EJED 2(1) 2019: 46 - 62
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj

Mass flowering and death of *Arundinaria alpina* (highland bamboo) impact on livelihood of rural community: the case of Gedeo Zone, Southern Ethiopia.

Debebe Abayneh Shewaye

Dilla University, College of Agriculture and Natural Resource, Dilla, Ethiopia
E-mail: shewayeabaynehdebebe@gmail.com; Tele: +251 911967032
Received: 18 April, 2019 /Accepted: 8 July, 2019

Abstract

Ethiopia owns the largest coverage of bamboos in Africa that sums up to more than 1 million hectares. This constitutes about 67% of the total area of bamboo in Africa. Bamboo plays a crucial role in the livelihood of the local people of Gedeo zone, south Ethiopia. However, the mass flowering and mass death currently hit the bamboo forest of the zone and affected both the people livelihood and the ecosystem of the area. Thus, this paper tries to highlight the consequences of mass flowering of bamboo forest on the livelihood of rural community of the zone. Two districts were purposively selected and 120 sample households were chosen randomly for data collection. Both primary and secondary data were deployed to answer the stipulated objectives. Extensive field observation, questionnaires, and group discussions were held to gather the primary data. Additionally, documents and other available materials were also used as a secondary data source. Descriptive statistics was conducted to analyze quantitative socio-economic data. Qualitative data were summarized by condensing the collected information. The result of the study indicated that, the local people have experiences of bamboo production using their indigenous knowledge. Lack of awareness about the time of mass flowering and death exacerbated the incident. There was no management plan prepared and used in the bamboo forest area. The flowering interval was estimated and the coming time of flowering and death is expected to be after 75-80 years. Massive socio-economic and ecological problems were also observed after mass flowering and subsequent seed setting. Hence, now it is time to search for different strategies to stop or to reduce the influences of mass flowering and death of bamboo in the area.

Key words: Bamboo, Arundinaria alpina, impacts of mass flowering, Ethiopia

1. Introduction

Bamboo is recognized as "poor man's timber" as it is directly related with human life from cradle to eternal voyage (Chuaby, 2013). It is the fastest growing plant in this planet one can almost watch it grow and is wonderful replacement for the slow growing forest with its short growth cycle (Kigomo, 2007; Groum, 2008). Bamboo belongs to the grass family *Gramineae* (also called Poaceae), the fifth largest flowering plant family, under the sub-family *bambusoideae* (Nadgauda, 2002). It is multipurpose non-timber forest resources that maintain the ecology, generate income and provide employment for alleviation of poverty (Abebe et al. 2009).

Due to its excellent flexibility and high tensile strength, straightness, woody nature, light weight, workability and suitable fiber characteristics, bamboo has been made into a wide variety of products. Thus it has been being used in our daily lives ranging from domestic household products to industrial applications. It has commonly been used for furniture, building, flooring, bio-energy, food, forage and medicine (Kassahun, 2000). Baboo also plays a vital role in environmental amelioration, biodiversity preservation, soil water conservation, waste purification potential; adaptability to low quality sites and it has also the capacity to redress most of the deforestation related problems (Woldemichael, 1980; Kassahun, 2000).

Despite the ever increasing global bamboo utilization, mass flowering and subsequent seed setting, bamboo is affecting the ecosystem and users livelihood. Many bamboo species only flower from 65 to 120 years intervals. This physiological cycle (the period between two consecutive flowerings) is the same for specific area and specific species (Chaubey, 2013). Once a particular species reaches its life expectancy, it will start to flower and die in some kind of a "mass suicide" (LUSO, 1997; Nadgauda, 2002). Dying after flowering is a characteristic phenomenon of monocarpic flowering, which shares as a member of the grass family (Nadgauda, 2002). Mass flowering isn't triggered by environmental aspects, rather it is as some sort of genetic alarm clock in each bamboo cell that signals the diversion of all energy to flower production and the cessation of vegetative growth. That means, it is the age of the seed which decides flowering time, not its shoot (Schroder, 2011).

According to many literatures, there are two most probable reasons why bamboo dies after flowering. The first is that the death of bamboo is due to resource exhaustion, as it would be more effective for parent plants to devote all resources to create a large seed crop than to hold back energy for their own regeneration. A second explanation is that the mother plant is creating an optimal environment for its seedlings to survive. When the mother plant dies, the bamboo seedlings will have full access to water, nutri-

ents and sunlight that would otherwise be used by the mother plant (Schroder, 2011; Wang, 2016), which is a Mechanism to create disturbance in the habitat to provide the seedlings and saplings a gap in which they grow. As bamboos are aggressive at their early ages, the seedlings would be able to outstrip other plants and take over the space left by their parents. Thus, fruiting at the same time increases the survival rate of their seeds by flooding the area with fruit. Therefore, even if predators eat their fill, seeds will still be left over the area. The total population failure after bamboo death leaves the land bare and takes at least few years for a bamboo to regenerate (Ramanayake, 2006). Subsequently, soil erosion and landslides prevail (Helen, 2008).

