcing and supply, thereby to suggest alternative strategies, and to recommend the possible product and process upgrading options in the value chain of bamboo in Ethiopia.

Materials and methods

Site selection and observation

In the first insight reconnaissance survey, the bamboo value chain development study team initially selected two regions: namely, Southern Nations, Nationalities and Peoples' Region (SNNPR) and Sidama Region, for highland bamboo value chain for preliminary assessment. Then, three zones were selected from SNNPR namely: Guraghe, Hadiya and Gamo based on their product prevalence. In addition to Hawassa city administration,

one rural district (Hula) was also considered for the study from Sidama region. From each zone at least one district was selected for initial assessment based on total bamboo area coverage and accessibility. Accordingly, Ejia and Gumer districts from Guraghe zone; Duna from Hadiya zone and Chenchu Zuria from Gamo Zone as well as Hula from Sidama Region were assessed. Finally, from Sidama region, Hula district and Hawassa city administration were selected for upgrading bamboo value chain based on selected criteria (Table 1). The criteria used were availability of bamboo resources; accessibility; existence of actors in the value chain; district-level institutional capacity and initiative; and job creation opportunity. Each criterion was given a weight based on five-point scale where five represents excellent and one is not visible. The site with the highest weighted mark was given the first priority in the site selection process.

Review of existing knowledge

Different knowledge products such as peer-reviewed articles, policy briefs, strategic documents, working papers, proceeding papers and gray literatures on bamboo value chain analysis and development, marketing, cultivation and resource base were reviewed in detail.

Key informant interview and market assessment

Key informants from key stakeholders such as zonal and district-level natural resource and climate change bureau experts, farmers involved in bamboo growing and cultivation, bamboo traders and processors were selected based on experience and were interviewed to give detailed opportunities and challenges in the bamboo sector. Indeed, with the key informants' information, market assessment was carried out to have enough information on bamboo product types and their price along the value chain.

Stakeholders' consultation workshop

Stakeholders' consultation workshop was conducted with key stakeholders including experts from different bureaus such as Regional Job Creation Bureau, Industry Bureau, Omo Microfinance Bureau, Tourism Bureau and Environment, Forest and Climate

Table 1 Preliminary study site and criteria used for site selection

Districts	Criteria (5 = Excellent; 4 = Very good; 3 = Good; 2 = Fair; 1 = Indifferent)					Sum	Rank
	Availability of bamboo resources	Accessibility	Existence of actors in the value chain	District capacity initiative	Job creation opportunity		
Guraghe zone (Ezghe and Gumer districts)	5	5	4	5	4	23	2
Hadiya zone (Duna district)	4	2	3	4	3	16	4
Gamo zone (Chenchu district)	5	3	3	4	3	18	3
Sidama Region (Hula district)	5	5	5	4	5	24	1

Change Bureau. Discussion was made on the opportunities and challenges in the bamboo sector in general and bamboo value chain development in particular.

Processors workshop visit and group discussion

Processors have given market price of the bamboo products with respect to their production costs. This has helped to determine the marketing margins for each bamboo product for the marketing price during the assessment period.

The team visited processors' workshops in the Hula district and Hawassa city. Identified and listed the equipment they were currently using and those additionally important to add value and for the production efficiency in the bamboo processing and product development. Moreover, the team collected information about the approximate costs of the required tools and equipment.

Group discussion was also made with jobs creation bureau, industry and enterprise development bureau, and processors especially on future support and tools utilization approach/modality while providing important equipment to processing associations. Three focus group discussions were carried out at Hawassa city, Hageresalam town and farmers at Hula district consisting of 8–12 members including women, men, and youths. The age group of the participants who participated in the focus group discussion ranged from 20–60 years.

Results and discussion

Bamboo value chain is a production-to-consumption process of bamboo products beginning from the growing of raw bamboo from natural and/or planted bamboos to the end consumers who buy and use the different bamboo products. In this assessment, it has been understood that there are opportunities and challenges in each stage of the value chain which have been discussed in the following subsections of this section.

