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Socioeconomic Factors Affecting Rural Households' Participation in Commercial Fuelwood Production in Jawi District, Northwest Ethiopia

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ABSTRACT

This study assesses the factors influencing household participation in fuelwood production in Jawi district, northwest Ethiopia. A multi-stage sampling method was used. The district and kebeles were purposefully selected. Snowball sampling techniques were employed to select fuelwood producers, while random sampling was used for non-producers. Data collection involved household questionnaires, key informant interviews, and focus group discussions. Binary logistic regression analysis was used to identify the determinants of household participation in fuelwood production. The results showed that the occurrence of crop pests, livestock holding size, total landholding size, distance from the homestead to the forest, institutional membership, education level of the household head, and total annual income are significant factors affecting participation. The study concludes and recommends that addressing crop pests, improving livestock productivity, creating alternative income sources, raising awareness, and promoting sustainable forest management through effective policies and stronger institutional frameworks can enhance rural livelihoods and help conserve natural forests.

INTRODUCTION

Fuelwood production remains a crucial livelihood for rural households in Ethiopia's dryland regions. Recognizing the socio-economic factors that lead households to gather fuelwood from dryland forests is essential for developing sustainable management policies and tackling energy needs and environmental issues (Eshetu & Tesfaye, 2024; Rawat & Tekleyohannes, 2021). The increasing demand for fuelwood across sub-Saharan Africa, fueled by rapid population growth, urbanization, and the profitability of charcoal from accessible natural forests, is putting unprecedented pressure on forest ecosystems (Bircan Bodur, 2023; Cerutti et al., 2015; Sulaiman & Abdul-Rahim, 2022). This dependency is particularly strong in Ethiopia and other African countries, where charcoal production plays a major role in household income, further escalating the strain on natural forests (Amare et al., 2017; Kiruki et al., 2020; Tazebew et al., 2023).

The degree to which communities rely on forest products like charcoal and firewood varies greatly, influenced by numerous factors (Lubega et al., 2022; Vihi et al., 2024; Wale et al., 2022; Ying et al., 2024). Geographic elements, such as proximity to forests and markets, directly impact access and availability (Belcher et al., 2015; Kazungu et al., 2021; Li & Cao, 2024). Furthermore, demographic traits like gender and age play a key role in determining who collects and uses these resources (Bitzer et al., 2024; Okoh, 2020). A household's socio-economic status often affects its involvement in fuelwood collection as a livelihood, with wealthier households possibly having other sources of income (Baba et al., 2015; Gebremedhin & Negash, 2023; Nyarko et al., 2021; Ogujiuba, 2020). Additionally, government policies,

the effectiveness of institutions, natural disasters, and socio-political events all significantly influence household decisions related to fuelwood activities (Brobbey, Pouliot, et al., 2019; Tassie et al., 2021).

Identifying the primary factors that contribute to household fuelwood production from natural forests is crucial for promoting sustainable forest management and optimizing resource use (Bekele & Kemal, 2022; Hido et al., 2023). This knowledge helps develop effective intervention programs, enforce strong forest policies, and develop long-term management strategies (Baskent & Kašpar, 2022; Blattert et al., 2022; Hajjar et al., 2021). Importantly, these insights support efforts to diversify household incomes, resulting in positive outcomes for both forest conservation and community livelihoods (Chama et al., 2023; Hailemichael et al., 2024; Park & Yeo-Chang, 2021; Wale et al., 2022). Therefore, this study offers valuable information for decision-makers, development agencies, and organizations dedicated to sustainable forest management and improving livelihoods.

MATERIALS AND METHODS

Study Area

This study was conducted in Jawi district in northwest Ethiopia. The district is rich in acacia woodlands, with the Acacia polyacantha tree as the dominant species in the area (Bantihun & Tesema, 2018). The total area of the district covers approximately 515400 hectares, with 33.57% covered by forest. Natural forests make up about 29.5% of the total forest cover, around 0.6% is privately owned, and institutions own 3.4%. Farmland accounts for roughly 173071.02 hectares of the district's total land area (JDOoA, 2021).

