Trees, Forests and People 11 (2023) 100379

Contents lists available at ScienceDirect

Trees, Forests and People

journal homepage: www.sciencedirect.com/journal/trees-forests-and-people

Importance of socio-economic and institutional factors in the collection of dry forest products: The case of gum and resin in Jawi District, Northwest Ethiopia

Muzayen Sheko [a], Getahun Kassa [a,*], Degnet Abebaw [b], Habtemariam Kassa [c], Abdu Abdelkadir [d]

[a] Wondo Genet College of Forestry and Natural Resources, Hawassa University, P.O.Box 128, Shashemene, Ethiopia
[b] Independent Researcher, Addis Ababa, Ethiopia
[c] Center for International Forestry Research, Addis Ababa, Ethiopia
[d] Ethiopian Environment and Forestry Research Institution, Addis Ababa, Ethiopia

ARTICLE INFO

Keywords:
Dryland forest
Heckman 2 stage selection
Jawi
NTFPs

ABSTRACT

Although the important role of dry forests in livelihoods is immense, empirical evidence on the role of socio-economic factors in the collection of dry forest products is still lacking. This study aimed to assess the determinants of household participation in dry forest product collection and its contribution to the household economy in Jawi district. The primary data were collected from 259 randomly selected households. The determinant factors affecting household participation in dry forest product (gum and resin) collection and the level of revenue from gum and resin were evaluated using a Heckman 2-stage selection model. According to the findings of this survey, dry forest revenue accounts for 23.69% of the total annual household income. Our findings reveal that age, proximity to the forest, distance to the market, participatory forest management (PFM) membership, frequency of forest extension, and poor wealth status have a substantial impact on a household's engagement in dry forest product collection and the level of income generated from engagement in dry forest product collection. Policies and strategies aimed at improving the well-being of households in the country's dry forest areas should focus on the market development of resources to boost the income of local people.

1. Introduction

1.1. Background of the study

Forests and trees provide ecosystem products and services that are essential for people's livelihoods and well-being in dry areas. In Africa, where 60% of the rural population is poor, dry forests constitute an important resource base for subsistence and economic development (Wubalem et al., 2020). Dry forests are endowed with many vegetation species that can produce multiple nontimber forest products (NTFPs) during the dry season, even when other major economic activities are limited by recurrent drought (Siyum, 2020). Dry forests have great potential for carbon absorption, maintaining diverse and resilient ecosystems, and conserving water (Portillo-Quintero et al., 2015). Despite their importance, these resources have been severely degraded by various ecological, socioeconomic, and policy-related factors (Teketay, 2004–2005). As a result, the conservation of tropical dry forests, which are found primarily in developing countries in sub-tropical regions, is a global concern (Neudert et al., 2018).

The term "dry forests" refers to the various plant types present in Ethiopia's drylands, which include both thick and sparse vegetation, as well as tropical rain forests in the southwest and Afro-alpine and sub-Afroalpine vegetation in the central highlands (Lemenih and Bongers, 2011). Ethiopia has the capacity to produce between 35,000 and 114,000 metric tonnes of gum and resin annually (Lemenih and Kassa, 2011). Although dry forest products such as gum and resin, bamboo, honey, medicinal herbs, charcoal, and others have long been used to produce substantial economic returns, their importance has been overshadowed by timber products, which are considered major forest commodities (Degnet et al., 2012). In Ethiopia's dry forests, 65,540 hectares of high forest, 91,400 ha of wood, and 76,400 ha of shrub lands have disappeared every year (WBISPP 2004), jeopardizing industry and community livelihoods.

Dry forests constitute 80% (approximately 17.3 million acres) of

* Corresponding author.
E-mail address: zgetah@gmail.com (G. Kassa).

https://doi.org/10.1016/j.tfp.2023.100379
Received 26 May 2022; Received in revised form 3 February 2023; Accepted 7 February 2023
Available online 9 February 2023

Ethiopia's total forest area (Atmadja et al., 2019). Dry forest products contribute significantly to rural household income and are used for several purposes, including food, feed, energy, medicine, revenue generation, and cultural rights (Bedru et al., 2008; Yemiru et al., 2011). Despite their socioeconomic and ecological benefits, the dry forests of Ethiopia in general and Jawi in particular have continued to suffer from both man-made and naturally occurring problems. The main threat to Ethiopia's dry land forests, as with other forests in the country, relates to forest land conversion into agriculture and fuelwood cutting (Eshete et al., 2021; Moges, 2021). In an attempt to reverse these problems, the Government of Ethiopia introduced a series of forest management reforms and devolved forest governance to regional governments and local communities, especially in the mid-1990s. As a result, many local communities in many places, including Jawi, have formed participatory forest management to take over the responsibility of management and use of the nearby forests allocated to them (Eshete et al., 2021). However, the quality and quantity of gum and resin producing forests in Jawi have not improved and they remain *de facto* open access. In this context, a key research question is whether and to what extent local communities rely on existing dry forests as their source of income.

Although recent studies from many dry forest locations have enhanced our understanding of some aspects of the forest-people interface, empirical studies on the level of people's forest income (Degnet et al., 2012) and the determinant factors of dry forest income are still needed in many dry forest areas (Dagim et al., 2016). No study has been conducted so far in the Jawi district on the importance of socioeconomic and institutional factors in the collection of dry forest product. This study was conducted to estimate the contribution of dry forests to total household income and to identify the factors that influence the level of participation in dry forest product collection to meet community livelihood interests and long-term dry forest conservation goals in the study area.

