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Forest products monetary contribution to households' income: A means to improve the livelihood of a low-income rural community in South Ethiopia

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ABSTRACT

Forest products and forest-based activities in Ethiopia play a substantial economic contribution to the livelihoods of rural households. Despite its pivotal role, empirical data are inadequate on forests' monetary contribution across a range of ecological locations and social situation, particularly for rural agrarian communities of the developing nations, like Ethiopia. We estimated the economic contributions of forest products and forest-based activities to forest-dependent rural households' income and highlighted key socioeconomic characteristics in Wolaita, Ethiopia. We collected demographic, socioeconomic, and forest use data using a semi-structured questionnaire survey of 384 households, and surveyed markets to determine the prices of forest products for the valuation of forest use in three districts. We used descriptive statistics, the Chi-square test, the two-sample *t*-test, and one-way ANOVA to analyze the data. Findings showed that all respondents were engaged in one way or another in forest-based activities, while 84.6 % were involved in farming. The annual average income from forest products was 252.7US per household, contributing to 28.1 % of the total yearly average income (989.4US$), and 38.3 % relative forest income (RFI). Annual mean household income from crops was 648.1US$. Average annual household income from grazing, charcoal, firewood, woodcutting, cut-and-carry, NTFP, seed selling, medicinal plants, and seedling selling was 77.3 %, 58.4 %, 50.2 %, 24.1 %, 18.5 %, 12.7 %, 7.1 %, 6.8 % and 5.4 % of the total annual mean income, respectively revealing a significant difference ($p < 0.05$). Family size, farmland size, distance to the forest, and occupation were the determinants of the contribution of forest products to household income. In general, poor households derive the highest relative forest income implying high dependence of the poorer on forest resources in the study area. The findings provide useful information for developing sustainable forest management policies and strategies to enhance the economic and ecological benefits of forests, and highlight the need for funding projects to pay attention to the specific household variables that affect forest use. Mainstreaming conservation activities in development sectors and integrating development and conservation projects may improve the livelihood of the low-income family in the region.

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1. Introduction

[1]Forests are useful natural capital with multiple socioeconomic and ecological functions, and are the most accessible resources available for low-income households' [1]. Millions of people particularly agrarian societies have been engaged in forest-based activities to support their livelihood [2]. For instance, 1.6 billion people depend on forest products globally [3]; 350 million live within and adjacent to dense forests and 200 million indigenous communities depend on forest resources [4,5]. Research [4] estimated between 1.095 and 1.745 billion forest-dependent people worldwide. About 20–25 % of rural peoples' income is obtained from forest resources in developing countries [6]. Two-thirds of Africa's population depends on forest resources for income and food and 90 % use fuel wood and charcoal [7,8]. Forests act as safety nets in periods of seasonal food shortages [9,10] where households can access the nearby forests to collect its product either for direct or indirect use to overcome the risk period seasonal food scarcity or lack.

Forest products worth billions of dollars globally, and has to be promoted to provide more incomes for forest-dependent households [11]. However, the original antagonistic thought of conservation and development should be changed into complementarity through proper forest products use [12] for this to continue. Regardless of the opposing views of ecology and economics, millions of households continue to use forest products to support their livelihoods [13]. Better understanding of why some households harvest forest products while others do not may help explain some of the problems of forest products promotion [14]. Research has highlighted key socioeconomic characteristics of forest-dependent households that can play roles in explaining forest use [15]. For instance, in the Philippines, elderly people were more likely to collect forest goods because of their more extensive knowledge of forest species [16]. Elsewhere, younger households are more dependent on forest products, as they set out to start families and have lower agricultural assets than older better-established households [17]. Another key variable of interest is the relationship between income and forest use [15]. Households with the lowest level of food self-sufficiency depended most on forest products for income in the Philippines [18]. Study [19] found that contributions of NTFPs to incomes in Sri Lanka declined as incomes increased. Alike arguments have been made elsewhere that the poor are more dependent on forest products than wealthier households [20]. Other studies indicate that medium-income or richer households are more likely to have forest income than the poor, owing to high labor requirements [21]. Often the role of income class depends on what variable is measured [15]. Absolute forest income increased as total household income increased, but forest income as a share of total income decreased, indicating the poor were more dependent on forest income [22]. In Ethiopia, wealthier households received more absolute income from forest produce, while poorer households were dependent on forests for a larger percentage of their income [23]. When comparing forest use in South Africa, poor, average and rich households did not differ in terms of the number of NTFPs used or the proportion of households using them [10]. However, the poorer households did use more NTFPs per person in terms of volume when both income and subsistence purposes were considered [15].

Study has noted the importance of land tenure where the landless and land-poor are often more dependent on forests than the land-rich [24]. For those who have no access to land for agriculture, forest products can provide a much-needed source of support [15]. In India, dependence on forest income was strongly correlated with size of land holdings, with the landless being most dependent [25]. Considering other social factors, a study reported that forest use was positively correlated with labor availability and gender ratio, and negatively correlated with income, education, distance to forest, and involvement in non-agricultural activities [23,26].

Despite all its importance, tropical forests in Africa suffer from massive deforestation [27]. There are more than 2 billion ha of deforested and degraded land globally [28] affecting 1.5 billion people [29]. With the increase in human population and change in land cover and land use patterns, human beings have had their footprints on the forests [30]. The gradual encroachment from the fringes towards the forests in the form of agricultural expansion for more products to meet the increasing demand of the human population and their settlement results in the fragmentation of forest with a patchy distribution, which in turn affects the livelihoods of rural people. This is even more important in developing countries like Ethiopia where the majority of the people are dependent on forests [31,32]. However, in Ethiopia where the livelihood of 80.5 % of the population resides in a rural area and is dependent on forest resources, the pressure on forest resources is high resulting in reduced agricultural productivity and poor quality of life [33]. Despite the high dependence of the local community on the forest resources, the economic contributions of the forests to local livelihood seem seldom surveyed in the region in general and in the study area in particular. This study, therefore, tries to narrow this gap by evaluating and providing empirical evidence on the economic contribution of forest use to livelihoods for the Wolaita communities. Hence, we estimated the economic contributions of forest products and forest-based activities to rural households' income in Wolaita, Ethiopia and answered the following research questions: 1) How do socioeconomic profiles affect the household income from forest resources? 2) What is the estimated monetary value of the various forest products? 3) What livelihood activities do the local people in the study districts perform to support their living? 4) What factors affect the household dependency on forest use? 5) What are the perceptions of the households towards forest ecosystem services and types of resources utilized?

Assessing the economic contribution of forest use to rural livelihoods is necessary for understanding the people living conditions and designing effective development and conservation strategies [22].

[1] Exchange rate in June 2021: 1US$ = 38.00Birr.

