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Farmers' Management Practice and Characterization Study of Commonly known Land Races of High Land Bamboo Species (*Arundinaria alpina)* at Bore District, Guji Zone, Southern Oromia

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Abstract

Bamboo plays manifold role in day-to-day life of rural community. However, in Ethiopia it is utilized below its potential due to lack of scientific knowledge and awareness on its management and utilization. To fulfill needs of rural people, recording farmers' traditional knowledge and effective conservation and sustainable utilization of the bamboo resource is very vital. Therefore, the overall objective of this study was to identify Farmers Management Practice of highland bamboo stands and to characterize and select superior land races of high land bamboo species (*Arundinaria alpina)* at Bore District, Guji Zone, Southern Ethiopia. Primary data was collected through Focus group discussion, Key informant interview and Questioner survey. The result of the study indicated that, local people have experience of developing bamboo stands using their indigenous knowledge. Bamboo growers' of the study District have their own calendar of bamboo planting time and based on their criteria easily identified commonly known land races of high land bamboo species of the area. Based on the farmers' criteria, the three commonly known land races of *Arundinaria alpina* such as Okotu, Shanto and Uratiti were collected from Bore District. All collected land races of high land bamboo species *(Arundinaria alpina)* were planted in a randomized complete block design (RCBD) by three replications at spacing of 3m between seedlings, 3m between blocks and 2m between plots. As the results of this study showed that, in terms of their survival rate and number of shoots, all collected land races of *Arundinaria alpina* were not significantly different at $P \leq 0.05$. However, Okotu land race of High land bamboo species was significantly higher (at $P \leq 0.05$) than High land bamboo species of Uratiti and Shanto land races by culm diameter, culm height, internode length and number of node. Based on the findings of this study, from all collected land races of *Arundinaria alpina,* Okotu land race was superior than the remaining land races of high land bamboo species (*Arundinaria alpina).* Therefore, for this superior highland bamboo land race sustainable conservation should be vital for long term utilization of the resource. In addition, based on their accumulated experience, bamboo growers of the study District have deep knowledge of bamboo management practice. Therefore, integration of their traditional knowledge with modern Scientific Knowledge is very important for sustainable management and utilization of bamboo resources.

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Arundinaria alpina, High land bamboo species, Land races, Management.

Introduction

Bamboo is the fastest growing perennial grass species that belongs taxonomically to the subfamily of Bambusoideae under the family of Pocaceae (Nath *et al.*, 2009). More than 1,500 species and 90 genera of bamboo are found in the world and distributed in the tropical and sub-tropical belt between 460 North and 470 South latitude at elevations as high as 4000m above sea level. Bamboo plants are commonly found in Africa, Asia and Central and South America (FAO, 2007).

It is estimated that about 21 million hectares of the earth surface is covered by bamboo forests (Kalbesa *et al.*, 2000). The Ethiopian natural bamboo forest is about more than 1 Million hectares, which is about 7% of the world total and 67% of the African bamboo forest area (Luso, 1997). Two species of bamboo comprise the bamboo forest in Ethiopia, namely the high land bamboo species (*Arundinaria alpina*) and the low land bamboo species (*Oxytenantera abyssinica*). Out of which the high land bamboo species comprises about 300,000 ha and low land bamboo covers 800,000 ha (Luso, 1997; Kasahun, 2003).

Bamboo is a plant of enormous importance in several regions of the world and it has age old connection with human needs. It is a preferred material for various uses due to its straightness, high strength, light weight, easiness to work with, suitable fiber for pulp production and absence of bark (Sahara and Seen 1990). Bamboo has become suitable for a variety of uses and services. It provides food, shelter and other consumer goods. The bamboo has high physical property for construction, industrial utilization and a considerable value in agriculture and stabilization of ecological balance (Kasahun, 2003).

Bamboo plays manifold role in day-to-day life of rural community and it has an imperative role in cultural, artistic, industrial, agricultural, construction and household needs of human beings (McNeely 1995). In order to fulfill material needs of rural people collection and characterization of bamboo germplasm is paramount for effective conservation and sustainable utilization of bamboo resources (Nayak *et al.*, 2003).