1.2. Conceptual framework

The main conceptual framework used in this study is the sustainable livelihood Framework (SLF). The SLF approach examines how households acquire assets, the activities they undertake to sustain themselves and the outcomes of these activities (Berhanu et al., 2021). Physical capital (such as distance to the market), natural capital (such as land, livestock, and one's own woodlot), financial capital (such as business income), human capital (such as educational attainment), and social capital (such as membership in social groups) can all be used to classify household resources and assets (Yego et al., 2021). The SLF approach examines household characteristics, resource usage and depletion, institutional changes, environmental change, and market accessibility in a particular location to study the sustainability of livelihoods (Jo et al., 2019). Additionally, SLF is frequently used to evaluate how vulnerable and resilient households are to seasonal changes in prices and production (Berhanu et al., 2021). The SLF models the influence of both internal and external factors that contribute to livelihood to better understand how people make a living (Jo et al., 2019). Consequently, this paradigm provides a basis for studying the factors that influence forest extraction among rural households (Nguyen et al., 2015).

As an extra source of income in the study area, agro-pastoralists frequently harvest gum and resin, which can be freely accessed and harvested from open woodlots. Agro-pastoralists rely on the extraction of gum and resin for survival. Therefore, it is crucial to examine the link between various household income components and dependence on dry forest products to comprehend how these natural resources support the livelihood of agro-pastoralists (Berhanu et al., 2021). In this study, four variables of human capital (age, family size, gender, and level of literacy); two variables of natural capital (landholding, livestock holding); two variables of financial capital (income, wealth status); one variable of social capital (PFM membership); four variables of physical capital (distance from home to market, distance to the forest, access to market information, frequency of extension contact) were used.

2. Materials and methods

2.1. Study site description

This study was conducted in the Jawi district of the Awi zone, Amhara Regional State, northwestern Ethiopia (Fig. 1). The area is 250 km from the regional capital (Bahir Dar) and 670 km from Addis Ababa. The climate ranges between a long summer wet season (June through September) and a winter dry season, with an average annual rainfall of 1569.4 mm (October through May) (Shimelis et al., 2011). The average temperature is from 16.68 °C to 37.6 °C, and the altitude is between 648 and 1300 m.a.s.1. The land is covered by different vegetation types, including savanna grasslands, forests, riverine areas, and bush lands, and the main agricultural commodities are sorghum, maize, sesame, and cotton (Shimelis et al., 2011). Gum and resin are the main dry forest products in the area.

2.2. Data types and sources

Information was gathered from both primary and secondary sources. Individual interviews with households, key informants from district experts, and focus group discussions were conducted to gather the primary data. Previous theses, literature, articles, journals, and published and unpublished reports of GOs and NGOs operating in the forest sector serve as secondary data sources. The Agricultural Office of Jawi district provided secondary data such as socioeconomic information on districts and kebeles. The household head ledger found in each kebele's government office was used to compile a list of household heads and their wealth statuses. We followed the conditions of the Ethical Conduct for Research Involving Humans. Ethical approval for this research was obtained from Hawassa University, Wondo Genet College of Forestry and Natural Resources. Informed consent was obtained from all the participants for interviews with human participants.

2.2.1. Sampling method

Four kebeles, Shimele igir, Banbluk, Jhaymala, and Kumbir, were selected from the 31 kebeles of Jawi district based on their security conditions, potential for gums and resins, and proximity to an all-weather road (Table 1). Using the formula provided, the total sample of respondents in the four kebeles was determined (Yamane, 1967). Simple random sampling was used to select samples from each kebele. Data from the Kebele Agricultural Office with DAs were used to randomize the participants.

The total sample responses for the four kebeles were calculated using Yamane's (1967) formula:

$$n = N/\left(1 + E^2 N\right) = 3950/\left(1 + (0.06)^2 * 3950\right) = 259$$

Where: E^2 = allowable error (6% owing to time and budget constraints)

N = total population

n = sample size

2.2.2. Preliminary survey

A preliminary visit to the Jawi District Agricultural Office and the district Environmental Protection Office was performed before gathering the actual data. The purpose of the study and identification of potential kebeles, as well as the security situation in the district, were discussed informally with the Agriculture Office's department head, during which, a field visit with Kumbir Kebele development agents and agricultural office experts was held. Before the survey, the questionnaire was pretested on five household heads to gather feedback from enumerators, and changes were made based on the results. Data were gathered between April and May 2021.

