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# Adaptation and Growth Performance of Different Lowland Bamboo Species in Bako, West Shoa, Ethiopia

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**Abstract**
Bamboo is a fast growing tree species than other trees and starts to yield within three or four years of planting. Even though Ethiopia is one of the most endowed countries in having huge coverage of bamboo resource in Africa, the country has narrow genetic diversity only has two species. Yushania alpine (highland bamboo) and Oxytenanthera abyssinica (lowland bamboo). The adaptation of lowland bamboo at Bako Agriculture Research Center conducted from 2010 to 2013 to evaluate the adaptability potential of different provenance of lowland bamboo species and to provide the best performing of lowland bamboo species around Bako areas. Based on the objectives, four different lowland bamboo species were collected from Debrezit Agriculture Research Center and Forestry Research Center of Addis Abeba. The species are: Oxythenantera abyssinica, Guadua amplexofolia, Dendrocalamus hamlitonii and Dendrocalamus memebranceous among those mentioned only Oxytenanthera abyssinica are indigenous the rest are exotics. The experiment was laid out in RCBD with three replications. The selected bamboo species has no problem on survival and adaptability at Bako area except some growth variation. Despite this fact, Dendrocalamus hamlitonii specie is show high difference in new emerging shoots, internodes length, culm height and culm diameter whereas, Guadua amplexofolia revealed low in all growth parameters. So, based on these results we recommend Dendrocalamus hamlitonii, Dendrocalamus memebranceous and Oxythenantera abyssinica for different production since they have a good internodes length, ability to emerge new shoots, culm height and diameter while the growth of Guadua amplexofolia is quite different when compare with others. Therefore, the adaptation of lowland bamboo under Bako and related agro ecologies is reliable so, we recommend for further economic and livelihood benefits for different stakeholders through expanding the plantation.
**Keywords**: Bamboo; exotic; indigenous; lowland; Plantation

## 1. Introduction

Bamboo is a perennial plant, which belongs to the Poaceae (sometimes called Gramineae) family (Wang X. 2006). In terms of taxonomy, it is considered as a giant grass. Ecologically, bamboo plants have tree-like functions (Dwivedi, 1993; John & Nadgauda, 2002). There are over 1,500 species of bamboo (Sharma, 1998) and Africa alone has 43 species (Kigomo, 1988). Ethiopia is one of the most endowed countries in area coverage of natural bamboo forest of the country that estimated to have about 1 million ha, which is about 7% of the world total and 67% of the African bamboo forest areas ( Embaye ,2000).

Even though Ethiopia is one of the most endowed countries in having huge coverage of bamboo resource in Africa, the country has narrow genetic diversity only has two species: *Yushania alpine (*High land*)* and *Oxytenanthera abyssinica (*Lowland*)*. With these two species, it is very difficult to secure constant supply of bamboo raw material for bamboo industries and local handcrafts.

Currently, there is indiscriminate forest loose and depletion hence the unique bamboo resource will be is appearing before its economical and environmental advantage is appreciated, unless important reversing mechanisms could not take place (Yuming *et al.,* 2004). The current economic policy of the nation strongly urges development practitioners to contribute to the economic development of the country. By the year 2020, Ethiopia is envisioning to reach middle income group countries of the world. In this regard bamboo can contribute more in generating income since it can be processed in to products for domestic use and export market. It can also create employment opportunity to a considerable portion of the society and harness environmental degradation problems. Despite these facts; research and development activities on bamboo resource of the country is scanty. Bamboo is not included in tree planting programs in which millions of tree seedlings have been established every year. Up to now only a very limited research works have been undertaken: vegetative propagation of highland bamboo (Tesfaye and Yohannes, 2005), propagation of lowland bamboo by seed (Kassahun *et al*, 2003), utilization-suitability of *Yushania alpina* for oriented particle board (Seyum, 2005), the use of lowland bamboo as re-enforcement in construction (Zhaohua Z., 2004). A bamboo protects steep slopes, soils and water ways, prevents soil erosion, provides carbon sequestration and brings many other ecosystem benefits. Its extensive root network may help to prevent erosion. Bamboo in the future may be able to increase the bio-capacity by simultaneously increasing the area of fertile global hectares. It has immense potential in reducing $CO_2$ that is blamed for environmental pollution and the most valuable species for environmental protection. And also bamboo is a fast growing and high yielding perennial plant with a considerable potential to

the socioeconomic development and environmental protection (Baghel *et al.*, 1998; Kumar *et al.,* 1998; Perez *et al.*, 1998). Therefore it is important to introduce and adapt high economic value of exotic bamboos species to improve the income of small farm holder, to divers the genetic resources of bamboos species and for environmental protection in Ethiopia. Bamboo is versatile with a very short growth cycle. Bamboo is a high yield renewable natural resource for agro-forestry and engineering based products (Robert Henrikson.2009). Based on this all indispensable values of the species, the study of bamboo adaptation was started at Bako condition since 2010 with the objectives of to evaluate adaptability potential of different provenance of lowland bamboo species around Bako and to provide the best performance of lowland bamboo species.