Highland bamboo resource base in selected districts

Bamboo resource status helps not only to understand the area coverage of the resource in certain area, but also helps to understand to design effective and sustainable utilization of the resource in the value chain. According to the information obtained from zonal and woreda experts, the area covered by bamboo resources varies from zone to zone and from district to district with varying densities. For example, the studies by Luso (1997) and Mulatu et al. (2016) found 11,000–20,000 bamboo culms per hectare in planted highland bamboo forests and 5869–8840 culms per hectare in natural highland bamboo forests. However, there is a need to conduct proper inventory to get a reliable and up-to-date data on bamboo resources of the respective district, zone, and region thereby getting a reliable national picture, which is important to upgrade the value chain and resource sustainability.

Bamboo follows four management systems: state forests, community bamboo, institutional bamboo and private bamboo (Durai et al., 2018). Based on the information obtained from experts in the studied areas, there exist only three ownership types: private (farmers), communal, and church (e.g., Guraghe zone) bamboo forests but the dominant ownership type is private (farmers owned) ownership. No state bamboo forest was

found in the study area, however, according to Boissière et al. (2019) bamboo forests owned by churches are categorized as institutional bamboo forests.

Highland bamboo production, trade, and processing

Almost all bamboo products are produced traditionally and manually and used for the domestic market except some recent efforts to produce a few products by using advanced technology (Teshome, 2014). The structure of actors in the value chain is almost the same in the bamboo value chain except for the existence of little variation in their marketing/trading places, distances, and the number of distribution sites. This variation usually depends or is influenced by road accessibility, demand for the resource, and availability of processing sites and so on. The actors, who are involved in the bamboo value chain in Hula district, are: (1) bamboo resource producers (farmers and churches); (2) traders/brokers/middlemen/whole sellers; (3) bamboo processing enterprises (factory owners, individuals, and micro enterprises); (4) consumers (individuals, hotels, offices, and exporters).

Bamboo value chain maps

Bamboo value chain starts from growing the bamboo culms mostly by rhizome with culm (offset) followed by production and transportation of the raw bamboo culms to firms and marketing places. Then the bamboo culms will be processed into different products and reach to the consumers. In order to have effective bamboo value chain, enabling environments like good policies, access to market, finance and resource governance are crucial. An example of bamboo value chain map at Hula district in Sidama Region, in Southern Ethiopia is shown in Fig. 1.

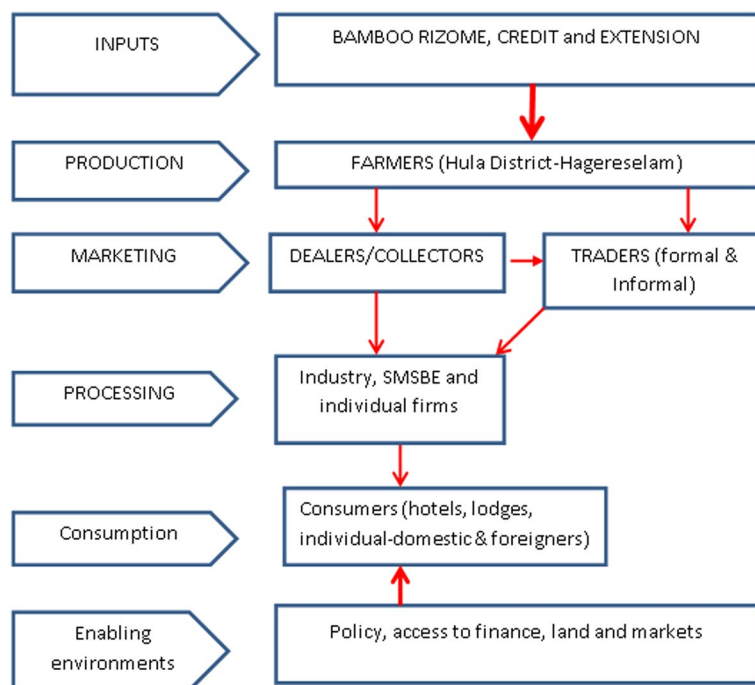


Fig. 1 Value chain map of highland bamboo in Hula district-Sidama Region, Ethiopia

Bamboo producers and production

Most of the farmers, not only in Hula district but also in all initially assessed study districts, prefer to plant bamboo at the lower side of their farm and riverside, which are considered marginal lands not suitable for crop production. Moreover, most of the naturally grown bamboos owned by churches are also found as mixed forests with tree species like *Juniperus procera* and *Hagenia abyssinica*.

