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Income Contribution of Bamboo (Arundinaria alpine) Based Agroforestry Practice in Dawuro Zone, South West Ethiopia

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Abstract
Ethiopia has over one million hectares of highland and lowland bamboo resources. Although the role of bamboo has not been well documented as an integral part of the economy of Ethiopia, it plays a very important role socially, economically and ecologically in areas where it occurs naturally and as plantation. However, the use of this abundant resource is largely restricted to the household level and it is not well studied at the country level about its major socioeconomic, ecological roles and it influences on physicochemical properties of the soil. Therefore, this study was one such attempt; it determines the relative contribution of bamboo income to household annual cash income. Sampling was based on a multistage sampling approach. The first and the second stage involved purposeful selection woredas, and Kebeles respectively, which were based on availability of bamboo, based agroforestry practice such as bamboo woodlot and boundary plantation. Accordingly two sites (Kebeles) were selected and 15% sample households from each of the KA were selected. A total of 112households (HHs) was selected using stratified random sampling. The Commonly used techniques for valuing the annual value of bamboo raw and products were the income approach or products and services approach. The result indicates that annual cash income from bamboo accounted about 19%. Linear regression model was used to see the effects of a number of socioeconomic and biophysical variables on bamboo income generated per households. Among the various characteristics considered Land size was positively and significantly related to household income gain from bamboo tree and products ($P < 0.05$).
Keywords: Agroforestry, Bamboo, Income

1. INTRODUCTION

Bamboo, one of the fastest-growing plants on earth due to its unique rhizome dependent system with reported growth rates of 250 cm in 24 hours. Technically, bamboos are grasses belonging to the subfamily *Bambusoideae* under the family of *Gramineae*. About 90 genera and 1500 species are known of which only about 50 species are domesticated so far (FAO, 2005). About 36 million ha of bamboo are distributed in the world forest ecosystems in Asia, Africa, and America (Maxim, 2009).

Africa holds about 40 bamboo species, of which two are indigenous to Ethiopia: the African Alpine Bamboo (*Yushane alpine* K. Shumann Lin; synonym: *Yushania alpina* K. Schumann) and the monotypic genus lowland bamboo *Oxytenanthera abyssinica* (A. Richard) Munro (Kassahun, 2000). These species are also found in some other African countries, but nowhere else outside the African continent. They are indigenous to Ethiopia and endemic to Africa, confined to the sub-Saharan region (Kassahun, 2000; Kassahun, 2003). Africa has 1,500,000 ha bamboo of which, Ethiopia has about 1 million ha of high and lowland bamboos, the latter being more dominant (850, 000 ha). Thus, 67% of African bamboo resources and more than 7% of the world total are found in Ethiopia (Kassahun, 2000). However, this asset together with its biological diversity is being decimated due to high population pressure, weak economic growth, and slow technological development, adoption, and distribution (Kassahun, 2000; Pamela *et al.*, 2003).

Although bamboo is not an integral part of the economy of Ethiopia, it plays a very important role socially, economically and ecologically in areas where it occurs naturally and where it is planted (Ensermu *et al*., 2000). The potential of this resource to serve as an engine for socioeconomic growth and development is enormous, as could be observed from the socioeconomic and environmental role of bamboo resource in the south East Asian countries (INBAR, 2006). Despite the very high potential value, Ethiopian bamboo forest management, expansion and utilization is very low and slow. There is neglect by the government due to lack of knowledge and financial incentive to value, protect and use it as a useful commodity. The lack of awareness has also been confounded with limited local market and very high transportation cost to relatively better markets in urban areas (INBAR, 2006).

In an agroforestry system there are ecological and economical interactions between the various components (Ahmed *et al*., 2007). Agroforestry systems are among the innovative options to manage and conserve soil and water, restore soil fertility, and halt desertification (Ahmed *et al*., 2007). They are principally essential to regions with high rainfall intensities, steep slopes, and sparse vegetation with high rates of runoff and soil erosion. Agroforestry fits within the environmental stewardship of soil, water, and air improvement towards a sustainable management of natural resources (Ong *et al*., 2006; Ong *et al.,* 2007; Humberto, 2008).