## 2. Methodology

### 2.1 Description of the study area

The study was conducted at Bako which is located at 9º 07' N latitude and 37º 05' E longitude. The altitude is 1650 m above sea level. The long term weather information revealed that the area has unimodal rainfall pattern extending from March to October, but the effective rain is from May to September (Legesse *et al.*, 1987). The mean annual rainfall is about 1237 mm, with a peak in July. It has a warm humid climate with annual mean minimum and maximum temperature of 13 ºC and 27 ºC respectively and the mean annual temperature is 20 ºC. Soils at the study site are dominantly reddish brown Nitosols. They are generally clay dominated with a pH in between 5-6 in surface soils (Legesse *et al.*, 1987).

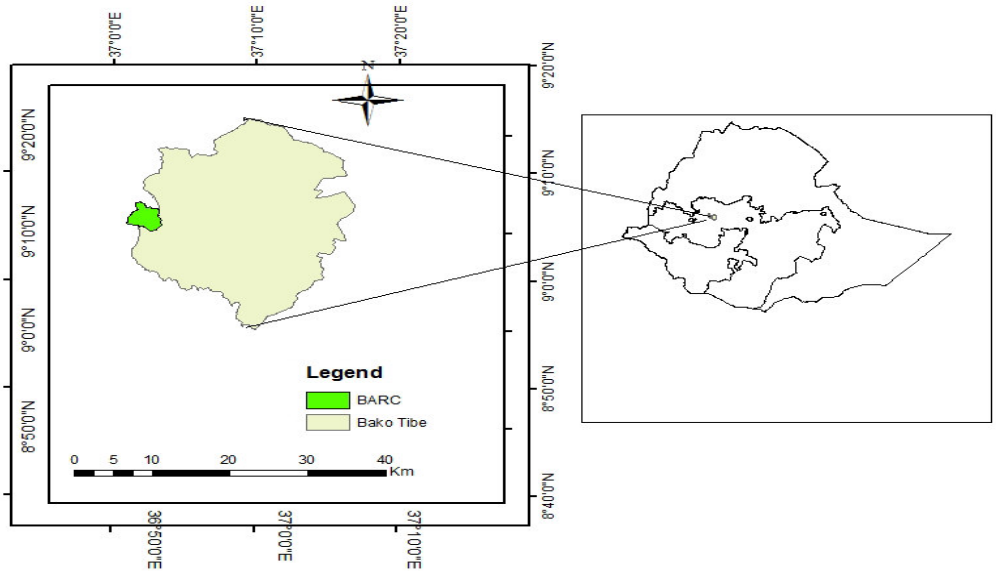


**Figure 1 : Location map of the study area.**

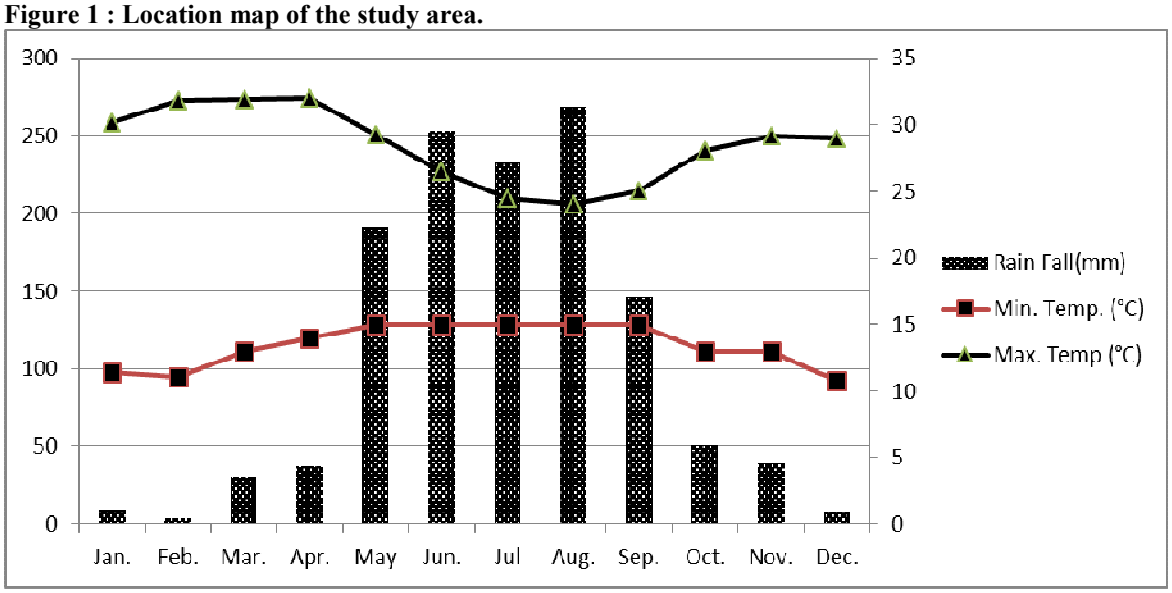


**Figure 2: Mean monthly rainfall (RF), maximum and minimum temperature (Temp.) of the study area during the four years trial period (2010-2013).**

### 2.2 Treatments and Experimental Design

The experiment was laid out in a RCBD with three replications. The block was folded to accommodate the four treatments within fairly uniform soil condition. The distance between blocks and plots was 3m and 2m, respectively. And also the space between each plant was 3m and the plot size was 1470 $m^2$ with a total of 108 plants per plot. As a treatment four lowland bamboo species were used: *Oxythenantera abyssinica*, *Guadua amplexofolia, Dendrocalamus hamlitonii* and *Dendrocalamus memebranceous*. Among those mentioned species *Oxytenanthera abyssinica* is the indigenous bamboo species. The seed and seedlings were collected from Forestry Research Center of Addis Abeba and East Africa Bamboo Project. The exotics bamboo species were originally comes from China in warm temperate subzone to tropical zone bamboo are growing wildly. The subtropical with annual average temperature of 14-26$^o$c and annual accumulation temperature 4000-8500$^o$c is the most important area for bamboo production in China (Fu Maoyi., 2005). The agro ecology of bamboo growing area in China is almost the same as Bako.