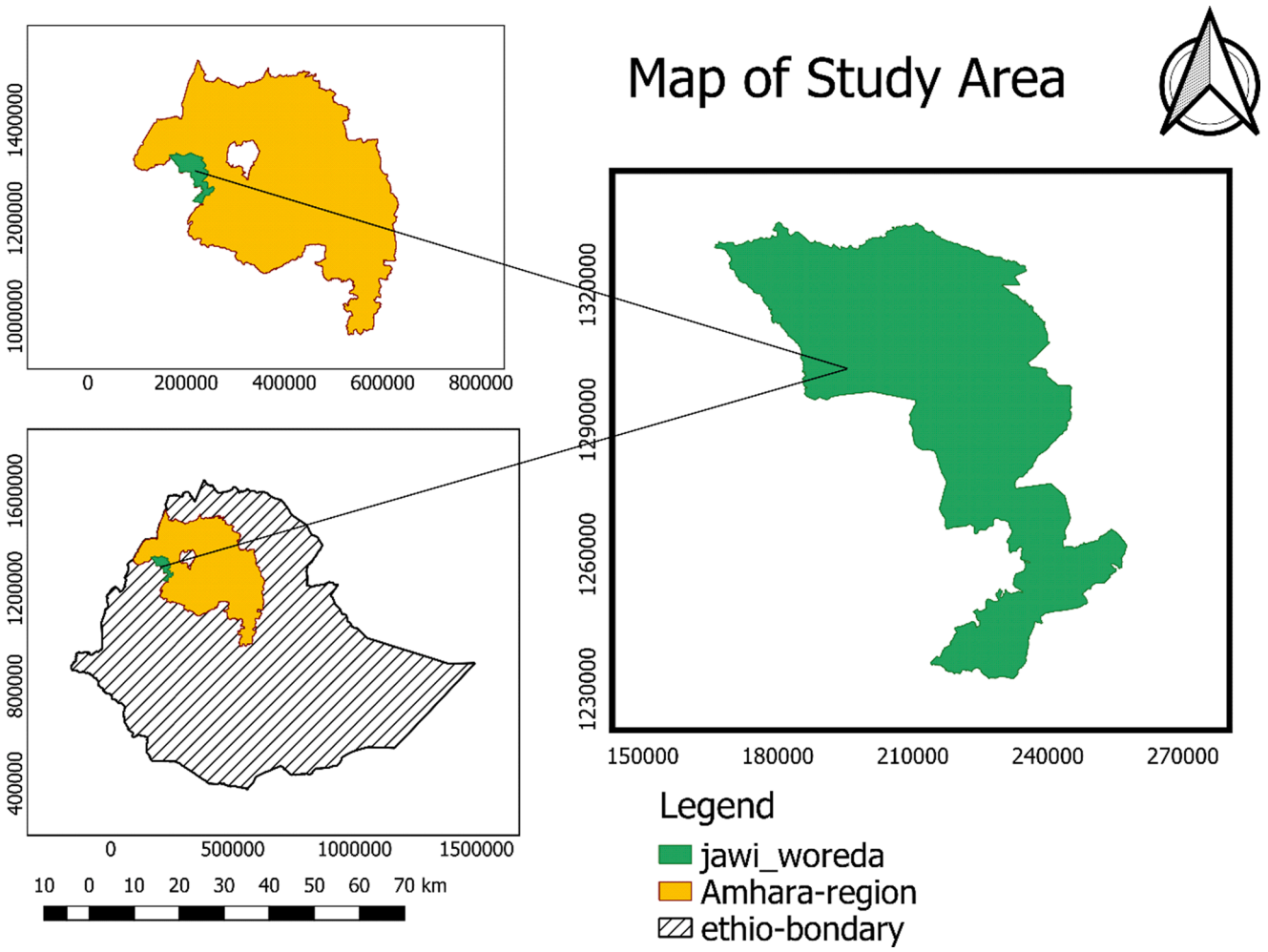

Fig. 1. Map of the study area.

Table 1
Number of household heads (HHH) in kebele and sample selection.

Name of kebele	Producer HHH	Non-producer HHH	Total sample selected
Jhaymala	686	215	62
Kumbir	778	276	71
Banbluk	824	228	64
Shimel igir	749	194	62
Total	3037	913	259

2.2.3. Data collection method

Primary data that addressed the objectives were collected using structured questionnaires, while checklists were directed to key informants and focus group discussants.

2.2.4. The questionnaire

The purpose of the questionnaire was to gather information on the collection of dry forest products, primarily gums and resins, including frequency of forest access, quantity collected and selling prices. The demographic, institutional, socioeconomic, and biophysical factors that may impact the collection of gums and resins and household members' means of subsistence were covered by the household survey. The household heads were approached for the interview (face-to-face interviews). The researcher and three enumerators distributed the surveys.

2.2.5. Focus group discussion

For this study, one focus group discussion (FGD) was held in each kebele, with six participants—four men and two women—chosen in close consultation with Development Agents operating at the kebele level. The FGD was conducted to gather broad information on subjects that the household interviews did not fully cover. Thus, FGDs were purposefully conducted to complement data from household surveys. The participants in the discussion were asked to speak openly about the primary opportunities and limits associated with using dry forest products, primarily gum and resin.

2.2.6. Key informant interview

In-depth interviews with key informants were conducted prior to the household survey. The data obtained from the key informant interviews were also used to validate the data gathered using other approaches, in addition to shaping the questionnaires. Eight key informants were interviewed, including two experts, four community leaders, one local elder, and one female association leader.

2.3. Method of data analysis

In this study, descriptive statistics such as mean, standard deviation, and percentage were used, as well as inferential statistics and regression analysis. Data were analyzed using Microsoft Excel and STATA version 14.2.

2.3.1. Heckman selection models

This study used a Heckman two-stage selection model to determine the factors influencing participation in the dry forest product collection, and the extent of extraction (income earned from the sale of gum and resin). Heckman's two-stage selection model comprises two estimation equations, the selection equation and outcome equation (Heckman, 1979; Azeez et al., 2018; Engida et al., 2022). Whether a household collects dry forest products is analyzed in the first step, followed by an analysis of the level of income from gum and resin.

The first stage (selection equation) is stated in terms of the likelihood of participation in dry forest product collection (Y_{1i}), which is a discrete choice as indicated in Eq. (1):

$$Y1i = \begin{cases} 1, Yi^* > 0 \\ 0, \ otherwise \end{cases} \quad (1)$$

$$Yi^* = X1i\beta 1 + \varepsilon i \quad (2)$$

Where Y_{1i} is the probability of participation in dry forest product collection; which is a dummy variable that assumes a value of 1 for participants, and 0 otherwise. Y_{1i}* is a latent variable; X_{1i} are the variables determining participation in the probit model; β_1 is an unknown parameter to be estimated in the probit regression model; and ε_i is a random error term as shown in Eq. (1).

