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Smallholder Farmers' Knowledge and Attitudes Toward Adoption of Exotic Bamboo in Southwest Ethiopia

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ABSTRACT

Bamboo is a fast-growing forest resource that offers significant economic potential and can contribute to sustainable development. Farmers' knowledge and attitudes about exotic bamboo influence the successful adoption and effective utilization of the technology. Enhancing farmers' knowledge and positive attitudes towards exotic bamboo can create economic opportunities and ensure environmental sustainability. However, empirical evidence on farmers' knowledge and attitudes towards exotic bamboo practices is limited. This study aims to assess farmers' knowledge and attitudes towards the adoption of exotic bamboo species through a combined survey and field demonstration in southwest Ethiopia over the past three years. The field demonstration is supported by continuous training and follow-up. A multi-stage sampling technique was used to select 30 respondents. The collected data was analyzed using descriptive statistics and correlation analysis. The results indicate that participating respondents had a low level of knowledge and positive attitudes towards adopting exotic bamboo before the implementation of the program. The outcomes of a three-year field demonstration program show the effectiveness of providing smallholder farmers with information and knowledge about the adoption and management of exotic bamboo technology. Almost all respondents recognize the importance of implementing exotic bamboo to narrow the demand and supply gap of wood and forest management. Moreover, the results reveal a positive correlation between farmers' knowledge and their willingness to adopt exotic bamboo technology. Therefore, the finding suggests the provision of capacity-building training and extension services for farmers to increase their knowledge and positive attitudes toward the adoption of exotic bamboo management practices.

INTRODUCTION

Bamboo is one of the most important plants, attracting significant attention for its numerous uses and the development of new applications that have emerged globally over the past twenty years (Chirwa & Meliczek, 2014). It offers a wealth of economic, social, and environmental benefits, including fuel wood, timber and non-timber products, construction materials, medicinal uses, and cultural value, particularly for local communities, especially smallholders (Meinhold & Darr, 2019; Shackleton et al., 2011). Over 600 million people derive their income from bamboo, while an estimated 2.5 billion people rely on it for their livelihoods, contributing an estimated US$7 billion annually to the global economy (Lobovikov et al., 2007). Bamboo also holds tremendous potential for environmental enhancement, shock resilience, and poverty reduction (UNIDO, 2009). Promoting bamboo planting and cultivation can help the poor provide with a natural resource that they have access to and ownership over and principally resilient to natural and man-made shocks and reduce the severity of poverty (Hallegatte et al., 2020; Phimmachanh et al., 2015).

Ethiopia has the highest bamboo resource in Africa in terms of area Kelbessa et al. (2000), accounting for approximately 67% of the continent's bamboo resource (Embaye, 2003). Studies have demonstrated that bamboo cultivated commercially is more renewable and sustainable than other woody plants, as the inefficient

harvesting and use of bamboo has become a global concern (Bansal & Zoolagud, 2002; Song et al., 2011). Bamboo plantations have become a valuable income source for smallholder farmers, providing them with increased livelihood options (Gebrekidan et al., 2018). Although there has been limited information for farmers on the diverse benefits of bamboo plantation, its contribution to the livelihood of rural households, socioeconomic, and cultural benefits are significant in Ethiopia (Desalegn & Tadesse, 2014; Wakweya, 2023). Moreover, recent attention has been given to the bamboo resources by local communities, as it has the potential to generate more income than what they receive from other sources while also promoting suitable environmental conditions.

Although Ethiopia is one of the most endowed countries in having huge coverage of bamboo resources in Africa, the country has narrow genetic diversity only has two species: Yushania alpine (highland) and Oxytenanthera abyssinica (lowland bamboo) (Gebrekidan et al., 2018). As a result, Ethiopian bamboo is shrinking due to deforestation and following the recent gregarious flowering of both lowland and highland bamboos in many places. Moreover, with these two species, it is very difficult to secure a constant supply of bamboo raw material for bamboo industries and local handcrafts. Thus, as an intervention to tackle these problems, exotic bamboo species have been introduced in the country (Mulatu et al., 2016; Vorontsova et al., 2016). There is a huge demand for the adoption of exotic bamboo species as a solution to the mass flowering of indigenous bamboo species from the farmers' side. The exotic bamboo species grows in various agroecologies in which Indigenous species cannot grow, less affected by disease and enhanced productivity.