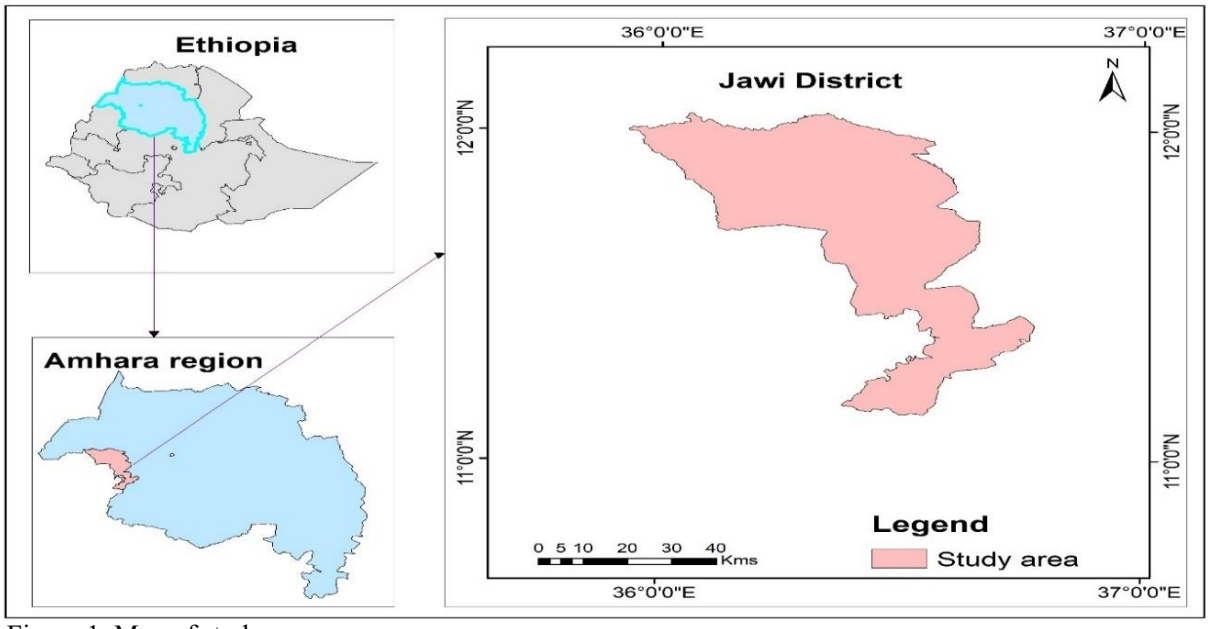

Figure 1. Map of study area

Sampling Technique

A multi-stage sampling method was used to select a representative sample of rural households. Four kebeles - Simida, Kava Abo, Asech, and Alkuran from Jawi district were purposefully selected based on their experience with fuelwood (charcoal and firewood) production from natural forests. For households involved in fuelwood production, snowball sampling was used, allowing respondents to refer other producers within their networks. This approach is particularly effective in identifying individuals engaged in less visible activities like charcoal production (Brobbey, Hansen, et al., 2019; Ndah et al., 2024; Okumu & Muchapondwa, 2020). For households not participating, a random sampling approach was employed to select respondents from the general population, ensuring a balanced comparison between the two groups. A total of 160 households were chosen, including 80 involved in fuelwood production and 80 not involved.

Data Collection

Data were gathered using a structured questionnaire that included questions on household

demographics, socio-economic characteristics, and specific details about participation in charcoal production. The survey targeted both households involved in fuelwood production and those not participating. Key informant interviews were conducted with local leaders and experts to collect qualitative insights into community practices and perceptions regarding fuelwood production. Four key informant interviews were held to gain a deeper understanding of the situation. Two focus group discussions were also held, one with participants and another with non-participants in each kebele.

Data Analysis and Model Specification

Data analysis was performed using both descriptive and inferential statistical methods. Descriptive statistics summarized the demographic and socio-economic characteristics of the respondents. Qualitative data from key informant interviews and focus groups were analyzed through thematic analysis to identify key themes and insights related to the motivations and challenges faced by households in fuelwood production. For the inferential analysis, logistic regression was used to identify determinants of rural households' participation in fuelwood production. This method estimates the odds of involvement based on various predictor variables (Sperandei, 2014; Sur & Candès, 2019). The binary logit model indicates the strength and direction of the influence of selected variables (Aabeyir & Agyare, 2020; Tassie et al., 2021). The binary logistic regression model requires defining dichotomous dependent variables, along with independent variables that can be continuous, categorical, or dichotomous (Table 1).