Then the factors can be reliably expected by truncated regression across n observations reporting values for Y_{2i} by including an estimate of the inverse Mills ratios, showing λ_i as an additional variable from the selection equation as shown in Eqs. (3) and (4), respectively. The observation equation is shown as follows:

$$Y2i = X2i\beta 2 + \mu i\lambda i + \ . \div \ i = 1, \ 2, \cdots n \quad (3)$$

Where Y_{2i} is the amount of income earned from the sale of gum and resin; X_{2i} is the independent variable determining the intensity of participation in gum and resin collection (amount of income earned from the sale of gum and resin); β_2 is an unknown parameter; μ_i is a parameter that shows the impact of selectivity bias on the general role, and ε_i is the error term.

$$\lambda i = \frac{f(Xi\beta i)}{1 - f(X1i\beta i)} \quad (4)$$

f (Xiβi) is a density function and 1-f (X i βi) is a distribution function.

When the IMR is statistically significant, it implies that there is an unobserved selection bias, which is corrected by including the IMR in the outcome equation. This ratio is a summarized measure that reflects all properties that cannot be observed (Obayelu et al., 2017).

If rho (ρ) is zero or approximately zero, there is no correlation between the error terms (εi *and* μi). Considering the significance level for the correlation coefficient of the two error terms, we can see whether our model is significant and effective for the data sets. This means that when our rho value is equal to or close to zero, we can conclude that there is no sample selection bias in the dataset and the outcome equation can be estimated using OLS regression of Y on X (Mahmudah and Safiih, 2011; Wooldridge, 2013).

2.4. Variable description

The dependent variables are divided into two: those that influence (1) the choice to take part in gum and resin collection and (2) the amount of income earned from the sale of gum and resin. The level of participation was assessed using "yes" or "no" responses. In contrast, revenue from the gums and resins was calculated by multiplying the quantity sold by the selling price. For the quantity of gum and resin consumed at home, income was calculated by measuring the whole consumption (in kg) and multiplying it by the average market price.

Socioeconomic factors like gender, age, education, household size, distance to market, size of landholding, proximity to forest, frequency of extension contact, livestock ownership, PFM membership, wealth status, and credit availability influenced the extraction of dry forest products and the extent of that extraction (Table 2).

3. Results and discussion

3.1. Socioeconomic characteristics of sample households

Male household heads accounted for most gum and resin producers (93.44%), and the remaining 6.56% accounted for female-headed households (Table 3). Approximately 50.97% of the household heads had no formal education, while the rest (49.03%) had attended primary education. The average years of schooling for those who produced gums and resins and those who did not were 1.82 and 1.03, respectively. This indicates a low level of literacy in the study area. The survey result showed that the sampled respondents had an average age of 38 and ranged in age from 25 to 63. On average, non-producers were 43 years old, whereas producers were 35 years old. The average household size of producers' sampled respondents was 6.56, whereas non-producers had an average household size of 5.54. The average distance between producer and non-producer households from home to the nearby market was 3.45 km. An average of 67.06 km of gum and resin were collected annually per household.

3.2. Livelihood strategies and their contribution to household income

The main sources of income for the sampled households were crop farming, animal husbandry, forest products, and non-farm earnings. Richer households had more income from livestock and crop production, but lower non-farm and forest income than medium and poor households (Fig. 2). The percentages of poor and middle-class households earning money from forest products were comparable. Crop production and livestock husbandry were less popular among the poor because they required more resources (land and capital) to provide larger returns.

An average total yearly income of the sampled households was

Table 2
Description of the variables used in the econometric model.

Variable Code	Description of variable	Measurement	Expected sign
Dependent variables			
Participation	Participation in gums and resins collection	Dummy	N/A
Income	Level of income from gums and resins	Continuous	N/A
Explanatory variables			
AGE	Age in Year of household head	Continuous	+
DFGR	Time is taken to reach the forest in minutes	Continuous	-
DFM	Time is taken in hours to sell forest products	Continuous	-
HSIZE	Number of people living in the household	Continuous	+
GENDER	Gender of household head, 1 if male, 0 otherwise	Dummy	+
FAE	Frequency of extension contact in the last 12 months	Continuous	+
TLU	Livestock holding size	Continuous	-
EDUC	Households' ability to read and write, = 1 if able to read and write, 0 otherwise	Dummy	+
LSIZE	Land size owned by a household in hectares	Continuous	-
PFM memb	Being a membership of PFM (1 if there is a PFM member, 0 otherwise)	Dummy	+
Wealth status	Being poor (income and land poor) (1 if the household is categorized as poor, 0 otherwise)	Dummy	+/-

Table 3
Demographic and socioeconomic characteristics.

Variable		Producers (%)	Non-producers (%)	Total (%)
Participation		58.69	41.31	100
Sex of the respondent	Male	94.08	92.52	93.44
	Female	5.92	7.48	6.56
Education	Read & write	48.68	50.47	50.97
	Unable to read & write	51.32	49.53	49.03
Extension Service	Yes	72.37	30.84	55.21
	No	27.63	69.16	44.79
		Min	Max	Mean
Age (years)		25	63	38
Family size		2	12	6.14
Distance to market (km)		1	5	3.45
Quantity collected (kg)		6	91	67.06

19,810 ETB. Income from gum and resin accounted for 23.69 percent of the household income, with an average of 4693.93 ETB per household head each year. Agro pastoralists in the study area gather and sell more gums and gum resins during the dry seasons (March to May). These results were greater than those published by Busha et al. (2015), who reported an average annual forest revenue of 1740 ETB, which could be due to variations in time and geography. Dagim et al. (2016) reported that forests accounted for 21.4% of the total household income.