2. Methods

2.1. Study area

We studied households forest use in the Sodo, Offa, and Kindo-koysha districts of the Wolaita zone (6°4 to 7°1′N & 37°4′ to 38°2′E), Ethiopia (Fig. 1). In the Sodo district, we selected Damot Mountain natural forest (503 ha; 2240–2965 masl); in the Offa district, Dawe Darke Danole natural forest (2616.7 ha; 1200–1500 masl) and in the Kindo-koysha district, Gelesho Dere natural forest (846.5 ha; 1200–1680 masl). The mean population density was 356.7 km^{-2}, with a household land holding <0.125 ha in the zone. The mean maximum temperature varies between 24 and 30 °C during the day and the mean minimum temperature ranges between 16 and 20 °C at night. The wet season is from June to October, while the dry season is from January to June. The average annual rainfall ranges from 900 mm to 1100 mm [34].

2.2. Questionnaire design and sample size determination

We designed semi-structured household-level survey questionnaires focused on socioeconomic, demographics, livelihood, and forest product use. We surveyed markets to get prices of various forest products for the valuation of forest use. We used [35] to determine the sample size as, seen below.

$\boldsymbol{n} = \frac{p*(1-p)*z^2}{e^2}$ Where; n = sample size; p = estimated proportion of respondents, as the proportion is not known, 0.5 was used as p value to get maximum number of respondents. Z = the number of standard error corresponding to 95 % confidence interval which is 1.96; e = margin of error that the researcher tolerates is 0.05.

Using the above equation, we selected 384 households from the three districts for interview. We selected the respondents proportionally (Table 1) with respect to the number of total households of each district following [36], as follows:

nh = $\frac{Nn}{\Sigma N}$ Where; nh = number of required sample from each district; N = total household head of each district; n = total sample size of all districts; ΣN = total household head of all districts.

We identified the first household randomly as the initial point and the next households at fixed interval starting from the first household to the others.

2.3. Sampling techniques and data collection

We selected Damot Mountain, Dawe Darke Danole, and Gelesho Dere natural forests purposively for this study from Sodo Zuria, Offa, and Kindo Koysha districts, respectively. Forest cover, agro-climate, distance of the forest to the households, socioeconomy, and topography were used for the selection. We collected data from October to June 2021. We interviewed household heads Face-to-Face.

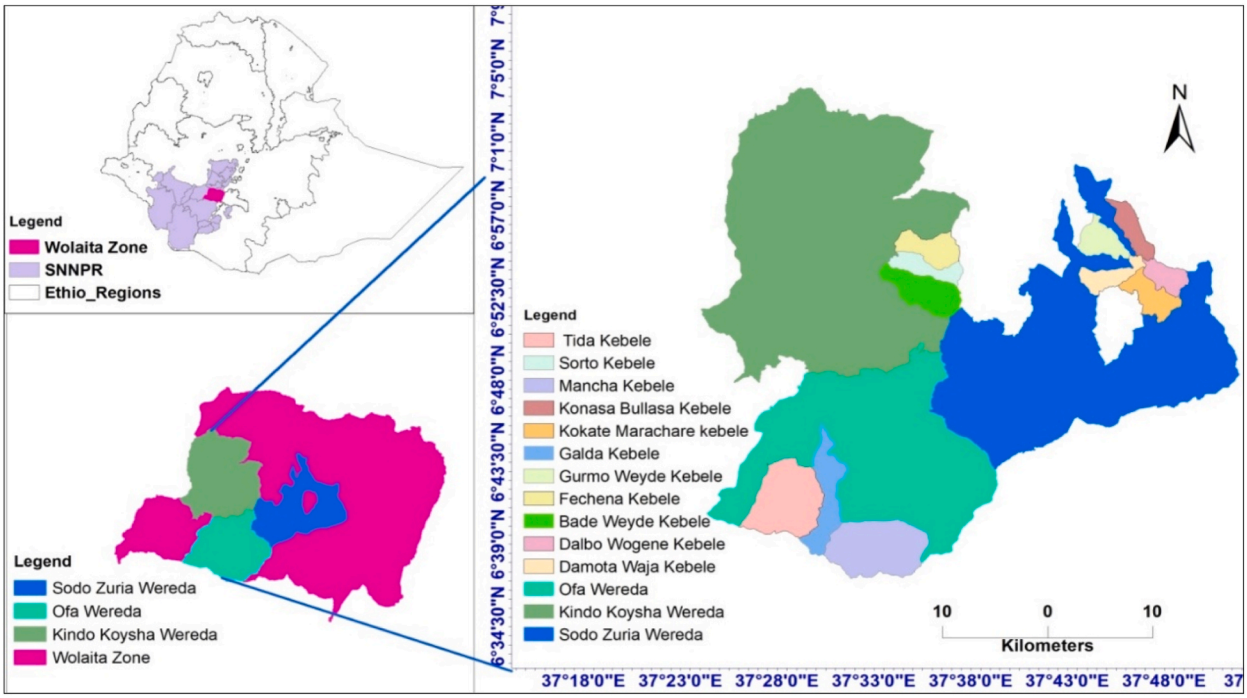

Fig. 1. Map of the study area.

Table 1
Proportional distribution of the sample size among the three districts for household interview (Numbers within parenthesis show sampling intensities in percent).

District	*Natural Forest*	*Households*		*Total*	*Sample households*		*Total*
		Male	Female		Male	Female	
Sodo Zuria	Damot Mountain	1817	909	2726	98 (5.4 %)	50 (5.5 %)	148 (5.4 %)
Offa	Dawe Darke Danole	898	430	1328	49 (5.5 %)	23 (5.3 %)	72 (5.4 %)
Kindo Koysha	Gelesho Dere	2137	864	3001	117 (5.5 %)	47 (5.4 %)	164 (5.5 %)
Overall total		4852	2203	7055	264 (5.4 %)	120 (5.4 %)	384 (5.4 %)

We collected quantitative data on household income from farm products and forest products. To assure data quality and to build the respondents' confidence, we used the local language (*Wolaytatuwa duuna*) for the interview. We collected the following socioeconomic data from each household: gender, age, literacy levels, family size, resident years, distance from the forest, farmland size, and sources of income. Forest use data such as forest product types and their estimated prices and crop incomes were collected. We surveyed markets to crosscheck that the costs of various forest products and crops we obtained during the household survey were consistent with the market price. We made direct field observations to collect information on the villages, the households, and forest-based activities. We collected secondary data through a review of published and unpublished documents.

2.4. Data analyses

Data were explored for the statistical assumptions (normality, homogeneity of variances, outliers) using Shapiro-Wilk, Levene's, and Grubbs's tests, respectively. Descriptive statistics were used to compute means and standard errors. A two-sample *t*-test was used to test the effect of categorical variables on numeric variables. One-way *ANOVA* was used to compare perceptions of annual monetary income among different age groups, education levels, sex, and districts. *Chi-square* tests were used to establish associations between households' demographics and forest products' contribution to household income. In all statistical tests, we used a $p \leq 0.05$. We used XLSTAT to analyze the data.

We measured the household dependence on forest by computing the relative forest income (RFI). RFI was derived as a share of forest income to total household income from forest products [37] as follows:

$RFI\ (\%) = \frac{TFI}{THHI} * 100$ *Where* THHI is the total household income and TFI is total forest income.