Mass flowering is flowering of entire populations of bamboo with all culms. The mass flowering of bamboos and consequential seed setting also have economic and ecological consequences that affect the livelihood of the local people. The huge amount of seeds in forests attracts large populations of rats which consume available food crops and may cause severe spread of diseases and food scarcity in surrounding areas (Schroder, 2011). Bamboo flowering and fruiting is something of calamity, since the culms and root stocking are no longer available quickly for the rural and urban population for different uses (Shanmughauel et.al. 1977). It may also cause soil erosion as the roots of the bamboo that binds the soil together dried up and loosen the soil especially in the hilly areas. Die-off events result in the loss of habitat and diversity (Demisew, 2011)

Ethiopia contributes the largest coverage of bamboos in Africa. It covers more than 1 million hectares. If this resource is managed and utilized effectively, Ethiopia can generate over 12 billion Birr every year (Melaku, 2008). Bamboo area of Ethiopia constitutes about 67% of the total area of bamboo in the continent (Kasahun, 2000). The two species of bamboo found in Ethiopia are the highland bamboo, *Arundinaria alpina*, and the lowland bamboo, *Oxytenanthera abyssinica* (Demelash et al. 2015). They are indigenous to Ethiopia and endemic to African (Kassahun, 2000).

The study area is covered with highland bamboo, *Arundinaria alpina*. This species is known in different languages as local names in Ethiopia. According to Woldemichael (1987) and Azene, (2007), it is called Anini (in Agew); Kerkeha (in Amharic); Kias (in Gamu); Shineto /Shinato (in Kefigna); Lemmen, Shimela (in Afan Oromo); Shenbek'wa (in Welayita); lema (in Konso, Kembata, Gedeo, Sodo Gurage and Sidamo); werye /shikaro /Shinato (in Kefa); lewu (in Nuwer).

Despite its current and potential advantages for social, economic development and environmental benefits, bamboo resource of Ethiopia has been given less attention. As a result, only few

researches have been done to solve the problems arising at different bamboo potential areas of Southern Region and Zones. Bamboo is one of the major sources of livelihood for Gedeo people. But these days, the loss of bamboo resource because of mass flowering and mass death is being a major concern and pressing issue. The problems are aggravated mainly because of lack of awareness about the causes and the consequences of mass flowering and death of bamboos. Therefore, this study tries to fill this gap through: 1) identifying the experiences of the local community that aggravated mass flowering problems and, 2) investigating the consequences of mass flowering and death of the highland bamboo.

2. Material and methods

2.1 Description of study area

Gedeo zone is found between 5 and 7 degrees North latitude and 38 and 40 degrees East longitude, in the escarpments of the southeastern Ethiopian highlands overlooking the Rift Valley, in the narrow strip of land running from North (Sidama zone) and to South, east and west (Oromiya region) (Tadesse, 2002). The land area of the Zone is estimated to be 1352.4 Km2 (GZAO, 2006). In altitude, the area ranges from 1200 meter above sea level in the vicinity of Lake Abaya to 2993 meter above sea level at Haro Wolabu Pond at Bule district (Tadesse, 2002). Gedeo zone is located 369 kms South of Addis Ababa and 90 kms South of Hawassa along Addis Ababa (Ethiopia) to Moyale (Kenya) international road. The study was carried out in the junction area of the two districts of Gedeo zone, namely Bule and Gedeb districts, which is called Jego community bamboo forest and surrounding individuals' bamboo plantations areas (Fig.1). This area was covered with dried bamboo of 1,156.41 hectares (Birhane and Melesse, 2015).

Gedeo Zone has sub-humid tropical climate which receives annual rainfall that ranges from 1200 to 1800 mm; the mean monthly temperature is 21.5° C with mean monthly maximum and minimum temperature of 25°C and 18°C respectively (Birhane and Melesse, 2015). Gedeo zone is endowed with two rainy seasons, which is from March to May and from July to December. However, the truly dry months are only January and February; others count with intermittent rain showers. The climate is suitable for abundant forest cover (Tadesse, 2002). Based on figures from the CSA (2007), the Gedeo zone had an estimated total population of 975,506 of which 486,996 were males and 488,510 were females with annual growth rate of 2.9%. This zone is one of the most densely populated regions in the country with an estimated population density of 769 people per square kilometer (CSA, 2007).