The knowledge and attitude of farmers on exotic bamboo species is a crucial factor in the adoption of the technology. Knowledge serves as a fundamental means by which individuals comprehend their own selves and the world around them (Ahmad et al., 2020). Knowledge allows one to understand, compare, analyze, interact, relate to, act upon, and interpret the ego, nature, and fellow human beings. In the modern era, knowledge has a profound impact on all aspects of an organization (Bose, 2004; Songlar et al., 2019). Farmers' level of knowledge encompasses the extent of their information and understanding regarding their local environment, as well as their ability to apply this knowledge to achieve specific outcomes such as crop yields, potential environmental benefits, risks, and costs (Tokede et al., 2020).

Attitudes toward behavior refer to the degree of favorability or unaffordability that a person has towards a specific behavior, which is derived from their beliefs about certain objects or behaviors (Scalco et al., 2017; Venkatesh & Bala, 2012). Previous research has revealed that the attitudes of farmers significantly influence their adoption of agroforestry practices in the Eastern highlands of Uganda (Buyinza et al., 2020). Attitude is a significant determinant of artisans' intentions to preserve bamboo (Mwanja et al., 2023).

Driven by stakeholder demand, the necessity to scale up and diversify the genetic resources of exotic bamboo species is believed to not only improve the income of smallholder farmers but also contribute to environmental protection in Ethiopia. Furthermore, effective management of the bamboo resource, including the utilization of modern technologies such as propagation, fertilization, and genetic improvement is crucial (MEFCC, 2018). Enhancing farmers' knowledge and attitudes toward the adoption of exotic bamboo helps in creating economic opportunities, ensuring environmental sustainability, and contributing to livelihood improvement and rural development (Asfaw, 2019). However, the evidence of farmers' knowledge and attitudes toward the adoption of exotic bamboo species is limited. Therefore, this study is aimed to assess farmers' knowledge and attitudes toward the adoption of exotic bamboo species. A case study of a field demonstration in southwest Ethiopia over the past three years is used to achieve the specified objectives. This paper makes a significant contribution to the existing literature in two ways.

Firstly, it presents empirical evidence on the knowledge and attitudes of farmers regarding the adoption of exotic bamboo species. Secondly, the study includes a field demonstration of exotic bamboo technology, which offers a deeper understanding and observation of how participants engage with practices in their local context in the adoption of the technology.

MATERIALS AND METHODS

Description of the Study Area

This study is conducted in the Gumay Woreda, Jimma Zone located in the southwest region of Ethiopia. Situated in the Jimma Zone of the Oromia Regional State, the Woreda is positioned at a distance of 420 kilometers southwest of Finfinnee and 69 kilometers from the zonal seat. The Woreda was founded in 1996 and has a total population of 77,680, of which 51.6% are men and 48.4% are women, as well as 8,961 houses in 14 administrative kebeles. It is surrounded by the districts of Goma in the south and east, Setema in the north, and Didessa in the west, and it is now administered by two urban and thirteen rural kebeles. There are 79,933 people living there in 2018 (39167 men and 40766 women). Geographically, it is situated 2,370 meters above sea level. The mean annual temperature is 20 to 25° C, and the average amount of rainfall falls between 1,400 individuals to 1,600 mm. 53% and 33% of this district's land mass are respectively in subtropical and temperate agro-climatic. Tropical weather can be found in the remaining 14% of the district's agricultural climate. The Woreda temperature ranges from 27 to 300 °C. The primary economic activity is agriculture, which includes a variety of goods including coffee, maize, teff, sorghum, and others (Biyena et al., 2021). Figure 1 shows a location map of the study area.