Thus far, farmers are cultivating and managing their bamboo resources in the traditional way that they have inherited from their families. They use only offset for the production and promotion of bamboo. They are planting bamboo offset with buds usually in April each year. Then, in July during sufficient rain, it will give the new shoot (culm). Farmers usually plant bamboo far from their enset (*Ensete ventricosum*) plant so as not to be invaded by bamboo rhizomes. Sometimes, farmers dig furrows as barrier to protect the enset plant as we observed in Chench district during the field visit. The depth of the hole for bamboo offset planting is about 50–60 cm. Farmers loosen the soil and prepare for planting before 5–6 days or in some cases it will be open for the whole dry season. Soil loosening and smoothening will help the bamboo to sprout new shoots and come out from the soil without difficulties. Most of the time, cow dung and house waste, which are prepared and supplied for enset production can also be used for bamboo. In the first year after planting, the emerged bamboo culm is very thin. Gradually, bamboo culms become bigger in diameter, especially after 3 years. Farmers usually cultivate bamboo stands once a year and that will be in May before the start of the rainy season.

As farmers foretold, harvesting of bamboo culm usually not practiced during moon days. Farmers only cut bamboo culms when there is no moon light with the belief that bamboo culm will not be affected by the culm weevils. Additionally, most farmers do not cut bamboo from February–June months of the year in Hula district, because farmers believe that this period is the time for shoot initiation and emergence. However, in Chench district, farmers prefer the dry period (October–February) when bamboo clumps are not at their shoot reproduction.

In most cases, unless the culm is more than 3 years old, farmers do not cut the culm for utilization. When demand comes from the buyers' side, however, culms with 2 years of age are also being cut in lesser quantities for weaving purposes. The timing of bamboo harvest is crucial in determining the quality of culms. In addition, culms become prone to insect attacks when stored in poor-quality shades (Jessie et al., 2019). Many farmers harvest their bamboo when they need income for their livelihood supplement.

The bamboo resources are declining from time to time and the reason varies from district to district. One of the reasons was that (e.g., Guraghe zone), farmers have become reluctant to plant bamboo and even converted the existing ones to eucalyptus plantations. The most limiting factor that affects the expansion of bamboo is the price of bamboo culms. This is also associated with shortage of labor to help farmers during planting and management in the case of Chench district. Most of the youth migrate to different parts of the country for labor where there are bamboo resources and associated job opportunities. Moreover, the mismanagement of bamboo, favored by lack of proper planning and incentives contributes to the widespread degradation of bamboo resources in state and communal forests (Edoardo, 2019).

Processors and processing

During field assessment, it has been observed that the production of different traditionally made bamboo products varies from place to place based on the producers' level of education, experience and tools/equipment owned by the processors. Bamboo has many different uses in the studied districts (Fig. 2). Some of the products that are produced locally from bamboo and used locally include, but are not limited to, fences, house construction, separation of rooms in the house, separation of home garden from house, baskets, hand tools to process enset, for coffee drying material, for cleaning grains, simple bamboo knife, sieves, beehives, chair, flooring material, for constructing animal shelters, grains stores, house construction and many other products. At farmer level, they are using for production of tools as they have no exposure to modern technology to produce other complicated and attractive products that require special training. From their long years of practical experience, farmers prefer bamboo for fencing instead of Eucalyptus because eucalyptus decays (rots) very fast. The same types of products that require similar skills are produced in the same area. For example, on the same road that stretches for many kilometers, mats are the only products available (Jessie et al., 2019). Once in a while, craftsmen receive special product orders from customers.

As the key informants explained, the price of the product varies from product to product depending on the time required to make the finished product (man-days) and the materials used (e.g., culm quality). The prices of bamboo products also differ from district to district. The variation in price of the product could have a connection with prices of culms that are related to distance from sourcing, the accompanying high transport cost and the demand and market options in a particular district. According to Grand View Research's bamboo market size, share and trends analysis report, in 2022, the