To test the level of household dependence on various forest products, we grouped households into three categories (poor, middle, rich) based on the amount of the total household income. Poor: Households whose total income was less than the mean annual household income minus SE (< the lower limit of the confidence interval), Middle: those whose income falls within Mean ± SE (i.e. within CI), Rich: those whose total income was greater than mean annual household income +SE (i.e. > the upper limit of the CI). The categories were based on local conditions and do not reflect the general poverty levels in the study area and Ethiopia.

We computed the total household income, forest income, and crop income following the formula used by [37].

Household annual income equals the summation of forest income and crop income:

$Ytinc = \sum_{i=1}^{n} [S_i]$, Where Y_{tinc} is the total household income and s_i is income source i.

Forest income equals the summation of incomes from the forest products. These are incomes from fuel wood, woodcutting (construction material: timber, poles, and fibers), grazing, seed source (collecting seeds from forests for sale), seedling source (collecting seedlings from the forests for sale), cut-and-carry (harvesting fresh grass as livestock feed for zero grazing), NTFP (extracting non-timber forest products other than those listed here such as forest fruits, spices and aromatics, resins, etc.), medicinal (extracting traditional medicinal plant materials and collecting money for the treatments).

$Yf = \sum_{i=1}^{n} [FiPi]$, Where Y_f is total forest income, F_i is quantity of product collected i, P_i is market price of forest product i.

Crop income is the summation of value of yields from various crops grown by a household.

$Yc = \sum_{i=1}^{n} [CiPi]$, Where Y_c is the total crop income, C_i is yield of crop i, P_i is market price of crop i. The production cost is not included in the computation due to the inconsistencies of data.

Ethical approval

The Institutional Review Board of Arba Minch University, Ethiopia, approved the questionnaire and methodologies of this study. We obtained permissions from the Wolaita Zone, and Offa, Kindo-koysha, and Sodo Zuria districts' administrative offices to access the study sites. We also obtained verbal consent from household heads or spouses before the interview.

3. Results

3.1. Socioeconomic and demographic profiles

The gender profile of the household heads depicted that 73 % (n = 280) were male-headed while 27 % (n = 104) were female-headed. Gender proportion within district (SDZ: $X^2 = 0.0007$, df = 1, $p = 0.9787$; Offa: $X^2 = 2.850 * 10^{-30}$, df = 1, $p = 1$; KK: X^2

$= 0.04139$, df $= 1$, $p = 1$) and among the three districts ($X^2 = 0.10839$, df $= 5$, $p = 0.999$) did not vary. The mean age of the household head did not vary significantly between female-headed (43.97 ± 1.11) and male-headed households (43.59 ± 0.76). Household heads were aged between 20 and 85, with a mean of 43.7 ± 0.63. The mean age of the households ($F_{2,\ 381} = 5.579$, $p = 0.004$) did vary significantly among the three districts (Fig. 2a and c). Older household heads live in Sodo zuria compared to Kindo Koysha ($p = 0.001$) and Offa ($p = 0.023$). Fig. 2(a–c) presents the mean age distribution of the responding households in the study. The majority (87.8 %) of the respondent household heads were married, with only 8.3 % widows/widowers and 3.3 % singles. The education profile of heads of households revealed that 33, 10, and 9 % attained primary, secondary, and tertiary levels, respectively, whereas 48 % did not attend formal education. The mean family size was 5.8 ± 0.11 ranging between 1 and 16 and varying among the districts ($F_{2,\ 381} = 5.302$, $p = 0.0053$) where Sodo holds lower than Kindo koysha ($p = 0.015$) and Offa ($p = 0.004$) districts (Fig. 3b). Family size ranges from 1 to 10 with a mean of 4.98 ± 1.8 for female-headed households, whereas it ranges from 2 to 16 for male-headed households (6.082 ± 2.3). Male-headed households had larger family sizes than female-headed ones (t $= -4.320$, df $= 382$, $p < 0.0001$) (Fig. 3a), which may imply that male-headed families depend more on forest resources than female-headed households.

The average farmland size was 0.89 ± 0.689 ha in the study area. The mean farmland size for female-headed and male-headed households was 0.792 ± 0.759 and 0.651 ± 0.659 ha with a range of 0–2 ha in both sexes showing no significant difference (t $=$ 1.785, df $= 382$, $p > 0.05$) between genders. However, farmland size did vary among districts ($F_{2,381} = 7.569$, $p = 0.00059$). Households in Kindo Koysha (t $= 4.018$, df $= 235$, $p = 00008$) and Sodo zuria district (t $= -3.3802$, df $= 217$, $p = 0.0085$) owned significantly larger farmland sizes than those living in the Offa district. We found that land is scarcer in the Offa district with an average size of 0.411 ha per household.

3.2. Forest products and estimates of their monetary value

The annual mean total monetary income of households was 989.4US$ in the study area, of which 28.1 % was from selling and/or using various forest products (Table 3). About 20 % of the respondents relied on the forests to collect non-forest timber products, followed by cut-and-carry (16.9 %) and woodcutting (11.9 %). The households graze their livestock (11.2 %), produce charcoal (10.9 %), and collect medicinal plants (10.2 %), seeds (8.6 %), seedlings (3.9 %) and firewood (6.25 %) from the forests.

The average annual production per household per ha in the study area was 16418 kg ± 16.49 stdev, with 18779 kg in female-headed and 15541 kg in male-headed households with no significant difference ($p > 0.05$) between the two groups. Though insignificant, female-headed households produced more than male-headed did. Mean annual household crop production varied significantly among the three districts ($F_{2,\ 380} = 7.254$, $p = 0.0008$) being lower in Offa than that of Kindo Koysha (t $= 3.915$, df $= 235$, $p =$ 0.0001) and Sodo Zuria districts (t $= -3.350$, df $= 216$, $p = 0.0009$) significantly (Fig. 4a).

Annual average monetary income from crop produce was 648.1US$ per household with a mean income of 741.3US$ for female-headed and 613.5US$ for male-headed ones with no significant difference between the two sexes (t $= 1.714$, df $= 382$, $p > 0.05$). Mean annual household income from crop sales was significantly different among the three districts ($F_{2,\ 381} = 7.18$, $p = 0.0008$), with