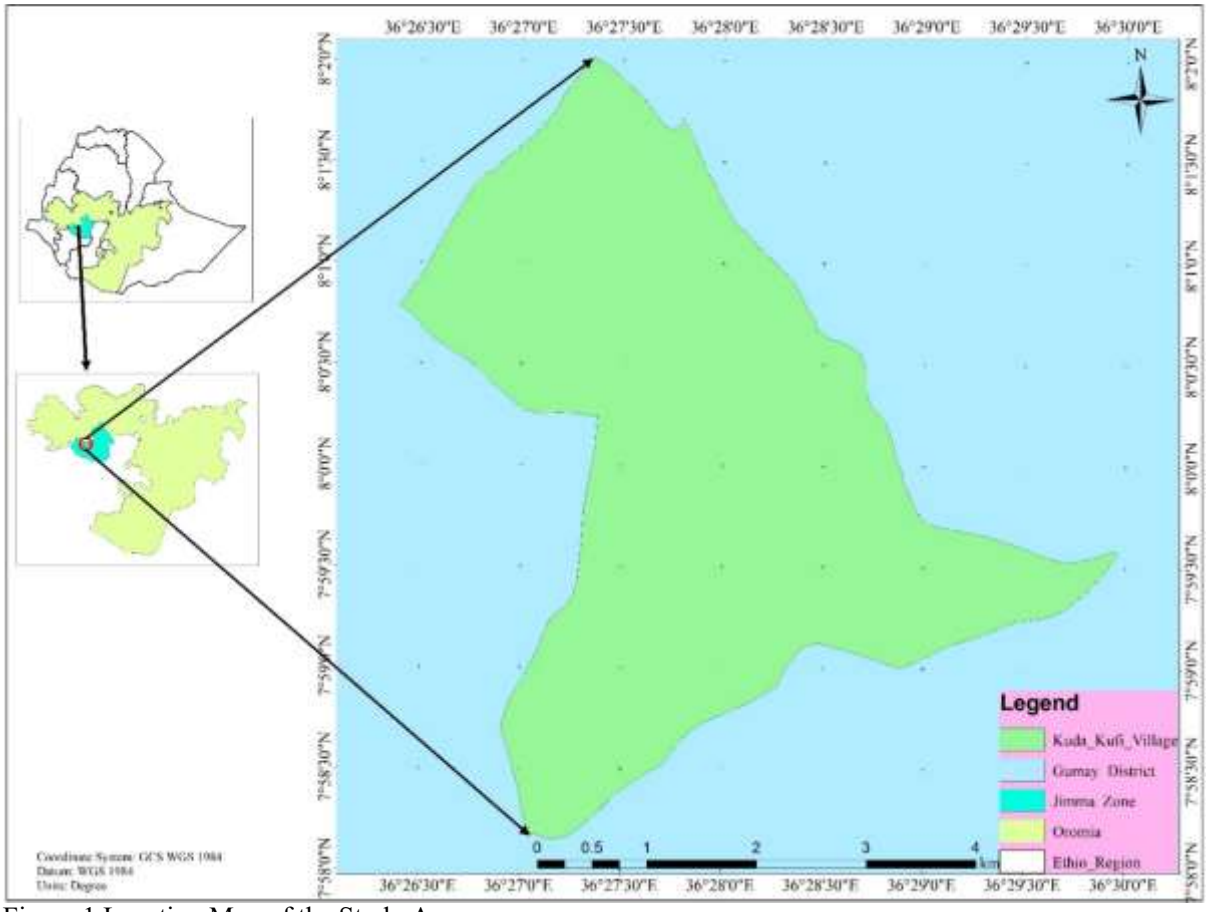

Figure 1 Location Map of the Study Area

Sampling Technique

A multi-stage sampling technique was employed to obtain sample respondents. First, Gumay Woreda was purposively selected among 18 Woredas of the Jimma zone. This is done due to the Woreda location within the midland agroecology and suitability for the cultivation of exotic bamboo species.