Table 1. List of independent variables selected for model specification

Variable	Data type	Description	Expected sign
Age	Discrete	Age of Household head (Years)	−
Sex	Dummy	Sex of household 1 = male1=male, 0 = female	±
Education status	Dummy	Educational level of household head 1= literate, 0 =Illiterate	+
Marital status	Dummy	Marital status of household head	±
Forest distance	Continuous	Distance from the homestead to the forest in km	−
Total Land size (ha)	Continuous	Household agricultural land size in ha.	−
Annual income (ETB)	Continuous	Total annual household income in ETB	−
Livestock holding (TLU)	Continuous	Total livestock unit in TLU	−
Crop pest/disease occurrence	Dummy	Occurrence of Crop Pests/Diseases in the last 10 years	+
Number of Relatives for support	Continuous	Number of relatives who support them during hardship	−
Institutional membership	Dummy	Membership status in formal and informal institutions 1=yes, 0=no	−
Own land used	Dummy	Utilization of own land for farming 1= yes, 0 =No	−
Drought occurrence	Dummy	The occurrence of drought in the last 10 years: 1 = Yes, 0 = No	$^{+}_{-}$
Residence in the area (Years)	Continuous	Number of years lived in the area permanently	±

To identify factors affecting households' participation in fuelwood production, a logistic regression model was defined, and the hypothesized variables were chosen. Fuelwood producers were denoted by 1 and non-producers by 0; thus, the dependent variable is participation in fuelwood production. The probability of households participating in fuelwood production is expressed as p(Y=1), a function of independent variables (x1, x2,…, xn).

$$p(Y = 1) = \frac{e(a+ß1X1+ß2X2+\cdots ßnXn}{1+\ e(a+ß1X1+ß2X2+\cdots ßnXn} \quad (1)$$

$$\text{Logit } (Y=1|X_i) = a +\ ß1X1 + ß2X2 + \cdots ßnXn \quad (2)$$

In the same vein, the logit for household participation in fuelwood production was formulated as Equation 3, and the regression analysis was conducted using SPSS 26 software.

$$\text{Logit } [P\ (FWP = 1)] = ß_o + ß1X1 + ß2X2 + \cdots ßnXn \quad (3)$$

Where FWP denotes participation in fuelwood production, x1, x2,… Xn represent independent variables, and β1, β2,… βn signify model coefficients, while the β0 coefficient is the constant term.

RESULTS AND DISCUSSION

Basic Characteristics of Respondents

Basic descriptive statistics, such as education status, the age of sampled households, and other characteristics, are presented in Tables 2 and 3 for both qualitative and quantitative variables, respectively. The results show that approximately 98% of the households were male-headed. Among the surveyed respondents, about 87.5% cultivate their own land, while the remaining 12.5% work on others' land for crop share or rent. This analysis indicates that there is a significant difference in some variables, such as sex, marital status, institutional membership, crop pest occurrence, and educational status, between participants and non-participants in fuelwood production.

Table 2. Descriptive statistics of respondents for qualitative variables

Characteristics	Categories	Participation in Fuelwood production			
		Non-participant	Participant	Total	X^2
Sex of household heads	Female	0	5	2.5	0.06
	Male	100	95	97.5	
Marital status	Not married	0	8.75	4.34	0.007**
	Married	100	91.25	95.63	
Institutional Membership	No	1.25	8.75	5	0.032*
	Yes	98.75	91.25	95	
Drought Occurrence	No	90	93.75	91.88	0.282
	Yes	10	6.25	8.13	
Crop pests/diseases Occurrence	No	35	60	47.5	0.001**
	Yes	65	40	52.5	
Livestock diseases or death	No	45	42.5	43.75	0.437
	Yes	55	57.5	56.25	
Education status	Illiterate	50	57.5	53.75	0.014**
	Literate	50	42.5	46.25	
Own land used	No	13.75	11.25	12.5	0.406
	Yes	86.25	88.75	87.5	

**, and * are Significant at a1% and 5% significance level

The respondents' ages ranged from 20 to 73 years, with a mean age of about 39 years, indicating that the majority are middle-aged household heads (Table 3). The average land operated was 3.19 hectares, with a maximum of 15 hectares, demonstrating variability in land availability among households. Respondents have lived in their current locations for an average of 24.34 years, with a range of 1 to 65 years, reflecting both stability and recent arrivals. Livestock holdings average 8.07 Tropical Livestock Units (TLU), suggesting that many households are involved in livestock farming. The average annual income is 54,510 ETB, with a range from 30,000 to 306,000 ETB. Additionally, the average distance from residences to the forest is 2.65 km, and the average number of relatives for support is 6.33, indicating a reliance on family networks. Overall, these statistics offer valuable

insights into the community's socio-economic conditions and resource availability.