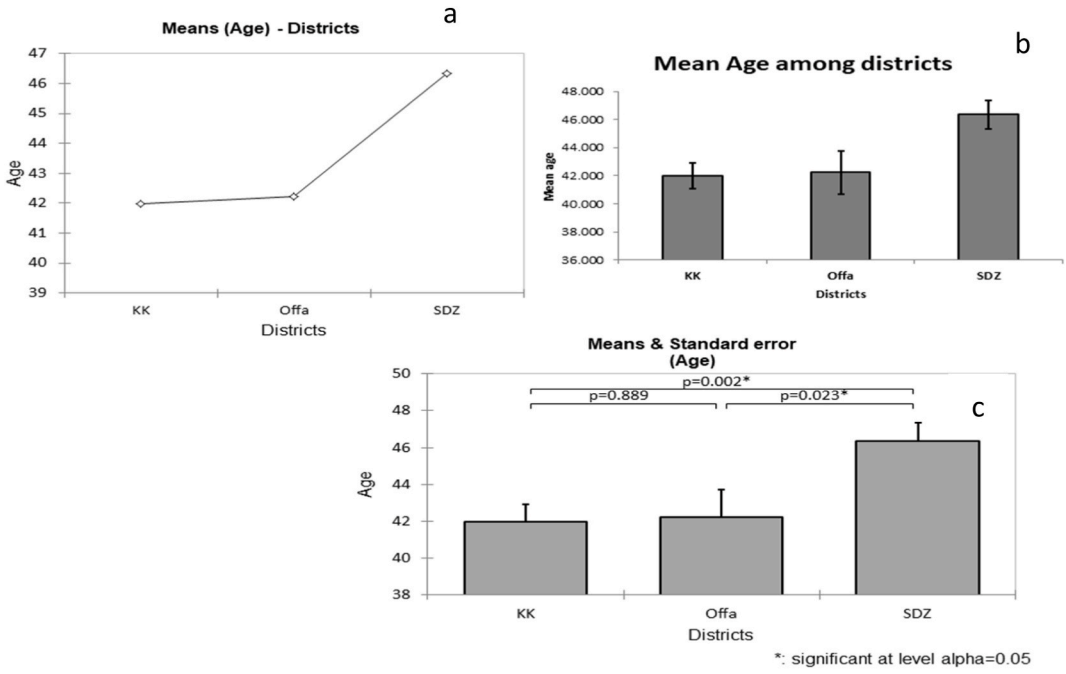

Fig. 2. (a–c) Mean age distribution of the households in the study districts (KK = Kindo Koysha; SDZ = Sodo Zuria) as depicted by line graph (a), Column chart (b) and p-value included (c).

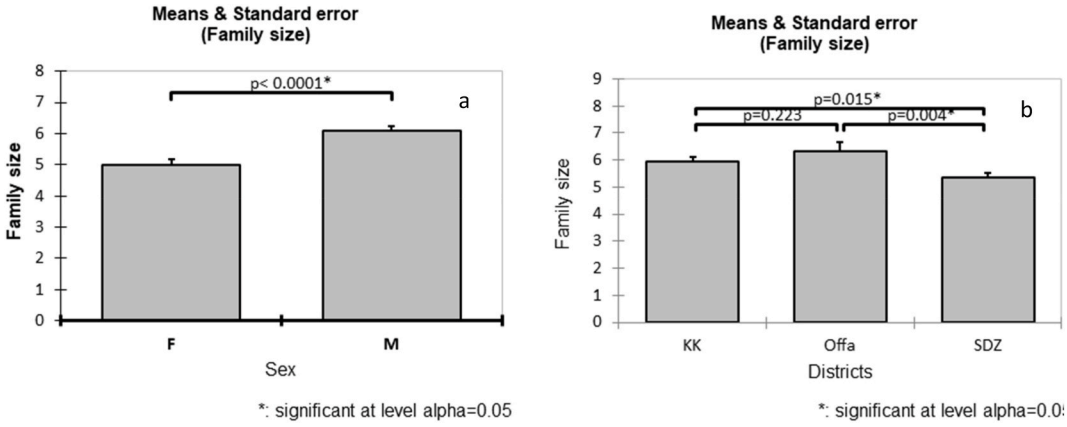

Fig. 3. Family size distributions between female-headed and Male-headed households (a) and by districts (b).

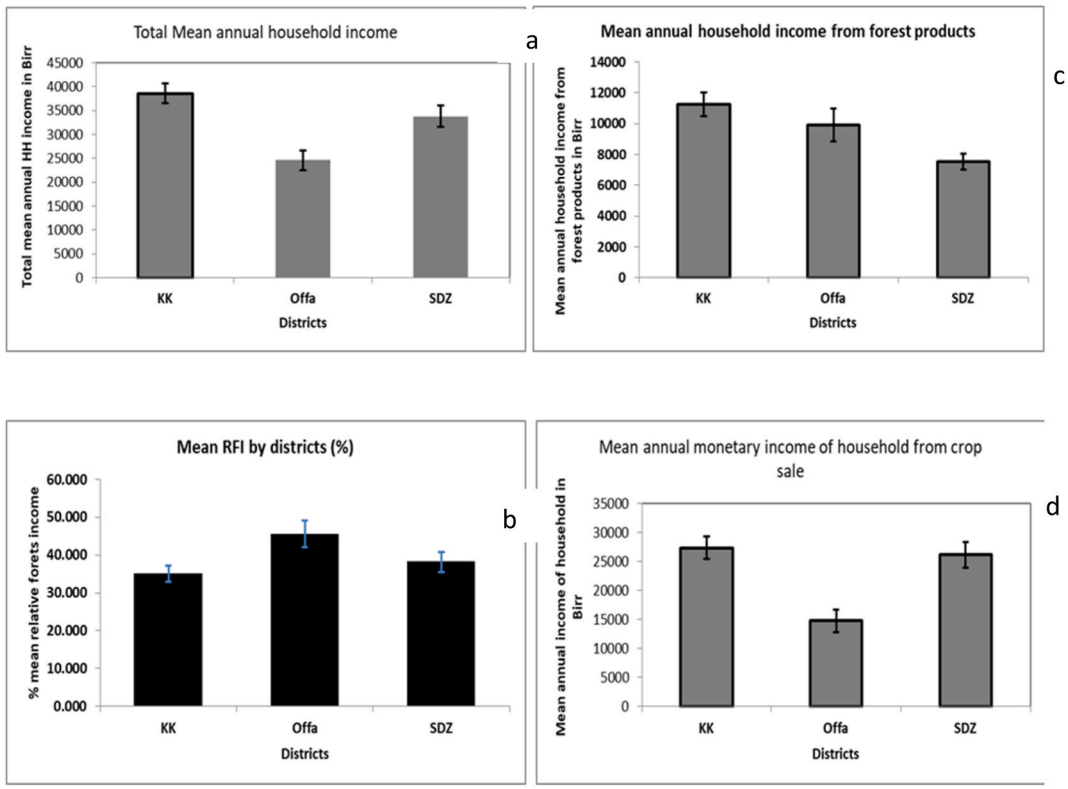

Fig. 4. Mean annual household income - a) Total; b) Relative Forest Income (RFI); c) from forest products; d) from crop. (KK: Kindo Koysha; SDZ: Sodo Zuria).

households in Offa generating lower than those in Kindo Koysha ($t = 3.92$, $df = 235$, $p = 0.0001$) and Sodo Zuria ($t = -3.3008$, $df = 217$, $p = 0.0011$) (Fig. 4d), maybe owing to farmland scarcity in Offa.

Annual average income from the forest products per household was 252.7US$ with a mean income of 257.2US$ for female-headed and 251.0US$ for male-headed ones with no significant difference, the range varying between 31.6US$ and 789.5US$ for females and 31.6US$ to 921.1US$ for males. The annual average income of households from forest products did vary among the study districts ($F_{2, 380} = 6.64$, $p = 0.0014$) significantly with dwellers of Sodo zuria earning significantly lower mean annual income compared to residents of Kindo Koysha ($t = 3.744$, $df = 310$, $p = 0.00021$) and Offa districts ($t = 2.037$, $df = 217$, $p = 0.047$) (Fig. 4c).