Bamboo is a fast growing species and therefore, known as "Green Gold". This green gold is

sufficiently cheap and plentiful to meet the vast needs of human populace from the "*child cradle to the dead man's bier*" that why it is sometimes known as "*poor man's timber*" in China (Nirmal, *et al*., 2010), "the friend of the people" in India and "the brother" in Vietnam (INBAR, 2003). Bamboo provides goods and services useful to mankind. It is a source for food, fodder, furniture, building materials, paper, particle board, energy, and medicine (Kassahun, 2000; Nadia *et al*., 2003). Due to its many uses and its economic importance, bamboo plays a noteworthy role in improving the livelihoods of poor rural people. Much of the bamboo used is harvested by the poor, and especially by women and children (Nadia *et al.*, 2003). The goods and services gained from bamboo both at village and national level are greatly essential in providing for basic human needs, such as; employment, fodder, food, shelter, and household materials (Melaku, 2006). Bamboo handicraft industry has also created a considerable casual labor market. Casual labor at bamboo workshops is an economic activity benefiting villagers (Banda *et al.,* 2005). In China the importance of bamboo at a national level is reflected by the fact that, while bamboo represents only 3% of total forest area, it contributes to around 25% of forest exports (Manuel *et al*., 2001). Bamboo has become an imperative trade commodity globally, in both local and regional market, and provides direct or indirect livelihood support to approximately 2.5 billion people (Banik 1995; INBAR, 1999) as cited in Parvez *et al., (*2009). Bamboo has been an important source of income for millions of rural people for sustaining their livelihood. The major proportion of bamboo is utilized as raw materials for paper and pulp industries, handicrafts, housing, and agricultural applications and also in packing industry, etc (Ombir, 2008). On a global scale, the gross value of world trade in bamboo was estimated to be between US$2.5 billion and US$7.0 billion (Hunter, 2003). More than 1 billion people live in bamboo houses, and 2.5 billion people depend on this resource for their livelihoods (Anuchit, 2009). In Ethiopia, a single bamboo stem of about average belt and height costs up to ETB 5(Azene, 2007). If the stem is processed it makes 2.5 mats, individual mats of about 1.5 by 2m sell at the farm gate for ETB 7-10 in Gonder and ETB 11-15 in Shire and Metema towns. Bigger mats fetch higher prices; mats of2x4m cost ETB7-8, mats 2x5m cost ETB9-10, and a 2x3m mat cost ETB 5 (Azene, 2007). In China, bamboo has an estimated 1500 uses including food, flavorings for alcoholic beverages, construction, fuel, charcoal, medicinal products and the manufacture of paper, flooring, screens and clothing (Anand *et al.*, 1999; Purdew, 2008). Recently, with the development of advanced processing technologies, bamboo is considered as a plentiful material resource supporting the modern industry with valuable products such as flooring, pulp, fiber, etc (Viet., 2010). It can 'add value' and provide for smallholder farmers through the production of ornaments and furniture (Purdew, 2008).

Although representative case studies are still rare, Adnew and Statz (2007) indicated that in Ethiopia, a great number of people are engaged in bamboo management to support their livelihoods. It was estimated that over 1.2 billion USD can be generated every year if the country's bamboo resource base is properly utilized (INBAR 2010). In their study on the role of bamboo for construction materials, Kibwage and Misreave (2011) reported that, bamboo accounted for 2–3% at the national level and more than 50% in rural areas of Southern Nation, Nationalities and People (SNNP) and Benshangul Gumuz National Regional States in Ethiopia.

Bamboo Trees on farmland form an integral part of the farming system. Here, bamboo is an important part of the farming systems that are based on the cultivation of Enset and a wide range of vegetables as well as the production of milk for cash incomes (Berhanu *et al*., 2007). However, lack of awareness about its multiple use, lack of technical information on small scale industry, lack of network and information gaps between various stakeholders of the sector, massive bamboo flowering followed by a death and the over exploitation of the resources are the main challenges. The currently alarming large scale deforestation of bamboo-growing areas coupled with the historical mass flowering and death of the species are resulting in loss of the unique resource before its economic, social, and environmental advantages are understood and appreciated (Sertse *et al*. 2011). Even though different research conducted related with bamboo, none of them significantly describe the relative income contribution has been conducted in the study area. Understanding the relative income contribution of bamboo plantation would not only help a large section of stakeholders at local, regional and national levels but also prove beneficial to policymakers, funding agencies and non-government organizations that have been an interest to contribute to the sector. The study was one such attempt; it examines the relative income contribution bamboo based Agroforestry practice.