Second, from the selected Woreda, Kuda kuffi kebele was selected due to its proximity to the road and its potential to function as a demonstration site, allowing other farmers to easily observe the performance and adaptability of exotic bamboo species. Third, simple random sampling was employed to select 30 sample farmers based on their willingness to participate in a project and their

ability to allocate demonstration land for the exotic bamboo technology.

Source of Data and Data Collection Methods

This study used both primary and secondary data sources. Primary data was collected from the sampled respondents using a structured questionnaire on the households' demographic and socioeconomic characteristics, and farmers' knowledge and attitudes towards adoption of exotic bamboo management practices from the sampled households. In addition, baseline data was collected on the knowledge and attitudes of respondents towards the adoption of exotic bamboo. Whereas, post-intervention (after implementation of field demonstration) data was collected following the completion of the field demonstration from the sampled respondents. Secondary data was collected from published and unpublished materials such as journal articles, technical manuals and reports, and other secondary data sources.

Research Design

Pre and post-evaluation of one-group research design was employed to examine responses and knowledge improvement of the respondents involved in this study. This study conducted both surveys and field demonstrations of exotic bamboo in the study area. Surveys provide quantitative or qualitative data on a broad range of variables, including attitudes, knowledge, and behavior, and are efficient for reaching a large number of participants at a relatively low cost. Field demonstrations, on the other hand, offer a richer understanding of how participants interact with technologies or practices in their local context, allowing for observation of behavior and provision of qualitative data that can be used to interpret survey results.

In 2019, seedlings of exotic bamboo species were distributed to 30 smallholder farmers who were part of the sample. This was aimed at demonstrating effective management practices and assessing the farmers' knowledge and attitudes regarding the adoption of the technology. As a result, combining both survey and field demonstration methods, participants were able to learn more about exotic bamboo practices and provide feedback more interactively. This can also help to triangulate the findings and increase the credibility and validity of the study.

A field demonstration is supported by training in which five days of training were provided to respondents regarding the socio-economic and environmental benefits of bamboo for consecutive three years. Additionally, the steps involved in the management of exotic bamboo practices, from initial planting to utilization, were provided to participants in collaboration with biophysical researchers on the topic. This included land preparation, post-planting management, harvesting, and post-harvest management. Field visits and continuous follow-up were also conducted with community members, local authorities, and government experts.

Method of Data Analysis

The quantitative data was analyzed using both descriptive and inferential statistics. The SPSS version 26 software was used for the analysis. Descriptive statistics, including mean, frequency, percentage, and correlation methods, were employed to analyze the data. Additionally, a Likert analysis was conducted to assess the attitudes of the respondents towards exotic bamboo technology practice in the study area. Likert analysis is a statistical method used to measure the intensity of people's attitudes, beliefs, or opinions. A five (5) points Likert scale is used to analyze the attitude of participants toward adoption of the exotic bamboo practices. One group pre and post-comparative analysis was conducted to evaluate the effects of field demonstration of exotic bamboo on the knowledge gain of the respondents.

RESULTS AND DISCUSSION

Socioeconomic and Demographic Characteristics of the Respondents

This section presents the descriptive summary of the respondents' socio-economic and demographic characteristics in the study area (Table 1). The result indicates that the majority of the sample respondents (90% (N=27)) are male-headed households, whereas the remaining 10% are female-headed households (Table 1). The mean age of the respondents is 41.93 years old. The average family size of the respondents is 5, ranging from 3 to 8 minimum and maximum family size, respectively. The mean annual income of the sampled household is found to be about Ethiopian Birr 59,939.3 ($1,158.1) with a minimum of birr 11,000 ($212.5) and a maximum of birr 130,000 ($2,511.8). About

70% (N=21) of the respondents reported they are enrolled in formal education, whereas the remaining 30% (N=9) did not enroll in formal education. Almost all of the respondents (96.67%) are engaged in mixed farming as their main occupation, whereas only one (3.33%) respondent is a government employee.