Fig. 2 Local bamboo product innovation by processors (top left—house utensils; top middle—table decoration; top right—lump shade; bottom left—grain store; bottom middle—chair; bottom right—guest houses)

global bamboo market size was estimated at USD 61.69 billion (GRV, 2022). To this end, bamboo resources in Ethiopia have the potential to generate 5 billion dollars in revenue and 1.3 million jobs (INBAR, 2018a, 2018b). In economic terms in the context of our study area, a bamboo firm in the study area produces seven different types of products by involving 18 man-days. The gross revenue from the products was 5650 ETB, which yields net benefit of ETB 3804.55 within 2 weeks. This contribution means a lot to local economic impact when estimated on an annual bases in terms of livelihood income and employment generation (Table 2). However, this economic contribution could be improved, if modern processing tools, machines, and additional trainings are provided to processors. Signifying the contribution of bamboo to local economies, the study by Mekonnen et al. (2014) has shown that household's cash income contribution of bamboo was 3.9% at Tikur Enchini, 3.4% at Masha, 5.7% at Asosa/Bambasi, 7% at Chencha, 18% at Hagerselam and 38% at Banja and Bahir Dar Zuria. Other studies have also shown the income contribution of bamboo to local people: 19% of household income in Dawuro zone, south western Ethiopia (Obsa et al., 2015), 17.2% in Beles River Basin, north western Ethiopia (Abebe et al., 2021), 13.3% in Guangxi, China (Hogarth & Belcher, 2013).

There are different bamboo landraces growing in the areas assessed. Indeed, there are knowledge gaps in using the different races for different uses by processors. Some did not make specific identification mechanisms to use them for specific purpose and/or use while others are, more or less, use different landraces for different purposes. Bamboo landrace with small hallow culm type is used for making legs for beds, sofas and chairs.

Marketing options are one of the challenges of bamboo processors. Due to lack of market linkage combined with lower quality bamboo products, which can be replaced by wood-made products (e.g., chairs and tables), processor went to different local markets to search for a buyer. Processors in Hawassa city and also in other zones usually produce products when they get orders from customers. Sometimes, the processors get orders from customers with specifications. An increasing trend of demand for bamboo products is observed around holidays specifically in September, and December to the end

Table 2 Types of bamboo products and production costs in Hula district, Ethiopia

Materials used	Type of the product and cost of production (ETB) in 2021						Total
	Stool	Large table	Small sofa	Large sofa	Bed	Coffee table	
Large bamboo culm	25	75	75	125	375	0	675.00
Medium bamboo culm	0	0	0	0	0	36	36.00
Small bamboo culm	0	0	16	24	0	0	40.00
Small Eucalyptus poles	0	0	0	50	200	0	250.00
Nail	14	17.5	23.5	105	70	23.35	253.35
Sandpaper	4	5.7	5	40	20	20	94.70
Glue	15	21.45	21.5	30	75	25	187.95
Paint	3	4.3	30	6	15	5	63.30
Varnish	17	24.3	56.5	34	85	28.35	245.15
Total cost in ETB	78	148.25	227.5	414	840	137.7	1845.45
Labor	1MD	2MDs	2MDs	3MDs	8MDs	2MDs	18MDs
Selling price	150	300	500	1200.00	3000.00	500	5650.00
Net benefits	72	151.75	272.5	786	2160.00	362.3	3804.55

MD is man-day

of April as consumers buy different bamboo-based decors and utensils during holidays. According to stakeholders' opinions, at local level in general, the demand for bamboo products has decreased over the years in the studied districts irrespective of the increase in towns and cities in other places in the country. This is due to the availability of timber made products which can be easily made locally or come from other cities with better quality produced by better tools. However, the price of bamboo products increased from time to time because the price depends on the price of the culm which is demanded by processors in other cities.

Processing tools/equipment and machineries

During field assessment, it has been observed that the processing tools are local and not suitable to create the required shape and design. They reduce productivity, efficiency and increase waste, while those in other countries (e.g., China) are modern tools that can increase efficiency and productivity. Processors have higher demand for modern processing tools and equipment. However, modern processing tools and equipment (e.g., splitting machines, shooter, etc.) are partially available in the market, and even those machines found in the market are costly and unaffordable by the local processors. Thus, the processors' capacities and products are affected due to lack of important machineries and tools. This requires financial support from financing agencies through allocation of appropriate credit facilities. During stakeholder discussions, it was noted that there were available credit facilities both from Omo Microfinance and Sidama Microfinance but bamboo was not considered as an important commodity by the corresponding institutions. On the other hand, most processors have no as such developed culture to take loans and they fear getting loans in suspicion of repayment challenges. On the contrary, during our discussions in Guraghe and Hadiya zones, it was understood that there is an absence of flexible financing mechanisms for bamboo processors, unlike metal and wood product processors. Lack of appropriate and easy credit facilities is one of the fundamental problems for their business (collateral and bureaucracy are some of the challenges). Sometimes processors are forced to look at informal institutions (like Edir) to borrow money to buy inputs, but the interest rate of informal institutions is higher up to 15% interest rate. Therefore, processors cannot afford to borrow from informal institutions for a long period. This will affect the promotion of bamboo products and marketing in the area.