Table 3. Descriptive statistics of respondents

Characteristics (N=160)	Minimum	Maximum	Mean	Std. Deviation
Age (years)	20	73.00	39.03	12.02
Total Operated Land in ha	0	15.00	3.19	2.75
Years of Residence	1	65.00	24.34	12.54
Livestock Holding in TLU	0	40.20	8.07	7.02
Total annual Income ETB (000)	30	306.00	54.51	48.53
Distance from residence to forest in km	0	20.00	2.65	3.61
Relative for support (Number)	0	150.00	6.33	19.30

Determinants of Rural Households' Participation in Charcoal Production

The binary logistic regression results, shown in Table 4, highlight the main factors influencing household participation in fuelwood production. Among the explanatory variables identified as statistically significant predictors of fuelwood production were: occurrence of crop pests or diseases, total landholding operated, distance from the homestead to the nearest forest, livestock holding size, total annual income, education level, and institutional membership. These findings emphasize the complex interaction of environmental, economic, and social factors that influence engagement in fuelwood production activities. Notably, institutional membership has a negative relationship with participation in fuelwood production ($B = -2.54$, $p < 0.05$). This suggests that institutional membership may grant access to alternative activities, promote sustainable resource management, or provide alternative income sources, thereby decreasing reliance on fuelwood marketing.

Table 4. Result of binary logistic regression for participation in fuelwood production

Dependent Variable: participation in fuelwood production (N= 160)					95% C.I.for EXP(B)		
Factors	B	S.E.	Wald	Sig.	Exp(B)	Lower	Upper
Institutional Membership status	-2.54**	1.25	4.11	0.04	0.079	0.012	0.148
Crop pests occurrence	1.42*	0.43	10.90	0.00	4.136	2.783	5.641
Education status of household head	-0.82**	0.40	4.24	0.04	0.440	0.140	0.923
Total land holding in ha	-0.65*	0.25	6.64	0.01	0.522	0.172	1.120
Years of residence in the area	0.29	0.24	1.42	0.23	1.336	2.130	3.830
The number of relatives depends on hardship	0.31	0.21	2.19	0.14	1.363	0.910	1.042
Distance from the homestead to the forest	-0.16*	0.23	11.34	0.00	0.852	1.283	2.343
Livestock holding in TLU	-0.43*	0.25	9.03	0.00	0.651	0.286	1.771
Total annual Income	-0.26**	0.22	4.32	0.04	0.771	1.031	2.445
Age of household head	-0.34	0.23	2.23	0.14	0.715	1.465	1.910
Constant	-0.80**	0.38	4.39	0.04	0.449		

Step	Chi-square	Sig.	Nagelkerke R Square	-2 Log likelihood
1	53.40	.000	.378	168.410a

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

This result supports existing research, showing that community involvement and access to alternative resources can reduce dependence on unsustainable resource extraction such as deforestation (Hussain et al., 2019; Pelane et al., 2023; Simbeye, 2024). Conversely, the presence of crop pests significantly increases the likelihood of engaging in fuelwood production ($B = 1.42$, $p < 0.01$), highlighting how agricultural problems can prompt households to seek alternative income sources. Studies have shown that crop pests and diseases threaten yields, potentially leading households to seek alternative livelihoods from natural resources due to reduced agricultural output and economic losses (Carley et al., 2024; Musumba et al., 2022).

Education status is negatively related to participation in fuelwood production ($B = -0.82$, $p <$

0.05). This suggests that individuals with higher education levels are more aware of the environmental consequences of fuelwood production. This finding aligns with the findings by Eshetu & Tesfaye (2024) and Garekae et al. (2017), which indicate that educated individuals are more likely to adopt sustainable practices and seek alternative livelihoods. Additionally, Salamatu et al. (2020) emphasized that educational attainment promotes critical thinking and environmental awareness, which help reduce reliance on practices like charcoal production.