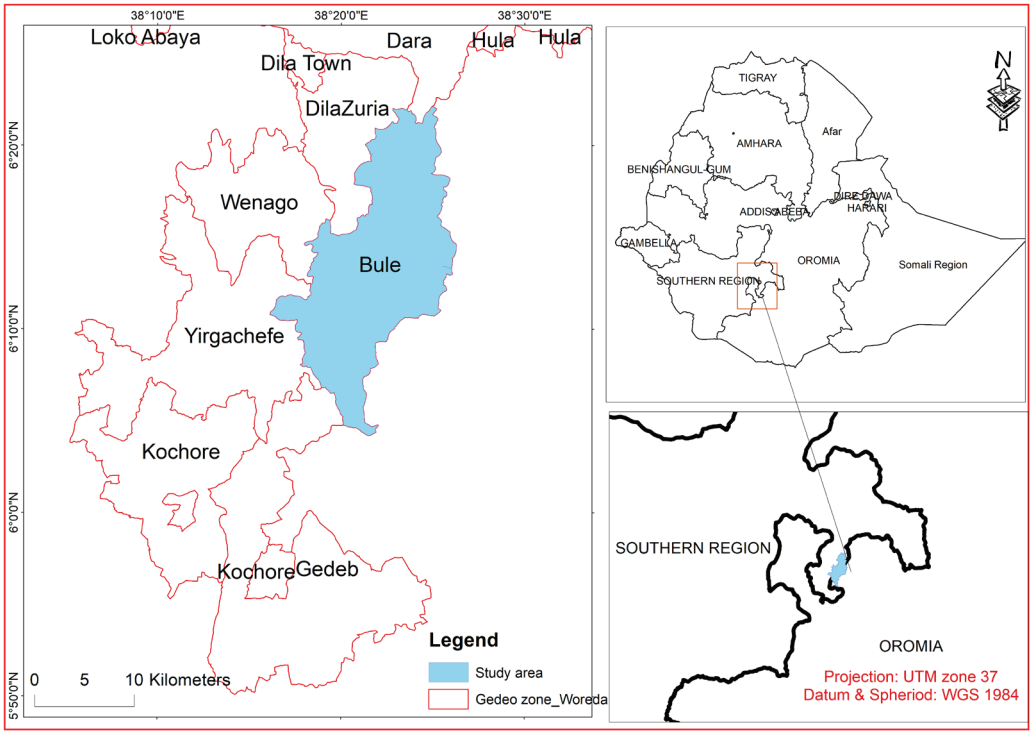

Figure 1 *Map of the study area*

2.2 Data collection

Two Districts of the Gedeo zone, Bule and Gedeb Districts were selected purposively based on the bamboo production potential and the current mass flowering and mass death experiences. A total of 120 households were selected from the two districts from both sexes and various age groups. By the help of district natural resource experts and Kebele committee members, six areas with large bamboo resource were purposefully selected for field and socioeconomic survey. Equal number of sites and farmers were selected from both districts since there are similar conditions in both districts. Therefore, 60 farmers were randomly selected from farmers who have long experiences in bamboo cultivation and utilization in each district. In addition to this, eight focus groups of elders who have long experiences in bamboo cultivation and utilization were purposefully. Natural resource experts of the districts and kebeles adminstrators/officials were also involved as an information source and facilitator. Along with questionnaires, extensive field observation, and group discussions were held to gather the data. Audio-visual tools like camera and tape recorder were also used to facilitate extensive documentation process. Moreover, documents and

different materials were also assessed as secondary data source.

2.3 Data analyses

The quantitative data were analyzed by using descriptive statistics such as percentages and graphs. In addition, MS-Excel was used to generate tables and bar graphs to determine the experiences and the impact of flowering on the socio-economic factors that influence the livelihood of the local community (Tesfaye et al. 2011). Qualitative data were summarized by condensing the information and were used to elaborate the results from quantitative analysis (Yin 2009).

3. Result and Discussion

3.1 Experiences on bamboo regeneration, management and utilization

3.1.1 Species distribution

According to the field observation and the information gathered from all the respondents and the district experts, the whole bamboo forest area has been covered by only one bamboo species. This species is *Arundinaria alpina*, highland bamboo and it is one of the two bamboo species found in the country. According to the respondents and researchers' observation, other bamboo species has not been introduced to the study area (Fig 2).

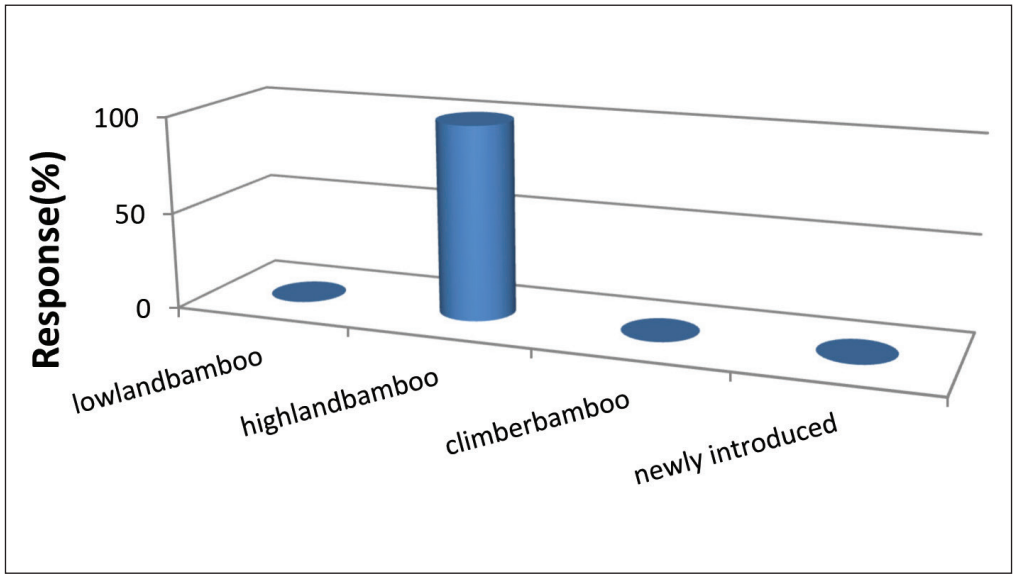

Figure 2 *Types of Bamboo in Gedeo zone*

This study supports that the introduced species in the South Region of Ethiopia are at their testing stage at Sheka and Wondogenet (Yigardu et al.