Traders and trade

Currently, the demand for bamboo raw materials is increasing in small and big cities. Most of the time farmers sell their raw bamboo either directly to traders and/or to locals for house construction or in some cases to dealers. Licensed traders are the main culm buyers from farmers. Traders either directly deal with the bamboo processors, lodge owners who want to construct lodges, big factory owners or whole bamboo culm sellers. Dealers and local collectors (youth group) are important for the traders, especially in bringing the bamboo culm from difficult sites. Dealers (collectors) in some cases buy culms from individual bamboo farmers; perform important storage functions at roadsides for bamboo culm traders and get their service payment. The wholesalers buy larger volumes of culms from either farmers or collectors and sell to processors (house

builders, furniture makers and small and medium enterprise owners) after paying royalty fees and getting permission papers at different urban markets in Ethiopia.

Bamboo, as raw material and semi-processed and processed products, is being sold at different locations passing through different routes based on the request and demand of the customers (Fig. 3). In the focus group and workshop discussions, participants claimed that identifying those major trading routes will help to set market strategy in linking the producers to other stakeholders in the higher value chains and as an alternative market to sale bamboo products.

The cost of transportation of raw bamboo from sourcing sites to Addis Ababa and/or other cities are based on distance of sourcing sites from Addis Ababa and/or other cities and the load capacity of a truck. In most cases, traders use different sized trucks with different culm loading capacities. Accordingly, the transport price also varies with the loading capacity of a truck. In 2020, the transport cost of medium-sized truck from Hagereselam to Addis Ababa and Adama was 8000 Birr but for that of larger sized truck to similar place was 12,000 Birr, whereas the transport cost by larger truck from Hagereselam to Hawassa was 6000 Birr. On the other hand, discussants underscored that when they make semi-processing of the bamboo culms at the farm gates, a medium-sized truck can load twice its capacity of loading the unprocessed bamboo culm. However, the loading capacity of a truck varies with the quality of roads and the time of the season. Asphalted roads and dry seasons are good for bamboo culm transportation from farm gates to urban yards.

Traders buy bamboo culms based on their sizes by giving different grades. Bamboo culm has four local grades which are considered as 1st, 2nd, 3rd and 4th. The first one has a culm circumference greater than 20 cm, the second one is 15–20, the third one is 10–14 and the fourth one is considered as the thin one. Accordingly, a medium-sized truck can load about 450, 550, 700 and 2000 culms of grade 1, 2, 3 and 4, respectively. The cost of the culm was based on these grades. There is an increasing trend in bamboo culm prices which has almost tripled in the last 5 years. In addition to the size, the quality of bamboo culm and price are also negotiated based on length and absence of damage on a culm caused by insect and/or other physical damage during harvesting and transport.

Farmers have limited market information and the only way of knowing the price is when the buyers/dealers are coming to their village. They do not know whether the price is high or low at other places including central markets in Addis Ababa. This will lead to marketing imperfection and cause farmers to lose profit. For instance, Solomon et al. (2016) found in their study that the major problems of producers were lack of road

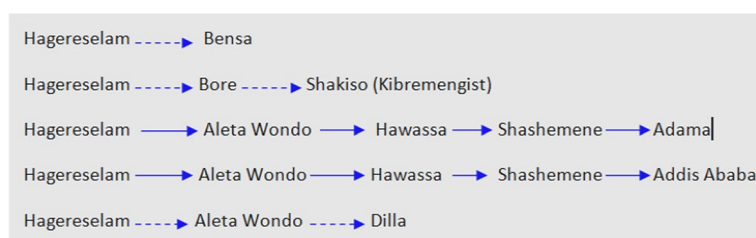


Fig. 3 Bamboo market routes from Hula district (Hagereselam town) in Sidama region, Ethiopia