Table 1. Socio-economic Characteristics of the Sample Respondents

Continuous variables	Minimum	Maximum	Mean
Age (year)	27	60	41.93
Family size (number)	3	8	5
Level of education (year)	1	6	2.47
Household annual income ($)	212.5	2,511.8	1,158.1
Length of time residence in the area (year)	12	49	35.17
Allocated land for woodlot (ha)	1.00	2.00	1.57
Dummy/categorical variables	Category	Frequency	Percentage
Gender of household head	Male	27	90
	Female	3	10
Main occupation	Mixed farming	29	96.67
	Gov't employee	1	3.3
Livestock ownership	Yes	24	80
	No	6	20
Access to enough grazing land	Yes	12	40
	No	18	60
Land ownership	Yes	21	70
	No	9	30
Allocated land for woodlot	Yes	13	43.3
	No	17	56.7

Farmers' Satisfaction and Feedback on the Training Provided

Over the past three years, the Ethiopian Forestry Development, Jimma Center has been provided training on exotic bamboo management practices and its socioeconomic benefits to involved farmers. To assess the satisfaction of the farmers with the training, feedback data was collected. The respondents were requested to state their satisfaction with the training.

Figure 2 depicts the level of satisfaction of the participants regarding the training on exotic bamboo. The results show that the farmers were generally satisfied with the training provided. The highest percentages were assigned to the usefulness of the training materials (80%), the content of the training materials (75%), and the technical knowledge of the researchers (70%). The lowest ratings were allocated to the timing of the training provided (60%). Nevertheless, the respondents were very satisfied with the usefulness of the training materials and reported that they were well-prepared and easy to understand, providing them with the necessary information to cultivate exotic bamboo. Additionally, the respondents indicated that the content of the training material covered a wide range of topics related to exotic bamboo cultivation.