Furthermore, the model indicates that large land holdings decrease participation ($B = -0.65$, $p < 0.01$), implying that households with more land are less reliant on fuelwood production. This supports the idea that land availability is a key factor influencing resource use in rural areas (Brown et al., 2022). Similarly, Jangarasheva et al. (2023) observed that households with more land tend to diversify away from extractive or supplementary activities like charcoal making. The findings of Das & Ganesh-Kumar (2018) and Tassie et al. (2021) also show that households with larger landholdings are more likely to rely on farm income and have less need to produce fuelwood.

The distance from the homestead to the forest also has a negative association with participation ($B = -0.16$, $p < 0.01$), aligning with the view that access to resources greatly influences livelihood strategies. Households with easier access to forests are more likely to engage in forest-related income-generating activities, while greater distance or limited access reduces participation and can shift households toward alternative strategies (Feurer et al., 2018; Shitima & Dimoso, 2020; Vázquez-Delfin et al., 2022; Wangmo et al., 2024). Another finding by Boškoviḉ et al. (2023) revealed that increased distance raises transportation costs and effort needed to access wood materials.

The result also revealed a negative association between livestock holdings and participation in fuelwood production ($B = -0.43$, $p < 0.01$). This indicates that households with more livestock are less likely to engage in fuelwood production, possibly because livestock may offer alternative sources of income and livelihood. This aligns with existing literature, which shows that households with diverse income sources tend to rely less on unsustainable practices like charcoal production (Amare et al., 2017; Kiruki et al., 2020). The presence of livestock may also signal greater economic stability, reducing the need to seek additional income through fuelwood marketing.

The finding also shows that total annual income is negatively associate to participation in fuelwood production ($B = -0.26$, $p < 0.05$). This indicates that as household income rises, the likelihood of engaging in fuelwood production decreases. This result aligns with the studies by Kiruki et al. (2020) and Mulenga et al. (2015), suggesting that higher income levels often correlate with less reliance on natural resources for livelihoods.

CONCLUSION

Understanding the factors driving Fuelwood production from natural forests is essential for identifying key moments for successful interventions in dryland forest management. Several interconnected factors motivate households to engage in fuelwood production. Based on this study, we found that crop pests, livestock holding, total operated land, educational level, institutional membership, and annual income are the significant factors influencing households' participation in fuelwood production. Additionally, according to focus group discussants, the lack of employment opportunities in the study area increases dependency on fuelwood as a source of income. Recently, unemployed youths have increasingly turned to fuelwood production to support their livelihoods.

A greater distance from the homestead to the forest decreases participation, which may be because of higher transportation costs. Households that are members of institutions are less likely to participate, possibly because membership may offer access to alternative income sources. Higher annual incomes also relate to less involvement in commercial fuelwood production, indicating that fuelwood is often a livelihood for poorer households. Additionally, household heads with higher education levels are less likely to participate. The study also highlights that crop failures caused by pests push households to depend on fuelwood production for income due to the decline in agricultural production. This study offers valuable insights for policymakers and development agencies

aiming to balance livelihood needs with sustainable forest management, thereby enhancing both community resilience and environmental conservation.

Based on the key findings in the study area, we suggested the following recommendations. First, addressing pest and crop disease issues through expanded agricultural extension services and accessible, effective control methods is essential. Reducing agricultural exposure can also decrease dependence on fuelwood production as a coping strategy. Second, efforts should focus on improving livestock productivity and health. Livestock can provide extra income as a supplement or alternative livelihood and help ease the pressure on forest resources used for producing fuelwood. Third, while acknowledging the economic significance of fuelwood for households, efforts toward formalization must be undertaken carefully, backed by effective policy development and strong institutional capacity to encourage sustainable harvesting and prevent further deforestation. Building institutions and promoting community participation, along with fostering alternative sources and livelihoods, can also help address the issue. Additionally, educating and raising awareness about sustainable forest management is vital for achieving long-term behavioral change. Ultimately, researching and promoting income diversification activities beyond agriculture and fuelwood production will strengthen the community's ability to maintain resilient and sustainable livelihoods, supporting the preservation of the lush dryland forest ecosystem.

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