infrastructure and market information which was agreed by 71% and 43.2%, respectively, of the respondents in their survey. Sometimes, the brokers/dealers mislead farmers about the market situation and inform farmers as if no demand exists for bamboo culm. By so doing they suggest the selling price of bamboo culm to be low. It has been understood that the zonal offices so far have done limited interventions that improve the value chain of bamboo. The bamboo market is believed to be a buyer's market by the experts. For farmers to produce better quality bamboo culm and get better prices, experts suggest organizing farmers into cooperatives with up to five members at village level so that they can have better bargaining power while selling raw bamboo culm. Otherwise, as indicated by Mulat et al., (2023a, 2023b) in their study result, it will lead to unfair share of producers' marketing margin (18.56%) from the total marketing margin as compared to processors (49.47%) in the value chain. Moreover, Teshome (2020) has also shown the highest market margin analysis result (about 90%) of the total gross marketing margin was added to bamboo culm price when it reaches the final receivers in Addis Ababa due to the inaccessibility of seasonal vehicle roads, loading and unloading costs, and huge care rent.

In most cases traders have no time to collect from each farm. They want to come with truck and want to load and take it once. This has been an opportunity for dealers to buy and sell it for profit. Most of the time, bamboo is cut and collected from the lower part of the farmers' land where water is available. It is located about 200–300 m from the farmer's house. Recently, the majority of the brokers/dealers or traders buy standing bamboo while bamboo is on the field to make selections of good quality fresh culms. There was a higher culm price variation between Addis Ababa and sourcing sites. However, when the value chain is elongated, the profit gained will be minimized.

Opportunities and challenges in bamboo value chain development

Opportunities and challenges

Many reports and studies indicated that there are more than 2000 bamboo uses (Abadega & Abawaji, 2021; Böck, 2014; Durai et al., 2018; EFCCC and INBAR, 2020; INBAR 2011, 2019; Kassahun, 2015; Kebede, 2018; Mathewos, 2017; Monaco, 2019; Mulatu & Kindu, 2010; Nigatu et al., 2020; Song et al., 2011; UNEP, 2014). This is an opportunity to consideration for bamboo value chain development in Ethiopia and elsewhere. Moreover, bamboo in Ethiopia has been used in commercial, industrial, domestic, energy, environmental services, job creation and other opportunities that contribute to sustainable development goals.

Nevertheless, value chain research has been applied in many studies globally and mostly focuses on upgrading and development, especially in supporting small-scale farmers and producers in rural areas where they are mainly categorized as disadvantaged actors in the chain (Marcellinus et al., 2021). There exist different challenges in the value chain that have effects on bamboo value chain development (Table 3). Similarly, other studies have shown the challenges of the value chain development in Ethiopia (Alemayehu & Hido, 2023; Alemu et al., 2022; Tsegaye et al., 2022). To this end, therefore, it is important to work towards alleviating/minimizing the major challenges considering all actors in the value chain and also strongly strive towards improving the value chain through utilizing the available opportunities and creating

Table 3 Challenges claimed by actors in the bamboo value chain in the study area Ethiopia (5 is high priority and 1 is least)

Actors	Challenges	Level
Farmers (bamboo growers)	Market channel is operated in business as usual with very limited market linkage and lack of strong market channel	5
	Traditional way of bamboo growing by farmers (poor management resulting in the production of poor-quality stands/culms)	2
	Availability of neither new bamboo species nor seeds of highland bamboo	4
	Porcupines, wild pigs, insects, and other animals that damage the bamboo shoot	3
	Farmers lack knowledge of highland bamboo seedling production due to lack of training	4
Processors (product designers and producers)	Lack of improved processing machineries in the local market	5
	Limitation of spray and varnish tools to make the product attractive	2
	Unavailability of marketplace/space for selling and displaying bamboo products	4
	Neither budget to buy inputs and machines nor financial options	5
	Reduction of culm quantity over years regardless of a gradually increasing trend of culm price	3
	Lack of awareness of the different products of bamboo and only producing traditional once	4
	Lack of innovativeness in product design and product differentiation and specialization is minimal	5
Traders (marketers of different bamboo products)	Labor intensive to harvest bamboo culm from the bamboo stand using local tools	3
	Capital shortage for large scale (expand) bamboo trading work	5
	Competition with illegal traders, especially after 2008, has made the legal ones to sale at lower prices that create a loss of profit	4
	Business capacity is limited and associated with no special training	4
	Unavailability of all-season roads and only in dry season affects marketing	3
	Increasing transport costs from time to time	3
	Lack of modern harvesting tools	4
	Price is determined by the whole sellers /fluctuation by customers as they want	4

favorable conditions for all actors in the value chain. Moreover, sustainable, participative, and coordinated management of both private farmland and state/community bamboo forests is crucial to fundamentally improve the quantity and quality of the sustainable resource supply and market linkage (Edoardo, 2019).