2016). Since the bamboo forest was drying, it was difficult to notice the morphological nature of the bamboo of the study site. On the other hand, very few bamboos were observed after a very long distance interval that didn't dry, which might indicate the presence of landrace variability under a single species. Though there is no detailed study of land race varieties, during our discussion, the elders call the land race varieties by the name "bamboo having teeth" and "bamboo without teeth".

As stated by all the respondents, there is no mass flowering and death differences observed from district to district and from Kebele to Kebele. In view of the fact that the whole bamboo forest is covered with only one species grown from the same seed year; the whole area is affected when this single species is affected, as a result the same species grown disappear at the same time. The problem is worsen in that, when the current species mass flowering and death happen, either there is no alternative species left or there is no bamboo forest of the same species grown from different seed year in the area for usage.

3.2 Propagation methods

In the study area, there are natural bamboo forest and bamboo plantation. As to the respondents' response, and the observation made, the natural bamboo forests are found around community lands and plantation of bamboo forest are found around homesteads in the study area. The community bamboo forests were originated from natural regeneration from seed regeneration and there is no interference of people on regeneration and management. Moreover, according to all respondents, bamboo plantations were originated from vegetative propagation by man. There is no nursery for the production of planting materials rather all bamboo propagation is done by farmers themselves on their own land. Almost all respondents confirmed that traditional rhizome cuttings were the common propagation method for bamboo plantations (Fig 3). In this method, rhizomes with the accompanying root system are detached from the parent rhizome in sections that are above 1m long culm containing nodes. This study agrees with the study, which says Propagating by means of rhizome with whole culm is traditionally known old age methods for bamboo propagation (Yared et al. 2017). The respondents prove that they all use vegetative propagation from their own bamboo forest rather than bringing it from other area of different seed year bamboos plantation. Furthermore, they strengthen their perception by saying it is the fastest and available method of regeneration for their uses. Though 65% of the respondents heard about the other methods of planting as stem cutting and bamboo seedling production from seed, still they are using this single method.

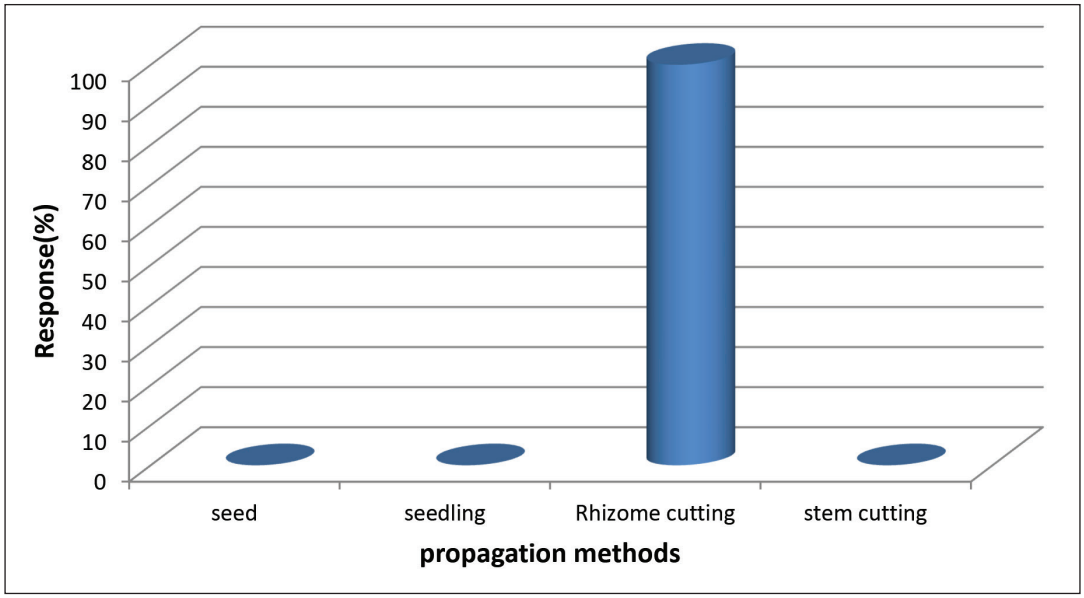

Figure 3 *propagation methods*

3.3 Cultural practices

During field survey, different size areas of bamboo plantations, which are owned by the respondents, were observed. Respondents have no experience of applying any cultural practices in natural bamboo forest to improve its productivity. In the same way, in bamboo plantation, thinning, fertilizing, protecting from diseases and pests are not as such known by local community. Though it is not satisfactory, there were experiences of soil loosening, weeding and partly fencing practices from our discussion with respondents (Fig 4). When they were asked why they were not using cultural practices, they justified their perception by saying bamboo does not need any Cultural practices and some of them have no idea about bamboo cultural practices. In addition, as it is observed, there was no management plan prepared and used in the bamboo forest area. As a matter of this fact, no one guessed the flowering time of the bamboo forest before flowering.