In Ethiopia, highland bamboo species (*Arundinaria alpina*) widely growing naturally in the south, south-west, central and north-west highlands of Ethiopia at altitudes ranging from 2200 to 4000 meters above sea level (Luso, 1997). However, the bamboo resource in Ethiopia is utilized far below its potential due to lack of knowledge on its management and utilization (Embaye, 2000) such as lack of technology for its utilization and lack of information on the propagation methods. The resource was neglected in the past but currently there are different initiatives to manage and develop the resource sustainably (Andargachew, 2008; Kelbessa *et al.*, 2000)

In Southern Oromia, Guji zone have five potential high land bamboo grower Districts and over 7,460 hectare of land is covered by bamboo plantation. However, traditional knowledge of Farmers management practice, Collection and characterization study of commonly known different land races of high land bamboo species existed in the high land Districts of Guji zone is not yet identified.

As well, the potential of these fast growing and high yielding perennial plants regarding to the economic development and improvement of the income of small scale farmers of Guji zone is very little. Therefore, this research was designed to identify Farmers Traditional knowledge on managements of high land bamboo stands and to collect, characterize and identify the superior local land races of high land bamboo species *(Arundinaria alpina)* of the study area for further diversification.

Materials and Methods

Description of the study area

Bore is one of the High land Districts in Guji Zone, Oromia Region, Ethiopia. From the total area of Bore District, 29% is arable land, 33% pasture land, 30% forest land, and the remaining 8% is considered swampy and degraded land. The traditional farming system of the area is characterized by cultivation of major crops such as Food Barley, Bread wheat, Maize, Faba bean, Irish Potato and Enset. From non timber forest products high land bamboo species also used as income generation for local communities of the study area. According to 2007 national census reports, a total population of Bore District was 210,179, of whom 105,726 were men and 104,453 women; 10,258 or 4.88% of its population were urban dwellers and With an estimated area of 1,296.88 square kilometers (CSA, 2005).

Collection and Characterization study of highland bamboo land races was conducted at Bore Agricultural Research Center, on station. The experimental site is about 385km far from Addis Ababa. Geographically, the experimental site is situated at altitude of $06^{0}23^{1}55''$N

and longitude $38^{0}35^{1}5''$E.The experimental site represented high land agro-ecologies of Guji Zone having an altitude range of 2200-2780m above sea level. The area receives an annual rain fall ranging from1400-1800mm with a bimodal pattern that is extended from April to November. The mean annual minimum and maximum temperature of the experimental site is 10^{o}C and 20^{o}C respectively. The soil type of the experimental site is red basaltic soil (Nitosols). The soil is clay loam in texture and strongly acidic with pH 4.53 to 5.13 while moderately acidic with pH 6.5.

Data Collection Methods

In order to identify Farmers Traditional Knowledge of high land bamboo species (*Arundinaria alpina*) of the study District, data collection tools employed were Focus Group Discussion, Key informant interview and Questioner survey. By using these tools, based on their traditional knowledge bamboo growers' of the study District were identified three commonly known land races of high land bamboo species. After those commonly known high land bamboo species land races were identified, their Collection and characterization study was carried out.

Sources of the planting material and Experimental Design

The three commonly growing land races of high land bamboo species (*Arundinaria alpina)* such as Shanto, Uratiti and Okotu were collected from Bore District, Guji Zone, Southern Ethiopia. All collected land races of high land bamboo species were planted in a randomized complete block design (RCBD) in three replications at Bore Agricultural Research Center, on station. Plot size of 9mx9m was used and on each plot nine bamboo seedlings were planted. The collected local land races of high land bamboo species seedlings were planted at spacing of three meters between seedlings, three meters between blocks and two meters between plots. The size of the planting pit used for this study was 50 cm deep at a size of 50 cm wide x 50 cm long pits and their planting carried out with some inclination.