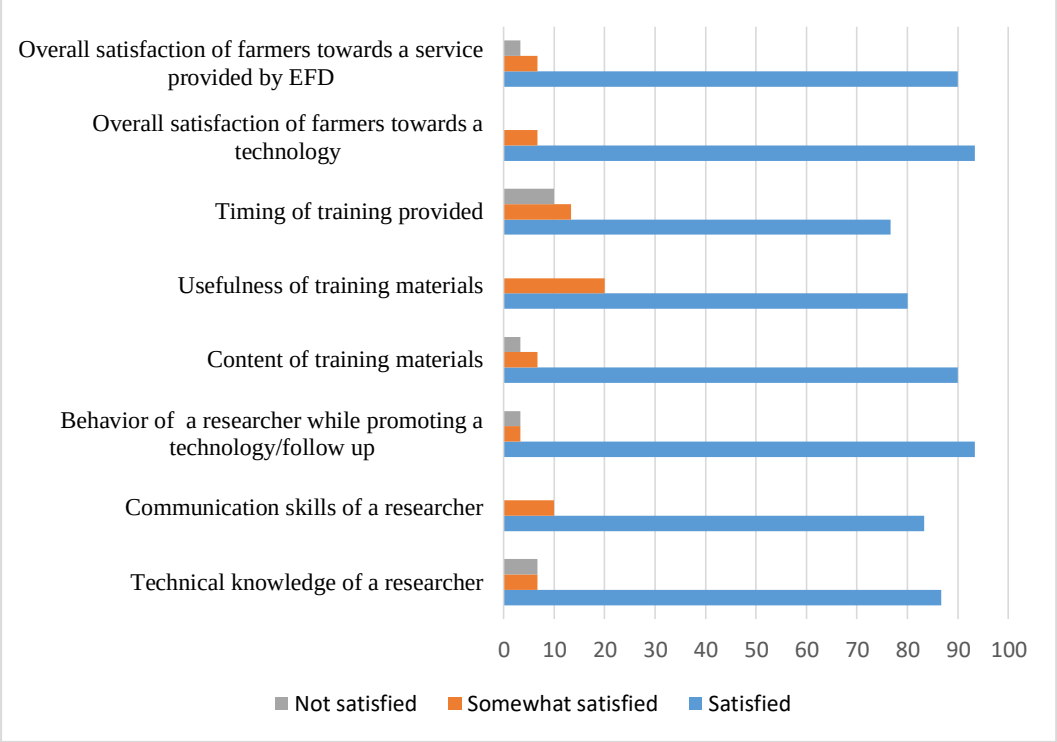

Figure 2. Trainees' level of Satisfaction toward Training on Exotic Bamboo

Respondents' Knowledge and Attitudes Toward Adoption of Exotic Bamboo

1. Respondents' pre-exposure knowledge about exotic bamboo

A baseline assessment regarding the knowledge of respondents toward exotic bamboo species is carried out before the start of the field demonstration in the study area. Table 2 illustrates respondents' self-reported knowledge about exotic bamboo practices before the launch of the field demonstration. The results indicate majority (60%) of the respondents reported that none of their family members obtained education/training on exotic bamboo practices before the implementation field demonstration in the area (Table 2). Similarly, almost all (90%) of the respondents reported that they did not get a guideline about practices of bamboo technology in the form of written documents. These imply majority of the respondents had a low level of information and knowledge regarding exotic bamboo practices before the implementation of the field demonstration. The result is aligns with the findings of similar previous studies (Babu et al., 2021; Belakeri et al., 2017) in which participants' low-level knowledge before exposure to the training programs were reported.

Table 2. Baseline Assessment of Respondents' Knowledge toward Exotic Bamboo

Baseline survey checklists	Response frequency	
	Yes	No
Do one or more of the family members get education/ training on bamboo/exotic bamboo	12 (40)	18 (60)
Have one or more of a family member participate in field days or on-farm trials/demonstrations	10 (33)	20 (57)
Do the household get written guidelines about practices of bamboo technology	3 (10)	27 (90)
Have any materials made from bamboo	4 (13)	26 (87)
	Information sources	Frequency

Other means of accessing information about bamboo production	Local media (radio)	13 (43)
	Orally from DA	8 (27)
	Neighbors	7 (23)
	Others	2 (7)

Note: The first figures in the table represent frequency, and figures in the brackets represent equivalent values of percentages (%)

In addition, the result indicates majority of the respondents did not participate in the on-farm demonstration before the implementation exotic bamboo program in the study area. Although farmers did not get sufficient formal training, they have information about exotic bamboo species. Households reported that local media (43%), development agents (DAs) (27%), and neighbors (23%) are the main sources from which they obtain information regarding bamboo management.

2. Respondents' post-intervention knowledge toward the adoption of exotic bamboo

The study assessed respondents' knowledge and understanding with respect to the exotic bamboo technology practices that have been demonstrated over the past three years in a study area. Table 3 presents the sample respondents' level of knowledge and attitude toward the adoption of exotic bamboo technology practice in the study area. The result indicates that that all sample respondents recognize a significantly increasing trend in wood prices over time. Similarly, almost all (80%) of the respondents reported that they agree with the statement about the importance of forest management and conservation, whereas, about (53%) of the respondents reported that the implementation of exotic bamboo serves as a source of livestock fodder (Table 3).

Table 3. Knowledge of Participants about Exotic Bamboo Technology Practice

Post-intervention checklists	Frequency (%)	
	Yes	No
The price of wood getting increased through time	30 (100)	0
Practicing forest management is very important	24 (80)	6 (20)
Implementation of exotic bamboo will benefit as a source of fodder for livestock	16 (53)	14 (47)
Implementation of exotic bamboo will create job opportunities	8 (27)	22 (73)
Implementation of exotic bamboo will minimize resource degradation	3 (10)	27 (90)
Implementation of exotic bamboo narrows the demand and supply gap of wood	28 (93)	2(7)
Implementation of exotic bamboo improves the productivity of land	1 (3)	29 (97)
Have got enough knowledge to grow exotic bamboo from a research institute	10 (33)	20 (67)