Household mean annual income significantly varied across forest products ($F_{8, 375} = 286.2$, $p < 0.0001$) (Fig. 5). Charcoal production income was higher than incomes from firewood, medicine, NTFP, seed and seedling selling, and woodcutting ($p < 0.05$) but was significantly lower than that of grazing ($t = 83$, $df = 83$, $p < 0.05$). Income from cut-and-carry was lower significantly than those of

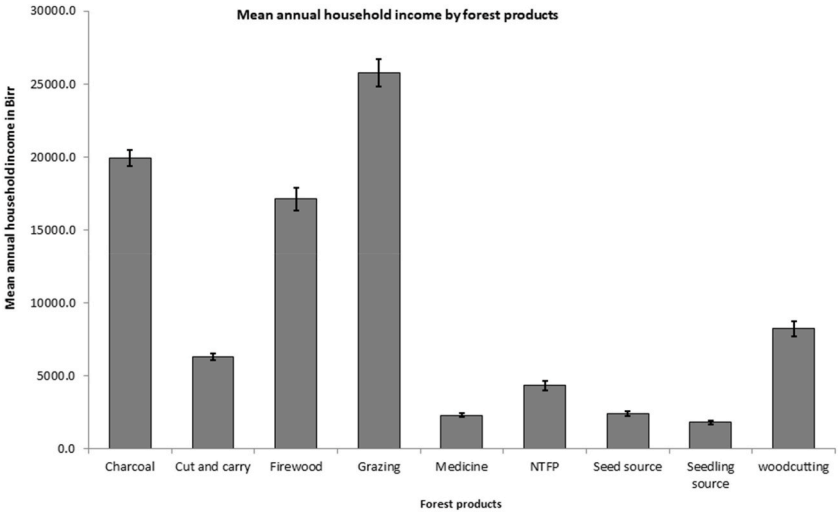

Fig. 5. Mean annual household income generated by different forest products.

firewood, grazing, and woodcutting but higher significantly than that of medicine, NTFP, seed, and seedling sources ($p < 0.05$). Income from firewood was lower significantly than that of grazing but higher than that of medicine, NTFP, seed and seedling sources, and woodcutting ($p < 0.05$). Income from traditional medicine was lower than that of NTFP and woodcutting but higher than that of seedlings ($p < 0.05$). Income from NTFP was higher than that of seedlings and seeds sources but lower than that of woodcutting ($p < 0.05$). Income from seed selling was significantly higher than that of seedlings but lower than that of woodcutting ($p < 0.05$).

3.3. Livelihood activities of households

Most (n = 325, 84.6 %) of the households were farmers, mainly depending on subsistence agriculture. Other livelihood activities in the study area were government employees as development agents (n = 15, 3.9 %) and as a teacher (n = 7, 2.6 %); Small-scale retail business (n = 12, 3.13 %); daily laborers (n = 15, 3.9 %) and house worker (n = 7, 2.6 %) and sale of forest products, a livelihood activity which all the respondents engaged.

The total average annual household income (summation of income from crop production and forest products) was different among the study districts ($F_{2, 381} = 7.616$; $p = 0.0005$). Households in Offa district earn low total annual mean income compared to those in Kindo Koysha ($t = 4.086$, $df = 235$, $p = 0.00006$) and Sodo Zuria ($t = -2.618$, $df = 217$, $p = 0.009$) (Table 2). This can be explained in terms of farmland size difference among the communities. In offa districts, farmland is scarce where the households owned small farmland size. Because of this, communities in Offa were less privileged from farmland relative to those of Kindo Koysha and Sodo Zuria, with no significant difference. Almost all (99.2 %) of the respondents owned their farmland close to forests, with females

Table 2
Socioeconomic and demographic profile of the household heads and forest products contribution to household income (KK: Kindo-Koysha, SDZ: Sodo Zuria). The same superscript letters in the same row denote no difference.

Socio-demographics	Offa (n = 72)	KK (n = 165)	SDZ (n = 147)	Total (n = 384)
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Age (yr.)	42.2 ± 1.5[a]	42.0 ± 0.9[a]	46.3 ± 1.0[b]	43.7 ± 0.6
Family size	6.3 ± 0.3[a]	5.9 ± 0.2[a]	5.3 ± 0.2[b]	5.8 ± 0.1
Farm size (ha)	0.411 ± 0.1[a]	0.777 ± 0.1[b]	0.733 ± 0.1[b]	0.640 ± 0.0
Annual crop produce (kg/ha)	9875 ± 2.0[a]	18254.5 ± 1.2[b]	17568.5 ± 1.4[b]	15,232.7 ± 0.8
Annual monetary income from crop produce (US$)	389.8 ± 78.2[a]	720.6 ± 49.1[b]	688.8 ± 55.9[b]	599.7.1 ± 33.6
Annual monetary income from forest products (US$)	257.8 ± 27.86	295.1 ± 20.23	202.3 ± 14.09	251.7 ± 11.66
Overall total (US$)	647.6[a]	1015.7[b]	891.1[b]	851.4
Sex profile	**Offa**	**KK**	**SDZ**	**Total**
Male	53	120	107	280
Female	19	45	40	104
Education level				
No formal education	38	83	63	184
Primary	31	44	53	128
Secondary	0	28	10	38
Tertiary	3	10	21	34
Duration of the residence in the area (years)				
0–19	17	41	40	98
≥20	55	124	107	286

Table 3
The contribution of forest products to the overall household income by district, age, and educational level. Column differences in superscript letters indicate significant differences between the districts. (KK: Kindo Koysha; SDZ: Sodo Zuria).

Independent variable	Mean annual income (US$/HH) ± SE from crop produce	Mean annual income (US$/HH) ± SE from forest products	Total average annual income (US$/HH)	Forest products contribution (%) of the total income (US$/HH)
District				
KK	722.48 ± 51.30[a]	295.90 ± 20.23[a]	1018.38	29.06
Offa	390.83 ± 51.05[b]	258.50 ± 27.86[a]	649.33	39.81
SDZ	690.59 ± 58.39[a]	201.42 ± 14.09[ab]	892.01	22.58
Age group (yr.)				
20–34	568.22 ± 60.93[a]	281.95 ± 27.38[a]	850.17	33.16
35–44	689.83 ± 63.59[a]	240.17 ± 20.40[a]	930	25.82
45–54	606.60 ± 61.11[a]	265.60 ± 22.53[a]	872.2	30.45
≥55	723.06 ± 81.57[a]	223.97 ± 23.9[a]	947.03	23.65
Education				
No formal	660.78 ± 48.99[a]	243.87 ± 16.12[a]	904.65	26.96
Primary	647.47 ± 58.53[a]	244.98 ± 20.38[a]	892.45	27.45
Secondary	612.41 ± 92.70[a]	280.41 ± 43.00[a]	892.82	31.41
Tertiary	621.60 ± 115.41[a]	298.62 ± 39.95[a]	920.22	32.45

encompassing all and the male included 98.92 %. Even though the mean farmland size for female-headed and male-headed households was insignificant, female-headed households produced more than male-headed ones. This can be explained in terms of the relationship between distance to the forest and income. It may be because of this that the income from both crop sales and forest product sales that female-headed households earn a bit higher incomes than male-headed ones. This may have positive implications to improve the livelihoods of female-headed households than male-headed households. It may also give female-headed households easy and frequent access to forest resources whenever they visit their farmland.