Management and Assessment of the experiment

Before and after the seedlings of collected land races of high land bamboo species (*Arundinaria alpina*) were planted out on experimental site, all necessary managements were done. Prior to the planting time, forest soil, animal dung and compost were prepared at Bore Agricultural Research Center on station. For better survival of the bamboo seedlings all prepared materials were mixed and used at planting time to make the soil more porous for the planted seedlings. After the collected bamboo seedlings planted out on experimental site basic managements such as mulching, watering, weeding and hoeing were provided properly. After the planting time, to see the performance of each land races of high land bamboo species (*Arundinaria alpina)* all the necessary data such as survival rate, number of node, number of shoot, internodes length, Culm height and Culm diameter were recorded quarterly.

Statistical Analysis

To identify Farmers management Practice of high land bamboo Species of the study District, both descriptive and inferential statistics were employed to analyze the collected data. For Experimental Research, the data was summarized and analyzed using appropriate statically package of SAS version 9.1. A one-way analysis of variance (ANOVA) was used to compare the mean using the least significant difference (LSD) at 5% level. Mean separations was done for those parameters which showed statically significance difference using least significance differences.

Results and Discussion

Farmers Traditional Knowledge on Management Practice of Highland

Bamboo Species

Farmers Participation and their Experience on Bamboo Planting

Based on the information obtained from Focus Group Discussion, Key informant interview and Questioner survey both Genders (Male and Female) and youngsters and aged farmers were participated during bamboo planting time. The finding of this study indicated that, in terms of gender category 78.5% and 21.5 % participated on bamboo planting task were Men and Women respectively (Figure 1). As well, respondent households indicated that, during bamboo planting time 80.4% participated farmers were aged and the rest 19.6 % were youngsters (Figure 2).

Majority of bamboo growers' farmers of the study District had experience of bamboo planting for many years. About 70 % of respondent households in the study

District got the experiences of bamboo planting from their family, 26% respondent households got practice of bamboo planting from their neighbors and the remaining 4% respondent households were obtained experience of bamboo planting from government organization (Figure 3).

As the finding of this study showed that, the contribution of other sectors in provision of technical support and training on bamboo management was very minimal especially from government and non government institutions. Therefore, if bamboo growers local people of the study District are supported with techniques and inputs like trainings, working tools, planting materials and if local administration is involved in resolving such issues and allocate idle areas like river banks and valleys for bamboo, the size of the plantation bamboo forest would significantly increase (Seyoum *et al.,* 2018).

Farmers Practice of Identifying commonly known High land Bamboo

Species landraces of the area

In the study District, majority of respondent households identified all available different commonly known bamboo landraces of the area and they have experience of naming different bamboo land races as Okotu, Shanto and Uratiti. Similar to this study finding, the study result conducted at Choke Mountain, Northern Ethiopia showed that farmers have experience of naming different bamboo landraces as Tifro, Wonde, Welele and Enkotekot (Yirgadu, 2012). In contrary to this study finding, the study result carried out in Kokosa District, South East Ethiopia revealed that, even if local communities of the area known availability of different bamboo landraces, they do not have experience of naming different bamboo landraces (Seyoum *et al.*, 2018).

Bamboo growers' farmers of the study District identified commonly known different land races of high land bamboo species of the study area based on their different criteria of bamboo characteristics. The participants of key informant interview and Focus Group Discussion indicated that the criteria farmers used to classify bamboo landraces were Internodes length, Culm diameter, Stem color, Splitting Nature, Rooting nature and Sprouting nature of the bamboo land races after harvesting. Farmers Traditional Knowledge used to identify commonly known land races of the study District is partially similar to that of criteria used in the study result of Mulatu (2012) and Seyoum *et al.,* (2018). The finding of this study also similar with Indigenous knowledge of bamboos by Naga community, Tasikmalaya District, West Java, Indonesia. Community of the area identified locally available bamboo species and variation of bamboos based on several groups, namely based on color of bamboo culm, size of stem diameter, bamboo reed wall thickness, edible and non-edible of bamboo shoot, utilization types, economic or selling price, and ecological functions (Budi *et al.*, 2019).