Note: The first figures in the table represent frequency, while figures in the brackets represent (%)

The level of household knowledge regarding who bears responsibility for the conservation of the forests, including bamboo forests, is one of the factors that may account for their attitudes towards its preservation. This aligns with the findings of (Zelalem et al., 2019), who reported that approximately 40.16% of households believe all stakeholders share the responsibility for protecting and conserving the environment and forests, while 28.69% believe the responsibility lies with the entire community.

Moreover, the results indicate that the implementation of exotic bamboo technology practice has the potential to narrow the demand and supply gap of wood, as supported by 93% of the respondents. This implies that the local community has a positive perception toward practicing bamboo technology and recognizes its role in lessening the existing demand and supply gaps. On the other hand, the result reveals that a small proportion (27%) of the respondents believe that the implementation of exotic bamboo technology practices can create job opportunities and minimize resource degradation. In line with this, the findings from previous studies reported the potential of bamboo forests in job opportunity creation in Ethiopia (Fekadu et al., 2012; Kassahun, 2014; Mekonnen et al., 2012; Tadesse, 2006). Furthermore, researchers have highlighted the significant role of bamboo in bridging the social gap

in the wood supply chain, serving as fencing, roofing, shade, housing, and utility items (Akwada & Akinlabi, 2018; Tambe et al., 2020).

The pre and post-evaluation results indicate that respondents' knowledge about exotic bamboo practices is improved post-implementation of the field demonstration relative to before the program. This implies implementation of a field demonstration program has the potential to improve smallholder farmers' knowledge regarding the adoption of bamboo technology. This further contributes to the promotion and scaling-up of exotic bamboo practices, thereby increasing economic and environmental sustainability.

Respondents' Attitudes toward Adoption of Exotic Bamboo Practices

Analysis was based on a five-point Likert scale, ranging from strongly agree assigned the highest value of "5" to strongly disagree with the lowest value of "1" (Table 4). Table 4 presents the results of participating farmers' attitudes toward the exotic bamboo practice based on the Likert analysis.

Based on the results of the Likert analysis, the farmers have a positive attitude toward the adoption of exotic bamboo technology. The Likert numerical mean value for the statement regarding growing exotic bamboo could be a good opportunity to narrow the demand and supply gap for wood is found to be 4 (Table 4). This indicates that the sample respondents generally agree with the potential of exotic bamboo adoption in lessening wood demand and supply gap, perceiving bamboo as a potential alternative to wood. Similarly, the mean value for both statements about exotic bamboo management via a participatory approach and accepting all exotic bamboo technology practices is 4. This implies that the farmers agree with the exotic bamboo management through a participatory approach and are aware of the importance of bamboo and are willing to take steps to protect it.

This further suggests that the farmers are more certain and have a positive attitude toward their acceptance of exotic bamboo practices and their agreement with managing exotic bamboo via a participatory approach. This aligns with a finding of a previous study by (Urgessa, 2003), that reported the success of natural resource management projects depends on both the biophysical context and the socioeconomic and cultural contexts within which they operate.

Table 4. The Attitude of Participants toward Exotic Bamboo Practice

Statements	Response category					Likert score	Mean value
	Strongly agree	Agree	Unsure/ neutral	Disagree	Strongly disagree		
Growing exotic bamboo could be a good opportunity to narrow the demand and supply gap for wood	15	9	4	1	1	126	4
Managing exotic bamboo via a participatory approach	17	8	3	1	1	129	4
Accepting all exotic bamboo technology practice	16	12	2			134	4
Every farmer has a responsibility to protect exotic bamboo	12	8	3	4	3	112	3

On the other hand, the result indicate that the Likert mean value for the statement regarding farmers' responsibility to protect exotic bamboo is 3, which means that respondents are generally uncertain or neutral regarding their agreement for the responsibility to protect the exotic bamboo in the study area. This could be attributed to that the farmers' responsibility to protect the exotic bamboo technology is a more complex issue the farmers need more information about the management and sustainable use of bamboo forests. Thus, it is important to provide farmers with training and extension services to improve their understanding and positive attitude toward the exotic bamboo

technology. Generally, the results suggest that smallholder farmers in the study have a positive attitude toward the adoption of exotic bamboo technology.