3.4. Households' dependence on forests of their locality

The households in Kindo Koysha, Offa, and Sodo Zuria districts depend on Gelesho Dere, Dawe Darke Danole, and Damot Gale forests for various products, respectively. The dependence of the households on the forest (expressed as a Relative Forest Income (RFI)) was calculated as the ratio of total forest income to the total household income expressed as a percentage. The level of dependence ranges from 0 % to 100 %, with an overall mean of 38.3 %. The mean RFI did vary among the study districts ($F_{2,\ 382} = 3.14$, $p = 0.04$). The RFI of the Offa (average: 45.5 %) was higher than that of Kindo Koysha (35 %) ($t = -2.61$, $df = 234$, $p = 0.009$) (Fig. 4b), but no significant difference was noted between Kindo Koysha and Sodo Zuria (38.1 %) districts.

3.5. Wealth status of the households and its determining factors

The wealth status of the households was affected by location, and it was significantly different across the study districts (X^2-test: $p = 0.048$). Overall, the households were grouped into poor (58.6 %) and rich (37.2 %), and only 4.2 % put in the middle class. The overall resource use in the study area was unequal among households in different districts, those in Kindo Koysha were rich (38.2 %) and in Offa were poor (66.7 %).

Wealth status was linked to occupation (X^2-test: $p = 0.029$). About 41.5 % of farmers were rich, while 54.2 % were poor. On the other hand, all the interviewed daily laborers were poor. Likewise, 90, 85.7, 80, and 58.3 % of the teachers, house workers, development agents, and merchants (petty traders) were poor.

Forest product consumption was strongly associated with the wealth condition of the household (X^2-test: $p < 0.001$). Of the 20.1 % NTFP users, 55.9 % were rich, and 44.2 % were poor. On the contrary, of the 16.9 % cut-and-carry users, 67.7 % were poor, and 30.8 % were rich. Poor households mainly engaged in woodcutting, seed and seedling selling, and medicinal plant extraction, whereas most rich families (69.8 % of the 11.2 %) use the forest for grazing. This is because many poor households do not have livestock, while many rich families rear livestock. The rich family uses the forest ecosystem as free grazing land for their livestock, and they fatten them to sell in the local market to generate high profits than the other forest products. On the other hand, poor families look for activities that do not require initial investment costs, like purchasing livestock, but involved in activities that they can directly collect from the forests and then could sell in the local market. In this process, the rich families are mainly involved in purchasing those products, while the poorer could directly bring them to the market.

Though wealth status did not vary significantly between genders, of the 27.1 % of female-headed households, 51.9 % were poor, whereas of the 72.9 % of the male-headed family, 61.1 % were poor. Similarly, though not significant, poor families have large family size. Wealth status and literacy levels were dependent (X^2-test, $p = 0.048$). The result showed that poor families were better educated than rich families though a higher level of education did not guarantee a better life. Poor thought that education is the primary means to live a better life. They assume that if they get educated, their dependence on forest resources will decrease, having a diversified income-generating portfolio other than the forest products. Households with no formal and primary education were actively and often involved in forest product exploitation, followed by primary education but respondents with secondary and tertiary education put low pressure on forest resources and utilized forest products wisely without destructing the forest structure. This indicates that educated

people have diversified sources of income and do not depend on trade of forest products for their livelihoods. They also have a better awareness of the conservation practices of natural resources.

3.6. Households' perceptions about forest ecosystem services and types of resources utilized

Enhancement of soil fertility was the most common ecosystem service claimed by 35.9 % of the respondents, followed by prevention of weather variability (28.9 %) and conservation of soil and water (22.9 %). The perceptions of the respondents on forest ecosystem services varied significantly with age group ($p < 0.05$). Non-Timber Forest Products were the most frequently utilized forest resources (43.0 %), followed by grazing (27.6 %) and woodcutting (12.2 %). The types of forest resources used by the households varied significantly between districts ($p < 0.01$).

The perception of households on the legality of forest use depends on location. Overall, 61.7 % of the respondents (19.8, 12.0, and 30.0 % of KK, Offa, and SDZ, respectively) perceived that they use the forest resources legally, whereas 38.3 % (23.2, 6.8, and 8.3 % of KK, Offa, SDZ, respectively) felt that they use the forest products illegally.

The location of the households' resident affected respondents' perception towards forest ecosystem services ($p = 0.0017$). Overall, 36.5 % of the respondents perceived that, the forest harbors different flora and fauna and, hence they believe that the forest was necessary for biodiversity conservation, whereas 28.4 %, 22.14 %, and 13.02 % perceived that it was crucial for climate change mitigation, flood control and soil and water conservation, respectively.

The majority (44.0 % of the overall 28.4 %) of households in Sodo zuria believe that Damot Gale forest provides regulatory services such as climate change mitigation. The majority (53.8 % of the overall 19.5 %) in Kindo Koysha believe that Gelesho Dere natural forest is a home for many plants and animals. They perceived that biodiversity conservation was the primary service of the forest. In the Offa district, climate change mitigation and biodiversity conservation took the first and the second choice of the households for the Dawe Darke Danole natural forest. Though the level of perception varies, the respondents in the three districts thought that the forest nearby their location was necessary to mitigate climate change (9.11, 6.8, 12.5 %), to conserve biodiversity (19.5, 6.5, 10.4 %), to control flooding (5.2, 3.4, 4.4 %) and to conserve soil and water (9.1, 2.1, 10.9 %) in the order of Kindo koysha, Offa and Sodo Zuria.

The respondents thought that drought (18.2 %), flooding (15.1 %), outbreaks of pests and diseases, prolonged dry spells, strong winds (10.93 % each), excessive rainfall (8.9 %), fall armyworm infestation, erratic rainfall, and change in rainfall pattern (8.3 % each) were the effects of climate change in their locality. However, this did not vary across districts ($p > 0.05$), which means the location of the households did not affect the respondents' perception of the effect of climate change.

The findings about households' perception towards the trend of the size of the forest over a temporal scale showed that location affects the perception of the household heads ($p < 0.05$); hence households' perception did vary across the three districts. Overall, 62 % (28.9, 17.7, 15.4 % for KK, Offa, SDZ), 28.7 % (13.0, 1.0, 14.6 % for KK, Offa, SDZ), and 9.4 % (1.0, 0.0, 8.3 % for KK, Offa, SDZ) believe that the size of the forest decreased, increased and stable, respectively along time gradient.

Households living in different districts perceived differently the pressures on the forest ($p < 0.001$). The majority (32 %) of the respondents thought that grazing was the main threat to the forest but a comparable number believes there was no pressure on the forest. Besides, farmland expansion (12.2 %), woodcutting (11.7 %), firewood collection (11.2 %), and charcoal production (4.2 %) were also identified threats to the forests.

The majority of the respondents (96.1 %) believe that there was unequal benefit sharing of the forest resource ($p = 0.002$) across the districts, believing those households living in one district were privileged more than others to use forest products.