Farmers Traditional knowledge on Bamboo planting practice

Based on information obtained from bamboo growers farmers of Bore District, location for planting bamboo is selected, particularly that close to water sources and being moist, such as river bank. This is intended to provide good condition to new rhizome to adapt with new environment. The biomass of grass and shrubs are used as compost for organic fertilizer. Participants from Focus Group Discussion and Key informant interview indicated that local communities of the study area have their own calendar of planting time and usually planting of bamboo activities conducted at the beginning of the rainy season.

Among the different propagation techniques used, majority of 95% of the total households responded that, they used offset plating technique and the remaining 5% responded households used rhizome planting technique. Bamboo offset planting is the process through which farmers carefully uproot bamboo Culms and transporting it together with the soil held by the roots and then plant in holes dug wider and deeper prepared. However, bamboo growers' farmers of the study District stated that, this type of propagation has many difficulties, such as time consuming and impossible to transport more culms at a time. Similar to this study finding, Mudoi *et al.,* 2013 and Singh *et al.,* 2013 on their study finding indicated that the traditional production method using offset technique is cumbersome and too inefficient for practical use.

Table.1 Analyzed parameters results of collection and characterization study of high land bamboo species Land races, at Bore Agricultural Research Center, on station, Guji Zone, Southern Oromia

	Parameters					
Treatment	S rate(%)	Nno	Nsh	Inl(m)	Cht(m)	Cdi
Okotu land race	92.67[a]	24.8 [a]	66.75[a]	24.625 [a]	5.2275[a]	3.4083[a]
Shanto land race	88.33[a]	21.915 [b]	57.783[a]	22.2[ab]	4.9433[b]	2.8083[b]
Uratiti land race	92.267[a]	21.292 [b]	53.702[a]	20.067[b]	4.275[b]	2.772[b]
Mean	92.56	22.67	59.253	20.067	4.8153	2.996
CV (%)	11	4.97	13.835	20.067	7.52	5.5587
LSD	NS	2.552	Ns	20.067	0.8204	0.3776

Level of significance ($p \leq 0.05$), ns =non significant; Means with the same letter are not significantly different; cv=coeffient of variance, lsd=least significant difference, Srate=survival rate, Nno=number of node, Nsh=number of shoot, Inl=internodes length, Cht=Culm height, Cdi=Culm diameter