2. Material and Methodology

2.1. Descriptions of study area

The study was conducted at Dawuro Zone, Southern Nation National and People's Regional State (SNNPRS), Ethiopia. It is situated within the coordinate of 6.59-7.34 latitude and 36.68 to 37.52 longitudes, with an elevation ranging 501-3000 meters above sea level. It located at about 500km in south western of Addis Abeba, the capital of Ethiopia and 275 km Hawassa, the capital of SNNPR.

Regarding the Agro ecology of the zone, out of the total land size 55.6% is kolla, 41.4% Weinadega and 3% Dega. The annual mean temperature ranges between 15.1-27.5oc and the annual mean rainfall ranges 1201-1800mm.

2.2. Sampling strategies

2.2.1. Site and village selection

Sampling was based on a multistage sampling approach. The first and the second stage involved purposeful selection woredas, and Kebeles respectively, which were based on availability of bamboo, based agroforestry practice such as bamboo woodlot and boundary plantation. Accordingly, from each woreda we select two KAs namely Boteri from Tocha wereda and Meri Guta from Merka woreda were selected based on the potential of bamboo resource, the relative access to the nearby village/towns and local access to external market. For the selection of sample households, stratified sampling technique was employed that involve groupings of the study population into different wealth strata (poor, medium and rich). To strength wealth classification, list of households in the KAs was taken using the criteria developed by key informants (David *et al.,* 2011). From each KA five to seven key informants were selected and the Procedure for wealth ranking was conducted as follows: village leaders and development agents listed every member of the community from KAs book list and together with key informants grouped the population using wealth ranking done by adapting techniques modified by Den Biggelar (1996).

Table 1: Criteria for Wealth Ranking developed by key informants

Number Indictors	Social classes		
	Rich	Medium	Poor
Farm size(ha)	>2	0.5- 2	<0.50.5
Enset size(ha)	>0.5	0.025-0.5	<0.025
Annual crop produced(qt)	10	5-10	5
Bamboo size(ha)	>0.5	0.025-0.5	<0.025
Number of animals	>10	5-10	<5

From a list of household heads available in the KA offices 15% sample households from each of the KA were selected. Accordingly, from Botri kebele 36 households and from Meri Guts 76 households were selected and a total of 112 household heads were selected.

2.2.2. Data collection

2.2.2.1. Farmers knowledge

The study requires the collection of both qualitative and quantitative data. Data on bamboo based Agroforestry practice knowledge were collected at two levels. At first level with key informants were employed. Using in depth guide questions and for further verification of information collected through household survey. At the second level Group discussions were also conducted with representative from kebeles including mini group formed by the government used to further understand. Household head were interviewed for data collection. Household is taken as unit of measurement in this study since most of the time income surveys use the household as the unit of measure. In addition to the individual interview on bamboo management aspect and the contribution of bamboo to the rural house hold income was obtained.

2.2.2.2. Valuing annual income

The Commonly used techniques for valuing the annual value of bamboo raw and products were the income approach or products and services approach. Following (Cavendish, 2002; Getachew *et al*, 2007; Bedru *et al*, 2009; David *et al.,* 2011) the total net income (monetary or cash income and income in kind) approach as a broad measure of a household's economic welfare status were used. Five major categories of household income were determined: crop income, livestock income, off-farm income, tree products income and bamboo products income. Information was collected on each source of income of the households and each respondent was required to give an estimate of how much was produced, consumed and sold from each source of income during the year 2014. This basically depends on household's estimation of the amounts harvested, consumed and sold rather than actually measured by researchers. In this study, income includes both cash and consumptive income of households.

Following the approach of studies elsewhere (Cavendish, 2002; Getachew *et al*, 2007; Bedru *et al*, 2009; David *et al.,* 2011), some simplifying assumptions were made in household income accounting:-

• Own labor value was not deducted from net income: For poor rural households working in areas where labor markets are absent or thin and alternative opportunities are limited, the net income is inclusive of own-labor costs.