### 2.3 Data collection Method

The adaptation of lowland bamboo at Bako Agriculture Research Center conducted from 2010 to 2013 to evaluate the adaptability potential of different provenance of lowland bamboo species and to provide the best performing of lowland bamboo species around Bako areas. Concerning about growth performance issues data like; culm heghit, culm diameter, internode length, number of nodes, new shoot emerging, and other growth parameters were considered during data collection. The data were collected every two month interval to see the changes among the species.

### 2.4 Data Analysis

The collected raw data were analyzed with analysis of variance (ANOVA) following the General Linear Model (GLM) procedure using SAS statistical software version 9.0. For significant differences, mean separation using LSD was conducted at 5 % level of significance. Therefore, for these analyses the following parameters were considered and measured; Number of new emerging shoots, Survival rate in %, root collar diameter, internodes length, number of nodes, culm height and dimater data were collected and completed with the following brief result.

## 3. Result and Discussions

### 3.1 New Emerging shoots

The capacity of lateral buds forming new rhizome and shoots is closely related to rhizome age, vigor, and nutrient storage. Based on the analysis results of the four year data *Dendrocalamus hamlitonii* bamboo species were revealed a significant difference in number of new emerging shoots throughout the trail periods. This is due to the well performance, adaptability and producing new emerging shoots ability of the specie when compare to the other lowland bamboo species which selected for this experiment at Bako condition. The result is similar with the report from Pawe Agriculture Research Center by Yared k, 2013 (unpublished) which shows higher shoot emerging for *Dendrocalamus hamlitonii*. Next to this *Dendrocalamus memebranceous* and *Oxythenantera abyssinica* the species which shows a good performance in emerging new shoots next to *Dendrocalamus hamlitonii.* Whereas, *Guadua amplexofolia* specie were revealed a low performance in emerging new shoots number during the trail periods.

Table 1: Means Comparisons between treatments at 0.05 significant levels (Mean ± SE).

| Treatment | Av. NES | Av. CH (m) | Av. IL (cm) | Av. CD (cm) |
|---|---|---|---|---|
| *Dendrocalamus hamlitonii* | 3.67±0.17$^a$ | 2.88±0.07$^a$ | 13.54±0.19$^a$ | 2.53±0.08$^a$ |
| *Dendrocalamus memebranceous* | 2.92±0.42$^a$ | 2.77±0.11$^{ba}$ | 11.75±0.72$^{ba}$ | 2.01±0.08$^b$ |
| *Guadua amplexofolia* | 1.75±0.29$^b$ | 1.54±0.05$^c$ | 7.06±0.40$^c$ | 1.59±0.05$^c$ |
| *Oxythenantera abyssinica* | 3.58±0.33$^a$ | 2.62±0.03$^b$ | 11.01±0.94$^b$ | 2.32±0.05$^a$ |