Correlation analysis was used to test the link between farmers' knowledge and attitude toward exotic bamboo technology and their willingness to adopt the technology. The result shows that the coefficient of correlation (r) value is 0.88 for the knowledge variable (Table 5). This implies that respondents' knowledge of exotic bamboo practices and willingness to practice exotic bamboo are strongly correlated with each other at 88%. Moreover, the positive relationship between the two variables implies that there is a positive correlation between the respondents' knowledge of exotic bamboo and their willingness to adopt the technology. Furthermore, as the farmers who have knowledge about exotic bamboo practice increases the probability of willingness to practice the technology will increase.

Table 5. Summary of the Correlation Coefficient (r) on Respondents' Knowledge of Exotic Bamboo Practices and their Willingness to Practice the Technology

Variable description	Coefficient correlation (r)	P - value
Knowledge of exotic bamboo and willingness to practices exotic bamboo species	0.88	0.645

The insignificant p-value is attributed to the small sample sizes, as for large samples, a small 'r' would be significant, and for small samples, a relatively large one would not be. However, the he p-value does not indicate how strong the relationship between the variables are.

On the other hand, the result shows that the correlation coefficient for the attitudes of respondents toward the adoption of exotic bamboo technology is (r = -0.33) (Table 6). This indicates that there is a weak negative monotonic relationship of about (33%) between the attitudes of respondents and their willingness to adopt exotic bamboo practices in the study area.

Table 6. Summary of Correlation Coefficient (r) on the Relationship between Respondents' Attitudes toward Exotic Bamboo and their Willingness to Adopt the Technology

Variable description	Coefficient correlation (r)	P-value
Attitude toward exotic bamboo and adoption of exotic bamboo species	-0.33	0.423

CONCLUSION

Promoting the adoption of exotic bamboo technology requires enhancing farmers' knowledge and their attitudes toward its management practices. This study examines smallholder farmers' knowledge and attitude toward the adoption of exotic bamboo technology in southwest Ethiopia. A combined survey and field demonstration of exotic bamboo practices is implemented. The results reveal that the majority of the respondents obtained better knowledge of practicing exotic bamboo technology post-intervention of the program in the study area. Moreover, the finding indicates there is a positive linkage between respondents' knowledge of exotic bamboo technology and their willingness to practice the technology. This suggests that increasing farmers' knowledge of the practice of exotic bamboo increases their willingness to adopt the exotic bamboo. Similarly having a positive attitude toward exotic bamboo increases the adoption of exotic bamboo species. Thus, it is recommended to promote stallholders' positive attitude and intensive extension services to expand the adoption of exotic bamboo technology to other kebeles and Woredas in the study area and beyond. In addition, the allocation of sufficient financial resources and organizing experience sharing with benefited farmers in different areas is very important to promote/upscale the exotic bamboo technology.

The outcomes of a three-year field trial program demonstrated the effectiveness of providing smallholder farmers with information and knowledge about the adoption and management of

exotic bamboo technology. This finding has significant policy implications, as it highlights the importance of information and knowledge as a crucial factor of production in the face of changing environmental trends in various agricultural sectors. To promote the adoption of exotic bamboo technology among smallholder farmers, it is essential to scale up effective promotion strategies through field demonstrations. Moreover, the huge demand for bamboo technology from the farmers' side necessitates the provision of bamboo seedlings as well as the necessary capacity building for effective technology management. Collaborating with local institutions, such as farmer cooperatives and NGOs, is also crucial to provide sustainable support.

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