Households in different districts did respond differently towards land expansion, implying a significant effect of location on household perception ($p < 0.05$). Overall, 67.2 % of the respondents believe there was land expansion in their locality, while the remaining 32.8 % deny this. About 60.1, 37.1, and 2.8 % of the household heads in Sodo zuria, Kindo Koysha, and Offa did not perceive land expansion towards the forestlands in their locality. On the contrary, 47.6, 46.5 and 25.3 % of the dwellers in Offa, Kindo Koysha, and Sodo zuria perceived land expansion in their locality.

4. Discussion

4.1. Socioeconomic and demographic profiles

It is important to acknowledge socioeconomic and demographic variations among the study target groups when considering policy and management interventions to support rural livelihoods and promote sustainable resource use [10]. This is because it is likely that different socioeconomic groups will perceive and use forest products differently, as reported by Refs. [20,38], in Zimbabwe [39,40], in India, and [41] in Peru. If this holds true across a range of sites, then policy formulations or local level interventions that evoke changes in local social or economic differentiation will have implications for use of forest products at large [10,42]. Having this in mind, we characterized the socioeconomic and demographic profiles of the sampled households. We also discussed how these variables vary among the study districts and how they affect the households' income from forest use since exploring the relationship between forest use and selected socioeconomic attributes are important for forest policy development.

The average household size of Ethiopia and SNNPR was 5.83 and 6.00 in 2016, respectively [43]. The average family size in the study area (5.8 ± 0.11) is comparable to the national and regional average. It is also comparable to that of Kenya (5.3) [44] but lower than that of the East Mau Forest Ecosystem, in ca. 50 km south of Nakuru town, Kenya [37]. The household size of Sodo zuria was smaller than Kindo koysha and Offa districts. Male-headed households, which are dominant, had larger family sizes than female-headed ones in our study. It is consistent with the customs of the country where females are expected to be the head for various

reasons. Households can be female-headed for different reasons. Of the 27 % of households in Ethiopia that were female-headed in 2016, 44 % were due to the death of the husband, 26 % were due to work migration of the husband, 22 % were due to divorce, and 8 % were single [37]. Our study depicted that the majority of the households were married.

Female-headed and male-headed households in the study area demonstrate equal mean age, but the age of the households follow different patterns among the three districts. Older households live in Sodo zuria [45]. Survey showed that the age difference between the household heads is smaller in rural areas of Ethiopia.

In Ethiopia, lack of education is a general characteristic of household heads where about 82 % of all household head did not complete primary education [45], which also corroborate our finding that 48 % did not attend formal education.

4.2. Forest contribution to livelihoods of smallholder house heads

The total average annual monetary income in the study area was 898.4US$ per household, of which 71.9 % was from crop selling and 28.1 % from forest products (Table 3). Even though crop income was the most important income portfolio for the sampled households in the study areas, our findings also revealed households dependency on forest income. Various [23,46–50] showed that forest-related income contributions range from 6 % to 45 %. In our study areas, the average annual contribution of monetary income from selling crop and forest products were US$ 648.1 and 252.7, respectively (Tables 2 and 3) [51]. Examined rural household income and the degree of dependence on forest income in Malawi constitutes around 15 % of total income. [52]. Indicated that income from forest environmental sources occupies the second largest share of total average household income next to crop income. [53]. Confirmed that village economic options, forest cover, and land suitability for agriculture and forestry are determining factors of peoples' well-being in rural areas of East Kalimantan in Indonesia.[54]. Noted that dry forests in South Africa are a vital component of rural livelihoods that help prevent deep poverty. [55]. Reported that the dependency of the rural peoples of the Madhya Pradesh, Orissa, and Gujarat states of India on forests varies from 37 to 76 %. [37]. Reported the forest income contributions between 25 and 36.5 % in East Mau Forest Ecosystem, Kenya. Our study revealed that forest products contributed to each household in terms of monetary income ranging from 23 to 40 % and did vary significantly, grazing and seedling selling accounted for the highest and lowest incomes, respectively. Grazing contributed the largest amount in the sense that households who owned livestock use the forest resources for grazing and browsing thereby fattening the livestock for sale in the local market where they compute the profit from the livestock selling. The rich households had an advantage over the poorer ones since the rich family owned livestock in most cases. Our findings also revealed that incomes from seed selling were higher than that of seedling selling but lower than that of woodcutting. These can be due to the price difference between seed and seedlings on one hand and maybe that of a high proportion of the community engaged in seed selling than seedling selling. Likewise, seedlings can be distributed by the Government Organizations and Non-Government Organizations to the community for free to encourage tree planting in line with the green legacy campaign of Ethiopia in the direction of establishing a climate-resilient green economy. On the other hand, woodcutting, which can also be represented by construction materials may cost a high price compared to seeds. [46,56,57,58]. Suggested that people's dependency on forest products varies substantially across households due to different factors like wealth status, education and land holdings, awareness levels, age, gender, family sizes, access to forests and nonfarm activities.

The average annual income of 28.1 % from forest share found in the current study was comparable to other studies [22,51,59]. The share of forest income of the total annual household income was 15 % in Chiradzulu District, Malawi [51], 23 % in Gore District, Southwest Ethiopia [59], and up to 22 % in Africa, Asia, and Latin America.[22,60]. found 34 % of annual income contribution from dry forests in the Somali region, Southeastern Ethiopia. In Wenbera district, Northwestern Ethiopia, income from dry forests contributed 39 % of the total annual household income [61]. About 32 % of the annual household income in the Somali region, Eastern Ethiopia, was obtained from the collection and sale of one forest product, Gum resin [62]. Based on our results, forest income contributed to the livelihoods of rural households living in the Wolaita community.

4.3. Perceptions about forest ecosystem services

Various authors [63,64] reported users' perception of ecosystem goods and services by local residents. We found that perception of respondents on the forest ecosystem services in the two districts (Kindo-koysha & Soddo-zuriya) were nearly the same whereas Offa district showed a different understanding of ecosystem services. Different age groups have different perceptions of forest ecosystem services. The older household heads were more knowledgeable about forest ecosystem services due to their longer life experiences than the younger ones. Enhancement of soil fertility was the most common forest ecosystem service, followed by weather variability and conservation of soil and water. Male respondents had a better understanding of forest ecosystem services than females. It is because females were mostly confined to indoor activities, whereas males have more interactions with their surroundings and natural process since they are more engaged with outdoor activities. Respondents with no formal education and primary educational background had a low understanding of forest ecosystem services, and those with secondary and tertiary educational backgrounds had a better understanding of forest ecosystem services.

4.4. Types of forest products utilized by households

According to discussions held with key informants, grazing, charcoal production, firewood collection, woodcutting, and NTFPs utilization were the main forest-related resource extraction areas accounting for 27.6 %, 10.9 %, 6.3 %, 12.2 %, and 43.0 %, respectively. These were the main perceived constraints for deforestation. Under current state law, local communities do not have the

right to extract major forest products, but they do have the right to access NTFPs such as pasture, wild honey, medicinal plants, wild fruits, roots, aromatic plants of cosmetic value, and hay at the caution of the forest development. The NTFP resource extraction of households in the study area was mainly hay production and collection of seeds, seedlings, wild fruits, wild honey, and medicinal plants. Meanwhile, NTFPs utilization, grazing, woodcutting (construction material, pole, and fiber), charcoal making, and firewood collection were ranked one to five, respectively.