3.2.1. *Factors affecting the household's participation in dry forest products collection*

Table 4 shows the results of the Heckman two-stage model estimation of the determinants' participation and intensity of participation in the dry forest product (gum and resin) collection. Wald chi2(12) = 48.20, which measures the overall significance of the model, was deemed significant at a level of less than 1%, indicating that at least one of the explanatory variables differs from zero.

3.2.2. *1st stage (Probit regression)*

According to the results of Heckman's selection (first stage) model, six of the twelve hypothesized explanatory factors involved in the Probit model are significantly associated with the likelihood of a household's engagement in the gum and resin product collection in the research area. Age, livestock size, distance to the nearest market, PFM membership, market information, and poor wealth status were significantly linked to market participation.

Age: age has a diminishing effect on participation in gum and resin collection. This implies that as people get older, they acquire less gum and resin. Because forest work necessitates physical strength, younger

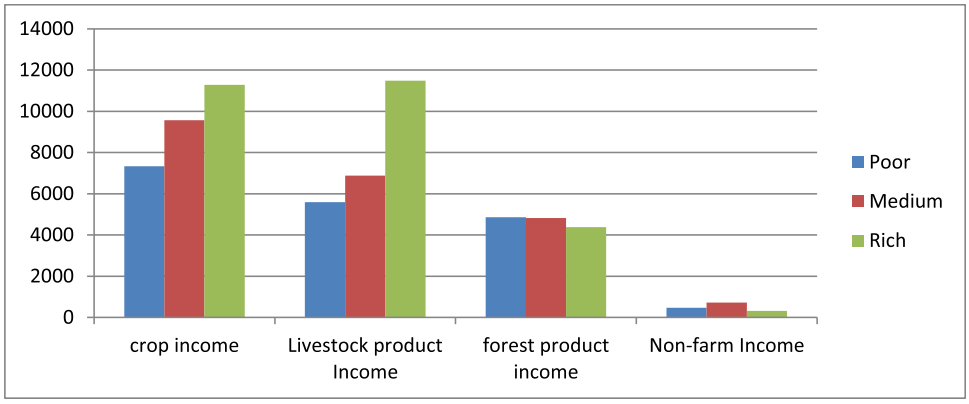

Fig. 2. Household incomes from different livelihood strategies across wealth categories.

Table 4
Heckman selection model — two-step estimates.

Heckman selection model — two-step estimates (regression model with sample selection)				Number of obs = 259 Selected=152 Non-selected = 107 Wald chi2(12) = 48.20 Prob > chi2 = 0.0000	
Variables	Participation in dry forest products market (1st stage)			Income from dry forest products (2nd stage)	
	Coefficient	P-value	M/effects	Coefficient	P-value
Gender	−1.019353	0.269	.2399208	−364.0313	0.328
Age	−0.1621394	0.000***	.0544853	7.991865	0.652
Level of literacy	−0.4323581	0.294	.1442002	41.25017	0.817
Household size	−0.1554153	0.281	.0522257	−14.90758	0.822
TLU	.1882466	0.003***	.0632583	……	…….
Landholding size	−0.2425909	0.146	.0815201	−94.08568	0.248
Crop income	.0000102	0.814	3.43e-06	−0.0088567	0.647
Distance_market	−0.6881618	0.041**	.2312496	−255.0662	0.056*
Distance_forest	−0.9785368	0.257	.2684501	−431.4292	0.096*
Extension	.4388203	0.291	.1485956	536.8287	0.006***
Market info	1.198719	0.079*	.351492	5.732238	0.982
PFM_member	2.565037	0.000***	.7918609	244.437	0.651
Wealth st (poor)	2.556692	0.000***	.7831801	948.837	0.017**
_Cons	9.040209	0.003		5583.395	0.000
mills| lambda	813.6563	0.075			
rho	0.79475				
sigma	1023.7879				

*,**, and *** are statistically significant at 1%, 5%, and 10% respectively.

household heads are more actively involved in the dry forest-product collection than older households. Gum and resin collection is arduous for older people since they lack the physical strength to take part in dry forest product collection. The marginal effect confirms as the age of the household head increases by one year, the probability of participation in the dry forest products market decreases by 5.44%, holding other factors constant. In line with our finding, Suleiman et al. (2017) in Nigeria found that household members' ages significantly influenced the household utilization of NTFPs negatively. Similarly, Mujawamariya and Karimov (2014) in Kenya found that age has a diminishing effect on the quantity of NTFPs collected.

Livestock ownership: There is a direct association between livestock ownership and participation in dry forest product collection. The marginal effect confirms that as herd size increases by one TLU, the probability of participation in the dry forest product collection increases by 6.33%, holding other factors constant. This might be because those who actively participated in dry forest product collection in the study area were agro-pastoralists. Thus, gum and resin collection can be considered important income-generating activities for agro-pastoralists in the study area. Similar to our findings, Asmamaw et al. (2014) found a positive association between livestock holdings and gum and resin income in the Abergelle district of the Afar region. According to Adefris et al. (2014), although dry forests are mainly managed as rangelands for livestock production in southeastern Ethiopia, additional income is earned from these forests.