Fig.1 Bamboo Growers' participation on bamboo planting task by Gender category

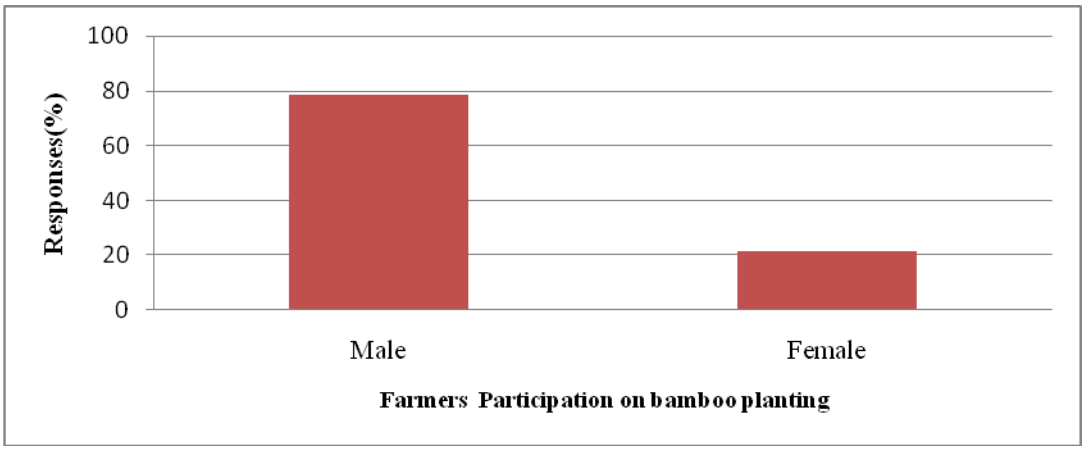


Fig.2 Bamboo Growers' participation on bamboo planting task by age Category

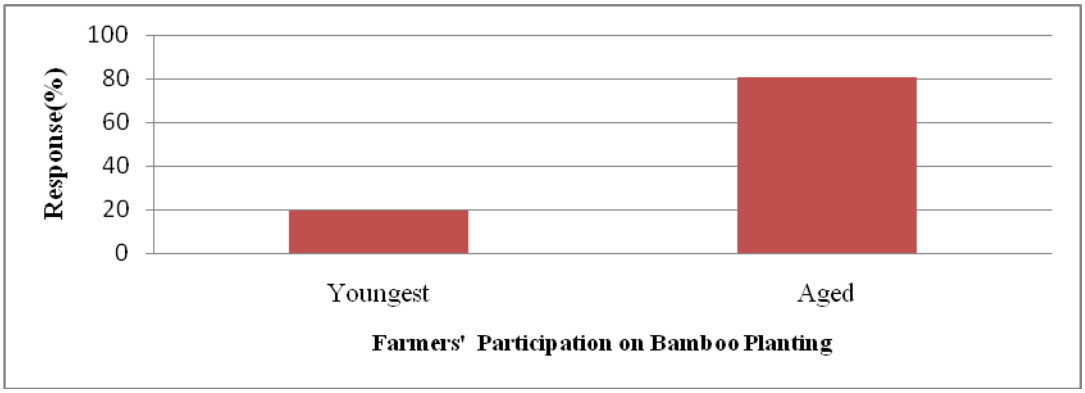
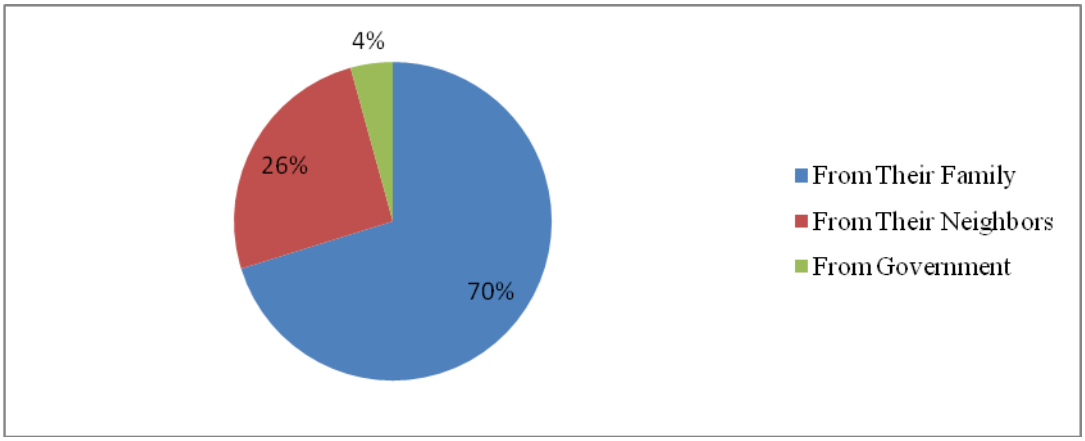


Fig.3 Farmers' Source of Experience on Bamboo planting



In contrary to this study finding, on their study finding Ray and Ali (2017) stated that use of bamboo cutting propagation technique is a viable alternative in most bamboo species but the indigenous bamboo species of Ethiopia have proved difficult to raise planting materials through cuttings. According to the information obtained from participants of Focus Group Discussion, key informant interview and respondent households farmers' practice of using Rhizome planting technique is very little. Bamboo growers' local communities of the study District used this technique by separating of rhizome base from bamboo clump and then planted in the prepared land. On their research findings, Ediningtyas and Winarno 2012 indicated that the technique of using rhizome is better than using of stem cutting because the rhizome has still nutrient stored in its base which can avoid desiccation.

Collection and Characterization Study Results of Commonly Known Land

Races of High land Bamboo Species in Bore District.