Gender of the respondents was one of the determinants that significantly influenced the use of forests and forest products, as also indicated by Refs. [65–67]. In the study areas, non-timber forest products (NTFPs) were the most frequently utilized forest resources (43.0 %), followed by livestock grazing (27.6 %), and woodcutting (12.2 %). This is because, a greater proportion of poor households were involved in the sale of one or more NTFPs, and they sold a greater number per household, compared to rich and middle households. Conversely, with increasing wealth, households own livestock and use the forest for free grazing. Study [68] showed that poorer households possibly use greater amounts, and are more reliant upon NTFPs compared to richer households. Even if absolute amounts used are similar between poor and rich, the income derived from NTFPs by poor households makes a greater contribution to overall livelihoods as it represents a higher proportion of all income streams, than for rich households. Rich households typically have a greater number of income streams; thus, NTFPs represent a lower, but still important, proportion of total livelihood income. In contrast [69], found that the total gross annual direct-use value of NTFPs per household was greater in a wealthy village relative to a poor one. The higher values within the wealthier villages can be ascribed to higher local prices, rather than greater consumption of NTFPs [69]. The types of forest resources utilized by the households significantly varied with the district ($p < 0.01$). This variation was due to the fact that Kindo-koysha and Offa's districts were rural districts with smallholder households that depend on natural resources for their livelihood. However, Sodo zuria district is closer to Sodo town with access to other means of livelihood such as petty trade, and labor work. We also found that males utilized more forest products than females due to the differential division of labor in the family.

In the study areas, the age groups actively involved in the utilization of forest products were ranging from 35 to 54 years old. As indicated by Ref. [70], age influences the intra-cultural variations in perceptions and traditional knowledge about wild plants. Learning about plant uses in a community begins at an early age and continues gradually as a person grows. Therefore, an old person usually has more knowledge about wild plants than a younger person [67,71]. Households with no formal and primary education were actively engaged in forest product exploitation followed by primary education while respondents with secondary and tertiary education put low pressure on forest resources and utilized forest products wisely without destructing the forest structure. This indicates that educated people have diversified sources of income and do not depend on the sale of forest products for their livelihoods. They also have a better awareness of the conservation practices of natural resources.

4.5. Determinants of annual monetary income from forest products

Study [72] has shown that per capita food production and farm income declined simultaneously with land size. According to Ref. [72] when farmland size is extremely small it is difficult to obtain the optimum level of production output required by the household. Most households with very small plots are vulnerable to food insecurity and income shortage. Our findings revealed that the land holding for the households in all villages ranges from 0.125 to 2.00 ha with average farmland size and annual crop produce being 0.64 ha and 16.4 quintals/ha, respectively. We reported that households in Offa district earn significantly low total annual mean income compared to those in Kindo Koysha and in Sodo Zuria. This can be due to farmland size differences among districts. The farmland holding is smaller in Offa than in the other two districts. The household annual mean crop production in Offa district was lower than that of Kindo Koysha and Sodo Zuria but its relative forest income was higher than the other districts, which may imply high dependence of the Offa district on the forest resources for their livelihoods. The annual average income of households from forest products did vary among the study districts significantly, with dwellers of Sodo zuria earning significantly lower mean annual income, compared to residents of Kindo Koysha and Offa districts. This might be because Sodo Zuria is close to Sodo town, and they may have diversified streams of incomes other than the forest resources. Respondents' in Offa district with farmland scarcity and high family size earn the lowest total average annual income but highest relative forest income and we also noted that 66.7 % of the respondents were poor, which may imply that in our study area the poorer were more dependent on forest resources. This may be contrary to64 who reported that the households deriving the most relative forest income were not the poor ones, and on the other hand, our findings are in agreement with the same study who reported that the households deriving the most absolute forest income were not the poor. The land size of the households is negatively and insignificantly related to the probability of a household being a forest destructor. The marginal effect of a unit change in farm size, computed at sample mean of holding size, on the probability of forest destruction. This means that the probability of forest destruction increases by 0.31 for a 1-ha decrease in farm size. Besides, family size was also another determinant of household income. Family size is closely connected with the total average annual monetary income of each household. This study indicated that family size had a negative and significant relationship with the probability of total average annual monetary income received from selling forest products. The average annual monetary income decreases with an increase in family size. Our findings also reported that the wealth status of the households was significantly different across the study districts and was linked to occupation. Although in all three districts and occupation types, above 50 % of the respondents were poor, 41.5 % and 51.7 % of farmers and petty traders were rich, which could be preferable occupations to earn more income in the study area. On the contrary, some jobs such as, teachers, house workers, and development agents were not preferred ones in terms of income generation, as 90 %, 85.7 %, and 80 % were identified as poor, respectively.

These findings highlight the need for conservation and development projects to pay attention to the specific household factors that affect forest use.

5. Conclusions

The main objective of this study was to estimate the economic contribution of forest products and forest-based activities to rural households' income of Wolaita community in Ethiopia. It particularly aimed at determining the absolute and relative forest incomes. We collected data through semi-structured household-level and market surveys. The study revealed that the annual absolute average income from forest products was USD 252.7per household, contributing to 28.1 % of the total yearly absolute average income, and 38.1 % of the relative forest income. Family size, farmland size, occupation, and location affect forest products contribution to the household income. Among the study districts, we reported significant difference in some socio-economic profiles. It is necessary to recognize such variations when considering policy and management interventions to support rural livelihoods and promote sustainable resource use.

The extraction of forest products and forest income are important components of household livelihood strategies. This may not only lead to land degradation and scarcity of forest products but also may exacerbate the effects of climatic changes on natural resources and people's livelihoods. The findings revealed from this study are of great importance for implementing sustainable forest management policies and strategies that can balance the needs for conservation and development of rural households living in Wolaita community and the rest of the country. The government should strengthen the forest management capacity to regulate access to forest resources that guarantee the maintenance and improvement of the economic and ecological benefits derived by community while sustaining the use of forest resources. An inclusive management approach could be strengthened. Diversification of income sources other than direct forest resources can help reduce pressure on the forest. Local communities and other stakeholders at all levels should be sensitized and educated on the values of forests. We also recommend improved management interventions for the sustainability of forest resources and awareness creation to the community to reduce the unwise use of forests.

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Data availability

Data included in article/supp. Material/referenced in article.

CRediT authorship contribution statement

Eyasu Chama: Conceptualization, Data curation, Investigation, Writing – original draft, Writing – review & editing. **Simon Shibru:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Writing – original draft, Writing – review & editing. **Tizazu Gebre:** Conceptualization, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Sebsebe Demissew:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – review & editing. **Zerihun Woldu:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Supervision, Writing – review & editing.

Declaration of competing interest

We, the authors and our immediate family members, have no financial or any competing interests to declare.

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Appendix A. Supplementary data

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