Distance from home to the market: There is a negative relationship between distance from the market and participation in NTFPs activities. This means that participation in NTFP activities decreases as the distance between the household's home and the market increases. Remote rural households with minimal access to market infrastructure are increasingly likely to rely on collecting gum and resin from the forests to supplement their livelihood. Holding other factors constant, the marginal effect confirms that as the distance from home to the market increases by one kilometer, the probability of participation in NTFPs marketing decreases by 23.11%. Similar to our findings, Yego et al. (2021) denoted that transaction costs reflected in distance to the market adversely impacted the decision on the intensity of forest extraction. In contrast, Suleiman et al. (2017) discovered that populations living near market centers have a wider range of economic alternatives and are thus less interested in collecting NTFPs.

Market information: There is a favorable correlation between market information and participation in dry forest product collection. Keeping all other conditions constant, access to market (price) information increases the possibility of participation in the collection of dry forest products. Holding other factors constant, the marginal effect confirms that as access to market information improves through either formal or informal means of communication, the probability of participation in NTFP marketing increases by 35.15%. According to Angelsen and Kaimowitz, 1999, greater access to market information often speeds up the collection or production of NTFPs that can be sold by households.

PFM membership: There is a direct link between participation in gum and resin collection and PFM membership. The regulation set in using and managing the forest might contribute to an improvement in the dry forest product stock for better extraction and income among members of the PFM. Keeping all other variables fixed, PFM membership increases the probability of participation in gum and resin collection by 79.19%. This is consistent with the findings of Fayera et al. (2021), who reported that non-PFM families have the lowest average forest income. Our findings contradict that of Kero (2020), who reported a negative relationship between PFM membership and yearly forest product income.

Wealth status (poor): There is a positive association between poor wealth status and participation in the dry forest product collection at less than a 1% level of significance. This implies that the poor are income-insufficient and reliant on gum and resin collection. The importance of gum and resin to household income diminishes as the wealth status of the household increases. The marginal effect confirms that poor households are more likely to participate in the dry forest product market with a 78.32% probability. In harmony with our findings, Sander and Zeller (2007) found that where forest resources are easily accessible, income derived from their sale is often important for poorer groups.

3.2.3. 2nd stage: factors that influence income earned from gums and resins

According to the Heckman second-stage model, four explanatory factors had a significant impact on gum and resin income: distance from the market, distance from home to the forest, extension service, and poor wealth status. Lambda (IMR), or the selectivity bias correction factor, has a positive impact on households' participation in the gum and resin collection at less than a 10% level of significance. This is an example of sample selection bias, which is produced by the presence of some unobservable household variables that influence the chance of engaging in gum and resin collection, and hence the amount of money earned. Positive rho indicated that the unobservable factors are positively correlated with income from gum and resin (Table 4).

Distance from the market: this variable has a negative and significant relationship with gum and resin income. When the distance to the forest resource is increases by one kilometer, the income from gum and resin falls by 255.07 ETB, assuming all other factors remain constant. The farther away from the market, the higher the transaction to engage in gum and resin collection. This conclusion accords with Abay (2013), who states that forest users who live distant from the market are subjected to transportation costs, time delays, knowledge problems about what is happening in the forest, and having less access to forest benefits than users who live close to the market. Similarly, Ermias et al. (2014) found that when the distance to the market was great, transaction costs increased, and households were less interested in harvesting NTFPs.

Distance from home to the forest: The relationship between forest cover and income from gum and resin is statistically significant and inverse. This implies households who lived closest to the forest had a greater dependence on forest resources than those who lived farther from the reserve, who would have more trouble getting dry forest items due to high transportation costs. The income from gum and resin reduces by 431.43 birr when the distance to the forest resource increases by one kilometer, while all other factors remained constant. This means that if you live near a forest, you can make more money by collecting gum and resin. This finding is consistent with the findings of (Getachew et al., 2007; Asfaw, 2008; Bedru et al., 2008; Yemiru et al., 2010; Ermias et al., 2014), who reported that people living near forests are more likely to rely on them extensively because of convenient access.

Extension service: the frequency of household extension contact had a positive impact on gum and resin revenue. Households will generate more money from the collection of gum and resin, as well as grow more reliant on forest income, because of increased contact. Based on the ceteris paribus premise, it was found that increasing the frequency of extension contact increased income from the collection of gum and resin by 54.10 birr for every unit increase. Dagim et al. (2016) denoted that households with an extension contact earn more forest income and are more dependent on forest income, which is consistent with this conclusion. Similarly, Ermias et al. (2014) indicated that receiving extension advice increases the probability of using forest coffee.

Wealth status (poor): Poor wealth status and income from dry forest products are positively correlated. Poor households are more likely to engage in gum and resin-related economic activities to raise their level of income. It's being a low-skilled sector makes dry forest extraction an attractive income-generating strategy for the poor and disadvantaged ones. In harmony with our findings, Suleiman et al. (2017) found that land-poor households are more likely to collect NTFPs from the reserve to supplement their households' incomes and other basic needs.

4. Conclusion

The study identifies key factors affecting participation and income

levels of households collecting gum and resin as a livelihood diversification strategy in the Jawi district. In our study, poorer households highly involved in the collection of gum and resin. Approximately 23.69% of forester's annual earnings come from dry forest products. In the research area, age, livestock size, distance to the nearest market, PFM membership, market information, and poor wealth status are significantly linked to participation in dry forest product collection. While the distance from the market, distance from home to the forest, extension service, and poor wealth status significantly affected the level of income earned from dry forest products.