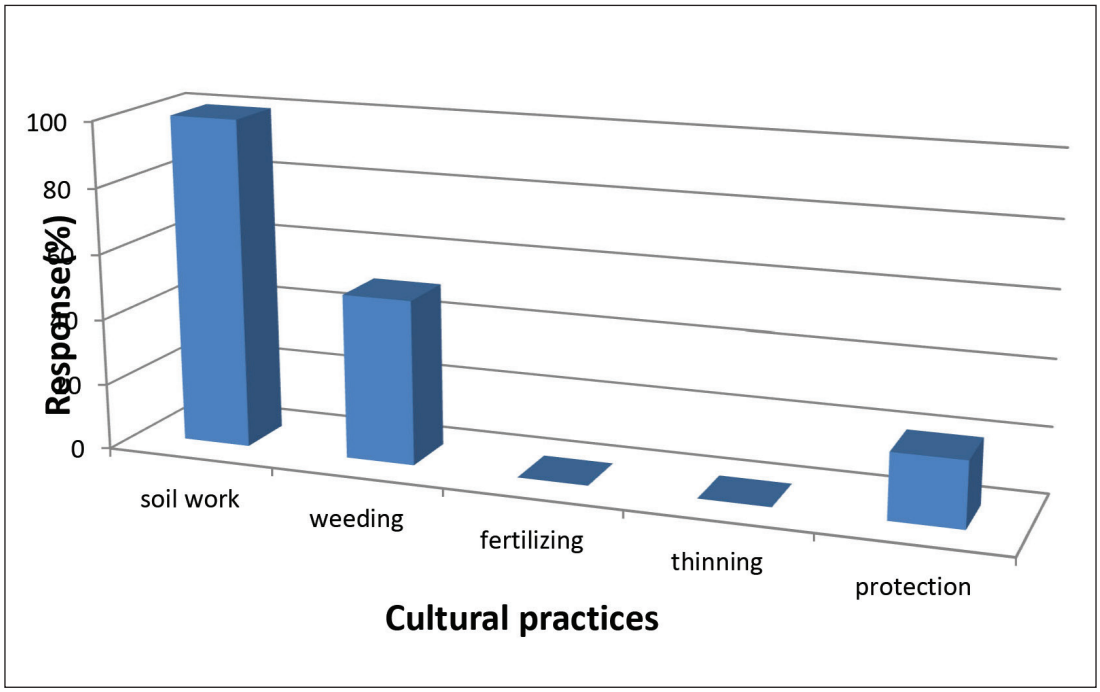

Figure 4 *Cultural practice applied to bamboo production*

3.4 Rural community awareness and perceptions about Mass flowering and death of bamboo

Respondents and experts reported that bamboo flowering is a new phenomena for most of the people especially for young ones. When bamboo starts to die, they assumed it was due to disease and they informed different organizations to treat the bamboo forest. After some information and observations, they noticed that their bamboos were flowering. According to the elders, mass flowering and mass death were experienced in this place around 75-80 years ago. This experience is agreed with study made by Schroder (2011) and Demisew et al. (2011). 69% respondents of elders have information about bamboo flowering. But none of them knows about the interval of mass flowering of bamboo. So, they did not prepare another option for their income source to reduce the challenges they are facing from mass flowering. The response of elders implies that the flowering interval or physiological cycle of mass flowering for this specific area takes 75-80 years since flowering takes place at the same time interval and at the same place.

3.4.1 Uses of bamboo resources

Arundinaria alpina is used extensively by the rural community for different purposes in the study area (Table 1). The present use is mainly limited to traditional uses for construction, fencing, firewood, fodder and also it is being

used for making different traditional bamboo crafts. The findings of Zenebe et al (2014) have similar ideas with the respondents of this study. 99.2% of respondents use main part of culm for construction, 96.7% of them use it for fence and 91.2% of them use it for craft making; and still all the respondents 100% and 25% of them confirm that the rest of the bamboo parts left from culm are used for firewood and fodder respectively. Surprisingly, the respondents said that they have no experience of using bamboo for food, charcoal, medicine and erosion control.

Table 1 *Frequency distribution of respondents regarding uses of bamboo*

Uses	Frequency	Percentage
Fire wood	120	100
Feed/fodder	30	25
Construction	119	99.2
Charcoal making	0	0
Crafts	110	91.7
Food	0	0
Erosion control	0	0
Medicine	0	0
Fence	116	96.7

3.5 Local community constraints related to bamboo resources cultivation and utilization

Concerning bamboo resources cultivation and utilization, there were a number of constraints mentioned by the respondents. The constraints include: shortage of planting materials, poor awareness on cultivation and utilization, limitation of budget and land (Fig 5). Of the constraints mentioned by the respondents, two of them are critical: lack of planting materials and poor awareness on cultivation and utilization. In view of the respondents, it is difficult to get large amount of planting materials by using rhizome method. So it is difficult to get planting materials for establishing large plantations. Besides, there are no government or private nurseries that supply planting materials.