1) Net crop income: In calculating net crop income, gross crop income is derived by measuring the value of different end-period crop products over the year for each household using the local market prices. Next, the values of inputs (fertilizers; plough services; seeds and hired labor) are summed to obtain a measure of total crop input costs. Then, we deduct these values from the values of gross crop income for each household to obtain the net crop income.

2) Net livestock income: Annual gross income from livestock products are obtained for each household. Livestock income consists of three main sub-components: livestock sales, livestock products and services. For

the first two sub-components local market prices were used for valuation. Imputed values are used for livestock services in the form of ploughing and transport services. Summing the three sub components yields gross livestock income.

Next, annual expenditures on cost items such as fodder or straw, veterinary services, and hired-in labor are aggregated to obtain the total costs on livestock production. Then, simple deduction of aggregate annual costs from gross livestock income results in net income from livestock.

3) Off-farm income: Off-farm activities may comprise wage employment, petty trade; small scale non-farm market production and other cash generating own business activities. Off-farm income is defined in net terms, that is, net of any costs incurred related to a person's engagement in an activity.

4) Tree products income: the measurement of tree product use relied on household's self-reported physical quantities and value estimates and the prevailing local market prices. Respondents reported the yearly amount of each product harvested the amount consumed/used, the amount exchanged, the amount given to other households (gift), the amount sold and the cash amount received from sales of these products.

5) Bamboo products income: the measurement of bamboo raw and bamboo products use relied on household's self-reported physical and value estimate and the prevailing local market prices. Respondents reported the yearly amount of each product harvested the amount consumed/used, the amount received from sales of raw and manufactured products. For a product whose local market price is not available the price of substitute was taken. For instance, local market prices for fodder were unavailable, so the value of fodder was calculated by converting grazing rental fees for grazing land into the yield equivalent. Production costs were deducted from the income generated in all cases.

2.2.5. Statistical Analysis

Different data analysis techniques were employed since both qualitative and quantitative data were collected. The contribution of bamboo to household livelihoods is measured by the cash generated through sales as a proportion of gross income per household and the amount consumed. One-Way ANOVA was applied using means and standard error (SE) of the means to compare household demography, income, bamboo sales, wealth among households. Linear regression model was used to analyze socioeconomic factors verses bamboo annual income.

3. RESULT AND DISCUSSION

3.1. The contributions of bamboo to the household income

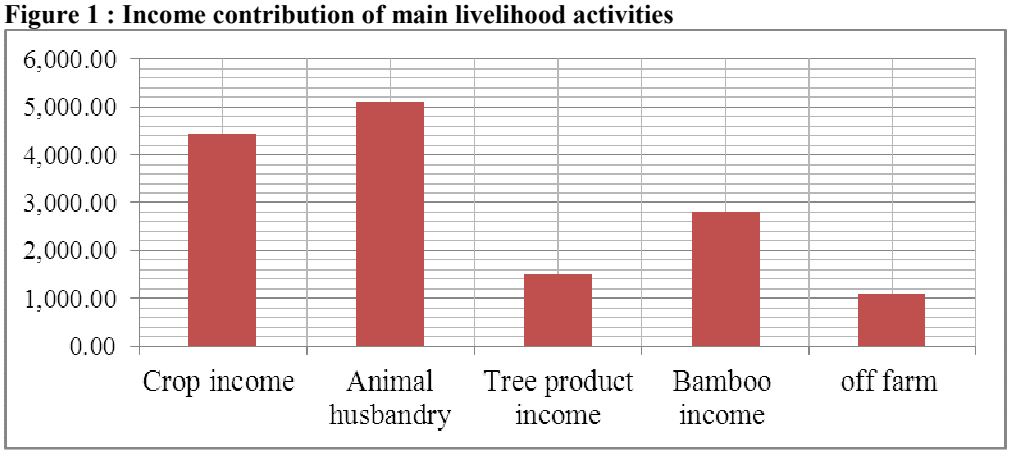
The livelihood activities of a household in the study area included: crop production, animal production, forest related activities, bamboo related activities and off farm activities such as petty trade and daily labor. The farming system of the study area can be classified as mixed crop and livestock subsistence farming. *enset*, *barley*, *wheat*, vegetables, pulses, and *maize* are the main crops grown in order of economic importance. The "false banana" enset (*Ensete ventricosum*) is important as source of energy for house consumption.