The negative association between age and participation in dry forest product collection implies that there is a good opportunity for youth economic empowerment in the forestry sector. Our research shows a strong correlation between PFM membership and engagement in the collection of dry forest products. This demonstrates how crucial community involvement is in the management of dry forest resources under PFM to guarantee the continued usage of gum and resin while maintaining the resource base. Extension service and income from dry forest products are positively correlated. This suggests improving extension services that can provide support for gum and resin collectors is imperative to improve the livelihood of agro-pastoralists in the study area. The inverse relationship between market distance and participation in the collection of dry forest products suggests that market conditions must be improved to fully realize the potential of gum and resin for local livelihood. Collecting dry forest products is an appealing income-generating strategy for the underprivileged and poor due to the favorable relationship between poor wealth status and income. Therefore, policymakers should take into account promoting the extraction of gum and resin as a pro-poor development strategy in the research area. Eventually, a better understanding of the importance of socioeconomic factors in the collection of dry forest products is crucial for designing future conservation and livelihood diversification initiatives.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

References

Abay, T., 2013. Factors affecting forest user's participation in PFM, evidence from Alamata Community Forest, Tigray: Ethiopia. MSc Thesis. Mekele University. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/4227.

Adeferis, W., Pretzsch, J., Habtemariam, K., Auch, E., 2014. The significance of dry forest income for livelihood resilience: the case of the pastoralists and agro-pastoralists in the drylands of southeastern Ethiopia. For. Policy Econ. 41, 51–59. https://doi.org/10.1016/j.forpol.2014.01.001.

Angelsen, A., Kaimowitz, D., 1999. Rethinking the causes of deforestation: lessons from economic models. World Bank Res. Obs. 14 (1), 3–98. http://www.jstor.org/stable/3986539.

Asfaw, T., 2008. The contribution of forest resources to rural livelihoods in Ashoka area of Arsi Negele district, west Arsi zone of Oromia national regional state, Ethiopia. Hawasa University WCFN Ethiopia.

Asmamaw, A., Pretzsch, J., Secco, L., Mohamod, T.E., 2014. Contribution of small-scale gum and resin commercialization to local livelihood and rural economic development in the drylands of Eastern Africa. Forests 5 (5), 952–977. https://doi.org/10.3390/f505095.

Atmadja, S., Abeje, E., and Boissière, M., 2019. Guidelines on sustainable forest management in drylands of Ethiopia. Rome: FAO. 54 pp.

Azeez, F.A., Balogun, T.A., Awe, F., Nosiru, M.O., Amoo, M.A., 2018. Determinants of forest households' income and participation in forest-related enterprises in Southwestern Nigeria. Int. J. Dev. Sustain. 7 (12), 2965–2985.

Bedru, B., Muys, B., Fredu, N., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2008. Household livelihood strategies and forest dependence in the highlands of Tigray, Northern Ethiopia. Agric. Syst. 98 (2), 147–155. https://doi.org/10.1016/j.agsy.2008.06.001.

Berhanu, Y., Vedeld, P., Angassa, A., Aune, J.B., 2021. The contribution of frankincense to the agro- pastoral household economy and its potential for commercialization - A case from Borana, southern Ethiopia. J. Arid Environ. 186 (2021), 104423 https://doi.org/10.1016/j.jaridenv.2020.104423.

Busha, T., Habtemariam, K., Zerihun, M., Christine, P., 2015. Contribution of dry forest products to household income and determinants of forest income levels in the Northwestern and Southern Lowlands of Ethiopia. Nat. Resour. 6 (05), 331. https://doi.org/10.4236/nr.2015.65030.

Dagim, F., Wubalem, T., Abdela, G., 2016. Economic contribution to local livelihoods and households' dependency on dry land forest products in Hammer District, Southeastern Ethiopia. Int. J. For. Res. 2016 https://doi.org/10.1155/2016/5474680.

Degnet, A., Habtemariam, K., Kassie, G.T., Mulugeta, L., Campbell, B., Teka, W., 2012. Dry forest- based livelihoods in resettlement areas of Northwestern Ethiopia. For. Policy Econ. 20, 72–77. https://doi.org/10.1016/j.forpol.2012.02.002.

Engida, G., Yaregal, T., Benyam, T., Kusse, H., Tewdros, L., 2022. Tree to fight hunger": the determinant of enset market participation and intensity of participation: the case of Southwest Ethiopia. Heliyon 8, e08721. https://doi.org/10.1016/j.heliyon.2022.e08721.

Ermias, M., Zeleke, E., Demel, T., 2014. Non-timber forest products and household incomes in Bonga forest area, southwestern Ethiopia. J. For. Res. 25 (1), 215–223. https://doi.org/10.1007/s11676-014-0447-0.

Eshete, A., Kassa, H., and Livingstone, J., 2021. Inclusive frankincense value chain development in Ethiopia: a historical perspective on forest governance and reforms for better livelihoods and conservation outcomes. PENHA, Addis Ababa, Ethiopia and Tropenbos International, Ede the Netherlands.

Fayera, B., Milkessa, A., Benyam, T., 2021. Factors influencing household participation in a participatory forest management scheme: bench-sheko zone, Southwest Ethiopia. J. Sustain. For. 1–13. https://doi.org/10.1080/10549811.2020.1867184.

Getachew, M., Sjaastad, E., Vedeld, P., 2007. Economic dependence of forest resources: a case from Dendi District. Ethiopia. Forest Policy and Economics 9 (8), 916–927. https://doi.org/10.1016/j.forpol.2006.08.001.