From respondents' response, the local people have traditional thinking that bamboo does not need cultural practices. The respondents replied that they did not have any training on bamboo cultiva-

tion, craft making, marketing, management and conservation, and utilization of bamboo resources.

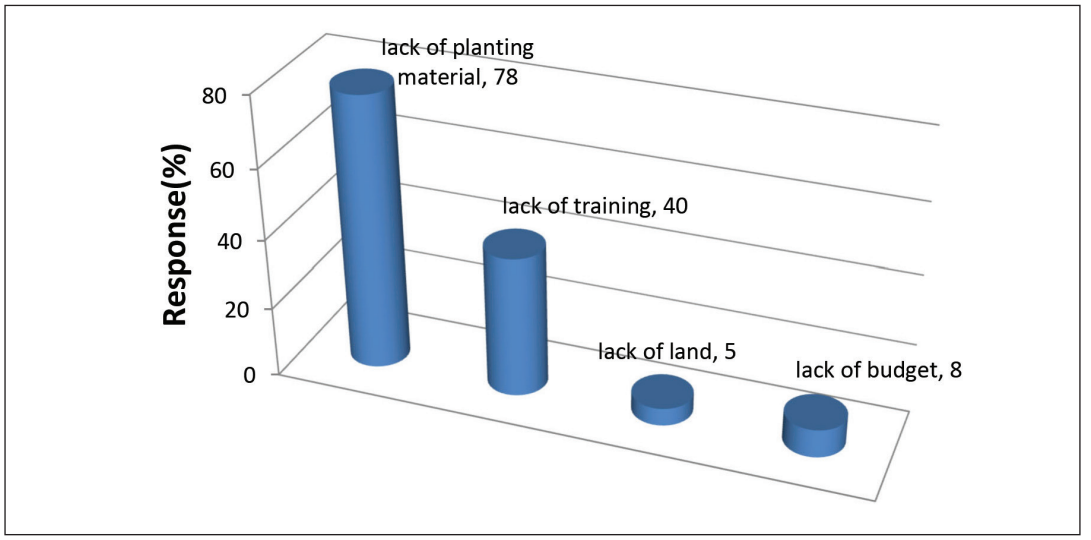

Figure 5 *constraints related to bamboo resource development*

4. Mass flowering impacts

4.1 Socio-Economic impacts of mass flowering of bamboo

4.1.1 Influence on Income generation

As to the respondents and expert's report, bamboo Culm is of owing high strength, light weight and easiness of working, it is suitable for different purposes. All of the respondents rated the influence of mass death of bamboo on income generation as high. When one local farmer explained, ''Bamboo is everything for us: it is construction material for our house and fence, for making household furniture, for feeding our animals, for heating and lighting and for cash source, etc. When mass flowering and mass death took place, we felt as if we had lost one of our family members, and now we are almost left bare handed".

According to Melaku's (2008) estimation, it can be easily deduced that 1,156.41 ha of dried bamboo area can lead to a loss of more than 13, 876,920 birr per year for the coming years until the area returns to its full production.

Figure 6 *Part of elders' group discussion*

4.1.2 Impact on job opportunities

Regarding to the perception of respondents, bamboo craft making is one of the main occupation in the study area. Bamboo poles, dissected/splits/ of bamboos and crafts making help to earn cash to fulfill the basic needs of their family and give self employment to the whole families. Most of the respondents engaged in bamboo craft making hand in hand with other agricultural activities. And a few of them use bamboo as the only job for them. Bamboo craft making is their traditional occupation so that they do not learn these skills from outside their locality. Finally they said "we will lose jobs for the coming at least 5-8 years due to death and absence of bamboo raw materials".

4.1.3 Vulnerability for extra cost

From the discussion with community, it is replied that bamboo is one of the most important thing for the people in their daily life. But due to the scarcity of bamboo resources resulted from mass flowering and death, no more bamboo raw materials will be supplied for the coming years. Thus, there is no way of getting low cost bamboo. According to the respondents' explanations, to embark upon this problem, they look for other materials as wood, iron bars; corrugated sheets that needs extra money for making furniture, construction and other uses.

4.2 Ecological consequences of mass flowering of bamboo

4.2.1 Conversion of bamboo forest to other open land use types:

All respondents including experts agree on the increasing rate of conversion of mass flowered and dead community bamboo forest to open agricultural land. During the discussion, one of the respondents said, "Leave alone these open places of mass flowering, some of the farmers were illegally found pushing the intact community bamboo forest". The respondents also explained that obstruct of bamboo based income could also have a possibility of forcing local community to convert the area into a farm land that can offer short-term returns to fill the income gap. The researcher also observed some indicators such as clearing and fire setting here and there around the boundaries of community bamboo forest that might be the sign of expansion of agricultural farm lands by minimizing the bamboo forest area. Animals were also observed grazing near and around dried bamboo forest. Similar stories were recorded for highland bamboo in Southern Ethiopia, Sheka Zone, Masha district where farmers gave up bamboo after its death and converted lands to 'Enset' plantation (Adnew and Statz, 2007). As it was observed, the conversion of land was taking place more in community bamboo forest than individually owned bamboo plantation forest.