It is, therefore, important to work towards alleviating/minimizing the major challenges considering all actors in the value chain and also strongly strive towards improving the value chain through utilizing the available opportunities and creating favorable conditions for all actors in the value chain.

Conclusions

Highland bamboo is used as a raw material for semi-processed and processed products and sold at different locations passing through different actors. The study identified major challenges such as lack of processing tools which limit the efficiency of processing household and office usable products in the value chain development. Local processors capacities and products are affected due to lack of important machineries and tools. Therefore, it is important to work towards alleviating the major challenges in the bamboo value chain by tapping the available opportunities.

Bamboo growers are cultivating and managing their bamboo resources yet in traditional way. The practices are inherited from their ancestors and need viable technical and management support to develop skills for better production. Therefore, technical training of farmers to improve marketable culms production on one hand, and enhancing bamboo management through technical training of farmers, and introducing and promoting modern processing tools and machines for processors through credit support system on the other hand, are crucial to make the value chain competitive. In addition to these, trader's capital limitations and business making capacity should get the attention of the government at all levels for special entrepreneurial training and credit support system.

Recommendations for further development, research, and policy interventions

Development interventions

It is crucial to provide training to farmers, district-level experts, and development agents on seedling production, cultivation, management, and utilization of bamboo to increase culm productivity and product quality guided by research outputs and better bamboo production and management guidelines. This could be supported by the integration of bamboo development into local forest development and watershed management plans by organizing and networking with regional governments, NGOs, industry, and consumers. In addition, establishing different forums for the promotion of products and allocating appropriate workshops/trading places for bamboo-based products; introducing and promoting modern processing tools and machines and facilitating credit support mechanisms will enhance the development of efficient bamboo value chain.

Research intervention

Introducing alternative best adaptable high yielding and performing bamboo species to increase productivity and studying on the use of different landraces for different end uses (products) to upgrade quality are crucial. Additionally, mapping the area extent of highland bamboo resources using GIS, assessment of consumers' needs, studying on alternative options for bamboo propagation, developing sustainable bamboo management technologies and assessment of the livelihood contribution of bamboo to farmers during ex ante and post ante interventions are essential for better production of the resource. Moreover, assessment of bamboo culm deteriorating insect pests and disease management would help to improve product quality and decrease resource damage.

Policy and strategic directions

Provision of formal education and market information is crucial for the bargaining power of the producers (Solomon et al., 2016). Linking growers with bamboo processors increases the profit margins of both actors because unnecessary costs are eliminated (Mulat et al., 2023a, 2023b). Moreover, it is important to organize neighboring farmers in grower cooperatives to enable them market their culm produces in large quantities for attractive prices. Good governance and effective implementation mechanisms, developing relatively simple rules and regulations for credit access, and operational marketing policy for bamboo products attract more people to invest in the sector. Establishing international partnerships in bamboo products export marketing will create more opportunities for product commercialization. Rural access roads facility is important step to bamboo growers for availing the bamboo culms to local markets as poor road network in most places hinders bamboo culm transportation and marketing.

Abbreviations

CIFOR	Center for International Forestry Research
DAs	Development Agents
EFCCC	Ethiopian Environment, Forest and Climate Change Commission
FAO	Food and Agriculture Organization
INBAR	International Network for Bamboo and Rattan
MD	Man-day
NGOs	Non-governmental organizations
SNNPR	Southern Nations, Nationalities and Peoples' Region
UNEP	United Nations Environment Programme

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Author contributions

All authors participated and contributed in conceptualization, data collection and analysis, writing the manuscript and reviewing.

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Availability of data and materials

All data for the research are available.

Declarations

Competing interests

The authors declare that there is no conflict of interest.

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