The degree of different uses of bamboo for income generation by 3 different wealth categories (Rich, medium and poor) indicated that all farmers use bamboo for house construction, fencing, firewood, grain container, and fodder for animals. From interview of selected house hold head, the comparison of different household income contribution indicated that 55% of the respondents ranked animal husbandry (1st), crop production (2nd), and bamboo production (3rd) as their main sources of livelihood activities respectively.

On average households' annual income from bamboo accounted to Birr 2,810 ETB for while crop income contributed about 4,446.67ETB and livestock income contributed about 5,105.23ETB. The total average annual household income of the sample households was 14,617.95 ETB for house hold income (figure 1).

Bamboo has always played an important economic and cultural role across Asia and its usage is growing rapidly in Latin America and Africa as well (Ombir, 2008). For instance According to Zhaohua and Yang (2004), for instance, the average bamboo income per household per year in Anji county of Hangzou province was 45% in 2002. On the other hand, studies in Northern Vietnam (La Nuguyen, 2004) and China (Shashi *et al*, 2000) shows that the contribution of bamboo to household income was 14% and 18%, respectively. In line with this, A study in Ethiopia, Shedema PA of Goba Woreda by Arsema (2008) and in Mvera, Dowa district, Malawi by Sosola (2005) showed on average 47% and 52% of the annual income of households is derived from bamboo sale respectively and study conducted by Kibwage and Misreave (2011) in southern regional states and Benshangul Gumuz National Regional States in Ethiopia reported that, bamboo accounted for 2–3% at the national level and more than 50% in rural areas. Similarly, Mekonnen (2014) indicated that Bamboo income contributed up to 11% of the annual cash income of the households, the lowest (3.4%) at Masha and the largest (38%) at Banja and Bahir Dar Zuria Districts. The present study 19.22% of the household income is more or less similar to these studies.

Figure 1 : Income contribution of main livelihood activities



Linear regression model was used to see the effects of a number of socioeconomic and biophysical variables on bamboo income generated per households. Among the various characteristics considered age of house hold and education of household head was negatively and no significantly related to income generated by household at ($P < 0.05$). On the other hand, household size positively and no significantly related to income generated to house hold income. However, land size was positively and significantly related to household income gain from bamboo tree and products ($P < 0.05$) (Table 2).

Table 2: Regression analysis of household bamboo annual income verses socioeconomic characteristics.

Model	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
(Constant)	2444.07	1526.42		0.17
Age of house hold head	-69.124	35.004	-0.988	0.10
Education of house hold head	-171.64	239.08	-0.248	0.50
House hold size	149.16	83.101	0.748	0.13
total size of land	563.09	198.72	0.716	0.00

Dependent Variable: Total bamboo income

4. CONCLUSION

Bamboo has many advantages for the rural livelihoods, such as local furniture, used as fodder for livestock and fuel-wood, construction material and also for soil conservation. The average bamboo income contribution to household cash incomes was almost half of the agricultural cash income. However, own farm consumption was highest. It contributes about one and half times as much as average bamboo cash income. The cash incomes from bamboo sold were used for household upkeep (buying food, transport, hospital and school expenses, and inputs for agricultural production). The study demonstrates that local bamboo-based AF practice is sustainable land use systems. As a hedgerow intercropping and woodlot plantations practice. The study also conclude that, although bamboo has great contribution to the local household, bamboo handicraft industry has limited in the area and there are no profound bamboo management practices by the local bamboo growers. In general the major bottlenecks affecting productivity and management of bamboo are shortage of land to plantation, low price of the products and infrastructure. Improving the existing poor market infrastructure will probably solve related problems that limit potential of bamboo for the development of the study area. Constraints related to poor access to market primarily limits improvement in productivity and production of bamboo. With these findings we recommend that further longer term research on the biophysical, socio-cultural and value chain are vital, Provide some small-scale bamboo-based firms for bamboo growing areas , policy and development intervention measures needed to address the various challenges and constraints and also develop some strategy that will encompass sustainable bamboo resource management and utilization.

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