4.2.2 Bamboo flowering and outbreak of rat population

Even though there is potential outbreak of rodents in the flowering and mass death area of bamboo forests (Demissew et al. 2011; Schroder, 2011), according to the respondents view in this study there has not been any significant effects of rats observed in the study area. From these contradictory studies results, it can be concluded that there might be other factors that discouraged rat outbreak in the study area.

4.2.3 Threats on regeneration and biodiversity

According to the respondents' response and experts' observation and Demissew et al. (2011) findings, bamboo forests were rich in life varieties. A number of Birds and different kinds of wild animals were sheltering and grazing in the bamboo forest. Now, the biodiversity is decreasing as the result of migrations of these animals due to the loss of their habitat, bamboo forest, by mass death.

Mass flowering has brought positive impact on regeneration. Previously reproduction of high land bamboo was done only by vegetative propagation from only single parent. Respondents were also told that mass flowering gave a chance of getting large amount of seed from sexual reproduction that helps to establish bamboo plantation. Unfortunately, as it is a new incident and due to

knowledge gap, most of the respondents are not using this opportunity.

5. Conclusion

The local people have experiences of bamboo production using their indigenous knowledge. The whole study area covered with only one species grown from the mother trees flowered at the same time; and they are germinated in similar time or are grown from the same seed year. New bamboo species was not introduced and there was no propagation and plantation of the same species having different seeding year to obtain an additional option of bamboo product. The local people were not using seeds or seedlings from other areas to have diversity. The cultural practices were not properly applied and there was no management plan prepared and used in the bamboo forest area.

Mass flowering and death of bamboo is natural phenomenon. The subsequent effect after death of bamboo was an expected due to lack of knowledge about the time of mass flowering and death as the local people didn't make any preparations for the coming problem. The local people have no idea about the interval of flowering. The flowering time of bamboo was estimated to be 75-80 years. Therefore, for this area, the coming time of flowering will be expected to be after 75-80 years as flowering interval is the same for the same area.

Bamboo is everything for the local people. Bamboo area, which is mass flowered and dead, can lead to a loss of more than 13, 876,920 birr per year. Hence, the local people have lost the income coming from bamboo and they also missed their job related to bamboo and now they are exposed to unnecessary cost due to mass death of bamboo. Besides, mass drying led to conversion of bamboo forest site to other land uses to get quick money. When bamboos disappear from the area, there happen migrations of wildlife to find better habitat. Mass flowering, on the other hand, has brought mass seed for mass regeneration. Generally, now a day, due to these facts, the local people are facing a big challenge. Training provisions and raising awareness on proper cultivation, particularly regeneration and utilization of bamboo should be given to the community to ensure sustainable development and management of the bamboo forest. Moreover, further research on optimization of propagation methods including tissue culture and land race varieties should be conducted.

6. Acknowledgment

The authors gratefully thank Dilla University for the immense support provided and financial support to carry out this task. Special thanks also go to Gedeo zonal officials and Bule District and Gedeb district administrators, development agents, and farmers for their imaginative opinions and cooperation during the field work.

Conflict of interest

The authors declare that they have no competing interests

References

Abebe, H, Million, B and Ridgewell, A. 2009. Small and medium forest enterprises in Ethiopia. IIED Small and Medium Forest Enterprise Series No. 26. FARM-Africa and International Institute for Environment and Development. London, UK.

Adnew, B and Statz, J. 2007. Bamboo market studies in Ethiopia. Technical report to United Nations Industrial Development Organization (UNIDO). Pp. 73.

Azene, B. 2007. Useful Trees and Shrubs of Ethiopia: Identification, Propagation and Management in 17 Agroecological Zones. Nairobi, RELMA in ICRAF Project, 552p.

Birhane, G and Melesse, M. 2015. Evaluation of Land Use Patterns across Agro-Ecological and slope Classes Using GIS and Remote Sensing: The Case of Gedeo Zone, Southern Ethiopia. International Journal of Advanced Remote Sensing and GIS. Volume 4, Issue 1.

Chaubey,O.P., Sharma, A & Prakash,R. 2013. Eco-Silvicultural Interventions for Rehabilitation of Gregariously Flowered Bamboo Forests with Special Reference to Dendrocalamus Strictus (Roxb) Nees. Global Journal of Science Frontier Research Agriculture and Veterinar Volume 13, Issue 13, Version 1.0.

CSA (Central Statistical Authority). 2007. The 2007 Population and Housing Census of Ethiopia Results at the country level. Addis Ababa, Ethiopia.

Demelash, A, Abdella, G and Kassahunn, E. 2015. Flowering and Causes of Seed Defects in Lowland Bamboo (*Oxytenanthera abyssinica*): A Case Study in Benishangul Gumuz Regional State, Northwestern Ethiopia. International Journal of Life Sciences 4(4): 251-259.