** Means with the same letter are not significantly different.*
** Av.NES – Average of New Emerging Shoots*
** Av. CH (m) – Average of Culm height in meter*
** Av. IL (cm) – Average of Internodes Length in centimeter*
** Av. CD (cm) – Average of Culm Diameter in centimeter.*

According to the comparison made among the treatments *Guadua amplexofolia* were significantly different in new emerging shoots when compare with others but the rest three species is not significantly different. The result coincides with the report from Pawe for *Guadua amplexofolia* at both sites it revealed lower shoot emerging ability this might be due the low growth performance of the specie.

### 3.2 Survival Rate

During the four year trail period the selected lowland bamboo species was adapted and well performed at Bako

area. From the collected data the survival rate in percent for all species was 100 %. These indicate that as the agro ecology of Bako is suit to the species. Beside this during the trial period the selected lowland bamboo species is not attacked by any disease and pest. These also another indicator as the species are well performed under Bako area. But some growth and morphological variation were observed among the species this is due to the growth and adaptability characteristics of the species.

### 3.3 Internodes Length

Bamboo culms structure is cylindrical and is divided into sections by diaphragms or nodes. The section between two nodes is called internodes. Internodes are hollow in most bamboos, but solid in some species. Direct or indirectly bamboo internodes length can indicate the quality of bamboo product which used for different purpose. As the present study revealed that the results of internodes length among the selected species were significantly different. So, as indicated in Table 1 *Dendrocalamus hamlitonii* show higher internodes length as compare to others which is similar with the report of Yared K, 2013 (unpublished) which show higher internodes length for Dendrocalamus *hamlitonii.* Whereas, *Guadua amplexofolia* is show lower internodes length.

### 3.4 Culm Height and Diameter

Culms are solid in the lower internodes, and are hollow from the upper half up to the top of the culm. The culms of *Oxythenantera abyssinica* are semi-solid when young but solid in older culms. Whereas, *Dendrocalamus hamlitonii* and *Dendrocalamus memebranceous* relatively semi-solid and hollow at the upper part of the culms when compare to *Oxythenantera abyssinica*.

The full length of the culm is may vary among the species. According to the current analysis *Dendrocalamus hamlitonii* is statistical significant as displayed in Table1 while *Guadua amplexofolia* shows the least in culm height with compare to the rest. The result agreed with the report from Pawe by Yared k, 2013 (unpublished) which shows higher culm height for *Dendrocalamus hamlitonii* and lower culm height recorded for *Guadua amplexofolia.* This may depend upon the growth performance and adaptability of the species. Beside this, the culm diameter also analyzed and compared. Though, the culm diameter is indicated by the thickness or size of the culm which is directly or indirectly related with the quality of bamboo production. As the result, the current analysis show slight variation between the species on culm diameter. So, as presented in Table 1 above *Dendrocalamus hamlitonii* and *Oxythenantera abyssinica* bamboo species were statistical higher than both *Dendrocalamus memebranceous* and *Guadua amplexofolia* in culm diameter.

## 4. Conclusion and Recommendations

Bamboo grows more rapidly than any trees and starts to yield within three or four years of planting. So, bamboo is one of the fast growing and responding well against drought which can make the species more acceptable in making ever green environment in addition to soil and water conservation, and rehabilitation of degraded lands. Accordingly, Agroforestry Research Team considers all the indispensable values of bamboo product and tries to initiate the adaptation trail. The selected bamboo species are well adapted at Bako.

Except some variation on growth performances used for comparison. Therefore, the adaptation of lowland bamboo under Bako agro ecologies is reliable so, we recommend for further economic and livelihood benefits for different stakeholders through expanding the plantation. Despite this fact, *Dendrocalamus hamlitonii* specie is show high difference in new emerging, internodes length, culm height and culm diameter whereas, *Guadua amplexofolia* revealed low in all growth parameters. So, based on these results we recommend *Dendrocalamus hamlitonii*, *Dendrocalamus memebranceous* and *Oxythenantera abyssinica* for different production since they have a good quality of internodes length, ability to emerge new shoots, culm height and diameter while the growth of *Guadua amplexofolia* is quite different when compare with others. Due *Guadua amplexofolia thorny* character on its culm which is not easily damaged by animals,it is better to use for soil and water conservation purpose on degraded area rehabilitation. Since bamboo gives seed once in 40 years which is a big challenge in expansion of the resource, he need further study on bamboo propagation method.

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