Heckman, J., 1979. Sample selection bias as a specification error. Econometrica 153–162.

Jo, J.H., Roh, T., Shin, S., Youn, Y.C., 2019. Sustainable assets and strategies affecting the forestry household income: empirical evidence from South Korea. Sustainability 11, 3680. https://doi.org/10.3390/su11133680.

Kero, A.D., 2020. Challenges facing community participation in participatory forest management in southwestern Ethiopia. Asian J. Agric. Rural Dev. 10 (2), 659–670. https://doi.org/10.18488/journal.ajard.2020.102.659.670.

Lemenih, M., and Kassa, H., 2011. Gums and resins of Ethiopia. CIFOR briefs, No. 3, February 2011.

Lemenih, M., and Bongers, F., 2011. Dry forests of Ethiopia and their silviculture. In the S. G€unter et al. (eds.), Silviculture in the Tropics, Chapter 8. 10.1007/978-3-642-19986-8_17.

Mahmudah, U., Safiih, L.M., 2011. A modified heckman sample selection model. In: Proceedings of the International Conference on Numerical Analysis and Optimization. June 6-82011.

Mujawamariya, G., Karimov, A.A., 2014. Importance of socio-economic factors in the collection of NTFPs: the case of gum arabic in Kenya. For. Policy Econ. 42 (2014), 24–29. https://doi.org/10.1016/j.forpol.2014.02.005.

Moges, Y., 2021. Dry forests types and composition in Ethiopia: characteristics, threats and policies.

Neudert, R., et al., 2018. Opportunity costs of conserving a dry tropical forest under REDD+: the case of the spiny dry forest in southwestern Madagascar. For. Policy Econ 95 (2018), 102–114. https://doi.org/10.1016/j.forpol.2018.07.013.

Nguyen, T.T., Do, T.L., Bühler, D., Hartje, R., Grote, U., 2015. Rural livelihoods and environmental resource dependence in Cambodia. Ecol. Econ. 120 (2015), 282–295. https://doi.org/10.1016/j.ecolecon.2015.11.001.

Obayelu, O., Farinola, L., Adepoju, A., 2017. Market participation of the local people in non- timber forest products (NTFPs) in Omo Forest Reserve, Nigeria. Small Scale For. 16 (2017), 327–345. https://doi.org/10.1007/s11842-016-9358-6.

Portillo-Quintero, C., et al., 2015. The role of tropical dry forests for biodiversity, carbon and water conservation in the neotropics: lessons learned and opportunities for its sustainable management. Reg. Environ. Chang. 15 (2015), 1039–1049. https://doi.org/10.1007/s10113-014-0689-6.

Sander, K., Zeller, M., Tscharntke, T., Leuschner, C., Zeller, M., Guhardja, E., Bidin, A., 2007. Protected area management and local benefits – a case study from Madagascar. The Stability of Tropical Rainforest margins, Linking ecological, Economic and Social Constraints of Land Use and Conservation. Environmental Science and Engineering Subseries: Environmental Science, pp. 363–385.

Shimelis, D., Habtamu, G., Getachew, A., 2011. A cross-sectional study on bovine trypanosomosis in Jawi district of Amhara Region, Northwest Ethiopia. Ethiop. Vet. J. 15 (1), 69–78, 2011.

Siyum, Z.G., 2020. Tropical dry forest dynamics in the context of climate change: syntheses of drivers, gaps, and management perspectives. Ecol. Process. 9, 25. https://doi.org/10.1186/s13717-020-00229-6, 2020.

Suleiman, M.S., Wasonga, V.O., Mbau, J.S., Suleiman, A., Elhadi, Y.A., 2017. Non-timber forest products and their contribution to households' income around Falgore Game Reserve in Kano, Nigeria. Ecol. Process. 6 (23) https://doi.org/10.1186/s13717-017-0090-8, 2017.

Teketay, D., 2004. Causes and consequences of drylands forest degradation in Sub-Saharan Africa. Walia 24, 3–20.

WBISPP, 2004. A national strategic plan for the biomass energy sector. Government of Ethiopia, Ministry of Agriculture, Addis Ababa, Ethiopia.

Wooldridge, J.M., 2013. Introductory econometrics: A Modern Approach (5thed.). Cengage Learning, Mason, OH: South- Western.

Wubalem, T., Tatek, D., Gizachew, Z., Getachew, D., 2020. Underutilized natural gum and resin resources in Ethiopia for future directions and commercial utilization. World J. Agric. Res. 8 (2), 32–38. https://doi.org/10.12691/wjar-8-2-2. http://pubs.sciepub.com/wjar/8/2/2.

Yamane, T., 1967. Statistics, an Introductory Analysis, 2nd Ed. Harper and Row, New York.

Yemiru, T., Roos, A., Campbell, B.M., Bohlin, F., 2011. Livelihood strategies and the role of forest income in participatory-managed forests of Dodola area in the Bale highlands, southern Ethiopia. For. Policy Econ. 13 (4), 258–265. https://doi.org/10.1016/j.forpol.2011.01.002.

Yemiru, T., Roos, A., Campbell, B.M., Bohlin, F., 2010. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. Int. For. Rev. 12 (1), 66–77.

Yego, P., Mbeche, R., Ateka, J., Majiwa, E., 2021. Forest-based livelihood choices and their determinants in Western Kenya. For. Sci. Technol 17 (1), 23–31. https://doi.org/10.1080/21580103.2020.1870577.