Demissew, S, Tesfaye, D, Kassahun, B, Mehari, A, Yared, K, Negash, E, & Sintayehu, E. 2011.

Mass flowering and death of bamboo: a potential threat to biodiversity and livelihoods in Ethiopia. Available from:https://www.researchgate.net/publication/228535274[accessed Apr 01 2018].

Groum, A. 2008. Ethiopia to export chopsticks. Capital, Vol. 10, No. 505, Sunday August 17.

Helen Keler International. 2008. Needs assessment report on bamboo flowering, rat infestation and food scarcity in the Chittagong hill tracts. Banglandeh.

Kasahun, E. 2003. Ecological Aspects and Resource Management of Bamboo Forests in Ethiopia. Doctoral thesis. Swedish University of Agricultural Sciences. Uppsala, Sweden.

Kasahun, E . 2000. The indigenous bamboo forests of Ethiopia: An overview, AMBIO: A journal of the human environment, 29(8): 518–521.

Kigomo, B.N. 2007. Guidelines for Growing Bamboo. KEFRI Guideline Series: No. 4. Kenya Forestry Research Institute. Nirobi-Kenya.

Kumar, S. 2013. Human rights issue and insurgency due to bamboo flowering: a case study of lushai hills district of Assam. Excellence International Journal of Education and Research 1(3):104-109.

Luso Consult. 1997. Study sustainable Bamboo Management: Second Interim Report. Addis Ababa, Ethiopia

Mansur, A. 2000. Analysis of calcalta bamboo for structural composite materials. Doctoral dissertation. Retrieved from Eindhoven University of Technology website: http://alexandria.tue.nl/extra3/proefschrift/PRF9B/9303473.pdf

Melaku, T. 2008. Bamboo has a potential to generate 12 billion Birr annually. Walta Information Center. Addis Ababa, Ethiopia.

Nadgauda, R. 2002. Bamboo flowering. [Online]. Available: http:// Bamboo flower/Bamboo flowering.htm [June 05, 2016]

Ramanayake, S. 2006. Flowering in Bamboo: an enigma! Cey. J. Sci. (Bio. Sci.) 35: 95- 105

Rongmei, L. 2013. Traditional Methods of Pest Management in Shifting Cultivation after Bamboo Flowering in North-East India: Experience of Tamenglong District of Manipur. International Journal of Humanities and Social Science 2(3): 01-03.

Schroder, S. 2011. Bamboo Flowering Habits. [Online], Available: http:// bamboo flower/Bamboo Flowering Habits — Guadua Bamboo. [June 03, 2016]

Shanmaghauel, P, Frances, K and George, M. 1997. Plantation bam-

boo. International book distributer. Dehradun, India

Tadesse, K. 2002. Five Thousand Years of Sustainability? A case study on Gedeo land use Southern Ethiopia. Wageningen.

Tesfaye, Y, A. Roos, B.M. Campbell & F. Bohlin. 2011. Livelihood strategies and the role of forest income in participatory-managed forests of Dodola area in the bale highlands, southern Ethiopia. Forest Policy and Economics 13(4): 258–265.

Wang, W etal. 2016. Delayed Flowering in Bamboo: Evidence from Fargesia qinlingensis in the Qinling Mountains of China. Front Plant Sci., vol 7, pp.151.

Woldemichael, K. 1987. A glossary of Ethiopian Plant Names. 4th edition. Revised and Enlarged. Addis Ababa, Ethiopia.

Woldemichael, K. 1980. The Bamboo Potential of Ethiopia. Forestry and Wildlife Conservation and Development Authority. Addis Ababa, Ethiopia, Monograph, 14 pp.

Yared, K, Zebene T, Abera, G, Yigardu, M. 2017. Vegetative Propagation Techniques of Highland Bamboo (*Yushania alpina*) in Amhara Region, North-Western Ethiopia. World scientific news 61(2): 122-136.

Yin, R.K. 2009. Case Study Research: Design and methods. Fourth Edition. Applied Social Research Methods Series, Volume 5, SAGE Publications, International Educational and Professional Publisher. Thousand Oaks London, New Deihl.

Yigardu, M. 2012. Growth, Morphology and Biomass of Arundinaria alpina (Highland Bamboo) (Poaceae) as Affected by Landrace, Environment and Silvicultural Management in the Choke Mountain, Northwestern Ethiopia. PhD thesis. Addis Ababa University, Addis Ababa

Yigardu, M, Asabeneh, A & Zebene, T. 2016. Bamboo Species Introduced In Ethiopia Biological, Ecological and Management Aspects. Ethiopian Environment and Forest Research Institute (EEFRI). Addis Ababa, Ethiopia.

Zenebe, M, Adefires, W, Temesgen, Y, Mehari, A, Demel, T, and Habtemariam, K. 2014. Bamboo Resources in Ethiopia: Their value chain and contribution to livelihoods. Ethnobotany Research and Applications, ajournal of plants, people and applied research vol 12, Pp 511-524.