Survival rate and number of shoots of the collected Land races of Highland

Bamboo Species

As the finding of this study indicated that, in terms of their survival rate and production of number of shoot, all collected land races of High land bamboo species *(Arundinaria alpina)* were not showed significant ($P \leq 0.05$) different (Table 1).This could be due to all land races of high land bamboo species (*Arundinaria alpina)* were collected from similar agroecology their survival rate and production of new shoots were very similar. However, Bennet and Gaur (1990) on their study results suggested that the study of young vegetative shoots which sprout annually during rainy season is very significant for identification and characterization of different bamboo species. Another research finding also indicated that the production of new culms (shoots) can be very prolific one year and quite sparse in another year, that is the growth rate may vary widely between the individual growing seasons (Were, 1998).

Number of node and internodes length of the collected land races of Highland Bamboo Species

The results of this study revealed that, in terms of their number of node and internodes length, all collected land races of high land bamboo species (*Arundinaria alpine*) were significantly different at ($p \leq 0.05$). The finding of this study is supported with the previous study of Chatterjee and Raizada (1963). On their study findings they were indicated that number of node, internode length and other vegetative parameters are a key for identification and good characters for distinguishing the different bamboo species.

From all collected local land races of high land bamboo species, Okotu land race of *Arundinaria alpina* was significantly higher ($P \leq 0.05$) than the remaining land races of *Arundinaria alpina* by internode length and number of node(Table 1).

Accordingly, mean values of number of node and internode length of Okotu land race of *Arundinaria alpina* was higher than by 2.85, 4.56m respectively as compared to the remaining land races of high land bamboo species. However, as indicated in Table 1 above as compared to Okotu and Shanto land races of

Arundinaria alpina, mean values of Uratiti land race of *Arundinaria alpina* was the lowest in internode length (0.2m) and number of node (24.29).

Culm Diameter and Culm Height of the collected Land races of Highland

Bamboo Species

Based on collection and characterization of commonly growing land races of high land bamboo species of this study, Okotu land race of *Arundinaria alpina* was significantly higher ($P \leq 0.05$) than Shanto and Uratiti Land races of *Arundinaria alpina* (Table 1). Culm diameter and Culm height mean value of Okotu land race of *Arundinaria alpina* was higher than by 0.412m, and 0.412m respectively as compared to the remaining land races of high land bamboo species used on this study. Similar to this study finding, growth characteristics of collected high land bamboo (*Arundinaria alpina*) land races from Choke Mountain, Northern Ethiopia showed that in terms of their culm diameter at breast height(DBH) and culm height significant difference were showed among each other(Yirgadu and Masresha,2011)

Recommendation

It is important to characterize and documented the existing farmers' traditional knowledge on the management of highland bamboo for development of bamboo stands, expansion and for effective sustainable utilization of the bamboo resources. Moreover, Collection and characterization study of locally available different land races of high land bamboo species (*Arundinaria alpina*) is vital for their conservation and effectively use of the resources without over exploitation.

The result of the study indicated that, local people of Bore District had sound experience of developing bamboo stands. Bamboo growers' local communities of the study area have their own planting season and they are planting bamboo seedlings during the beginning of rainy season. Bamboo growers' farmers of the study District also identified commonly known different land races of high land bamboo species of the study area based on their different criteria of bamboo characteristics and they have experience of naming different bamboo land races as Okotu, Shanto and Uratiti.

Based on the findings of this study, there was significantly difference between all collected local landraces of *Arudinaria alpina* species (Okotu, Uratit, and Shanto) in terms of the collected parameters. From those three local landraces, Okotu was higher than other landraces by its internode length, Culm diameter and Culm height which make it more superior than the others. Whereas, Uratiti was the lowest in internode length, Culm diameter, Culm height and number of node as compared to the remaining local provenances. Generally, from the results of collection and characterization study of locally available three commonly known land races of high land bamboo species of the study District, Okotu land race was the most superior provenance. Therefore, for sustainable utilization of this superior local landraces effective conservation is crucial to diversify benefits of local communities ranging from domestic household products to industrial applications. Moreover, integration of bamboo growers' traditional knowledge with modern Scientific Knowledge is very important for sustainable management and utilization of bamboo resources.

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