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The Watershed Communal Land Management and Livelihood of Rural Households in Kilte Awlaelo Woreda, Tigray Region, Ethiopia

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Abstract: While the degradation of natural resources has a substantial impact on the livelihood of farmers in rural areas, there is scant empirical evidence about livelihood status and benefits from communal resources, especially whether the benefits are equally distributed among local farmers. This study examines how the conservation of communal lands affects the food security status and the livelihood of the poor people in the Tigray region of Ethiopia. This paper employed both descriptive statistics and econometric analyses using the ordinary least square regression and quantile regression models. The food security status of rural households was found to be negatively associated with the direct use of natural resources generated on conserved communal lands. The study further affirms that households in the lower quantile harness more of the direct use of common property resources. However, households in the median and the upper quantiles tend to engage in the indirect use of resources generated on communal lands. These findings pose a critical policy implication regarding how to reconcile the trade-offs between the consequence of heavy dependence of the poor on the direct use of communal land-based resources and ensuring sustainable livelihood by allowing the poor to collect benefits from the conserved lands.

Keywords: communal land; conservation; coping strategy; livelihood; food security

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1. Introduction

The depletion of communal land-based resources has been a critical challenge for sub-Saharan African (SSA) countries in their efforts to fight poverty. The land degradation and depletion problems in this sub-continent are the results of the overuse of natural resources, which in turn leads to the deterioration of the productive capacity of the resources [1]. SSA has been experiencing the most severe land degradation in the world over the past decades such as desertification, deforestation, soil erosion, drought, and other extreme weather events [2]. The sub-continent also bears the largest share (22%) of the global annual cost of land degradation [3], and in most SSA countries, a substantial portion of their land is seriously degraded. It has been reported, for example, that about 28% of the land area in sub-Saharan Africa experiences degradation, and 22% of its population lives on degraded lands [3]. The level of degradation in some parts of SSA is even more severe. A study by Le, Nkonya, and Mirzabaev [4], for instance, shows that about 51% and 41% of land area in Tanzania and Malawi, respectively, is covered by land degradation hotspots. Such challenges jeopardize the efforts to reduce poverty in the continent since most rural livelihoods depend heavily on both the direct and indirect use of the natural resources base. The degradation of natural resources has immense economic, social, and human costs, with a substantial impact on the livelihood of farmers as well as national income [5]. Moreover, the most vulnerable populations to the harmful effects of the degradation of natural resources are rural people whose primary incomes derive directly from the natural resources base. However, well-managed communal lands can tackle the land degradation problem and generate a flow of benefits that provide the basis for improving the livelihood condition at the household level [6]. It can also contribute to achieving sustainable economic growth at the aggregate level. Therefore, reversing the threat of land degradation and its consequences is among the priory policy agendas of many African countries since a large proportion of rural farmers depend on common property resources such as forests (woodlots) and grazing lands for their livelihood in developing countries [5,7,8].

Studies conducted in many African countries confirm that communal land-based resources have a strong association with the livelihood of farmers. For instance, a study in the Democratic Republic of Congo (DRC) finds that improved watershed areas helped to increase the freedom of movement via improving roads and thereby reducing transportation costs and increase farm-gate prices, which all improve the livelihood conditions. Similarly, in South Africa, a strong linkage between communal land resources conservation and livelihood indicators has been reported [9,10]. A relevant study in another southern African country, Namibia, reported a positive impact on the community-level benefits as a result of watershed development programs [11,12]. Despite these positive associations between livelihood improvements and the conservation of communal lands, other studies conducted in developing countries reported that the overburden put on natural resources is a cumulative effect of higher economic activity. The excessive use of communal resources is derived from high population growth, increases in per capita income, public good nature of communal resources, and other related factors [13–16].

In Ethiopia, like many other SSA countries, the reality is not different. Although Ethiopia is said to be endowed with huge potential for natural resources, land degradation, particularly in the highlands, has been a critical challenge to improving livelihood in general and ensuring food security for rural people in particular [17,18]. In the northern part of Ethiopia, particularly in the Tigray region, where the current study was conducted (Figure 1), the land degradation problem has increasingly been exacerbated over time [2,13].

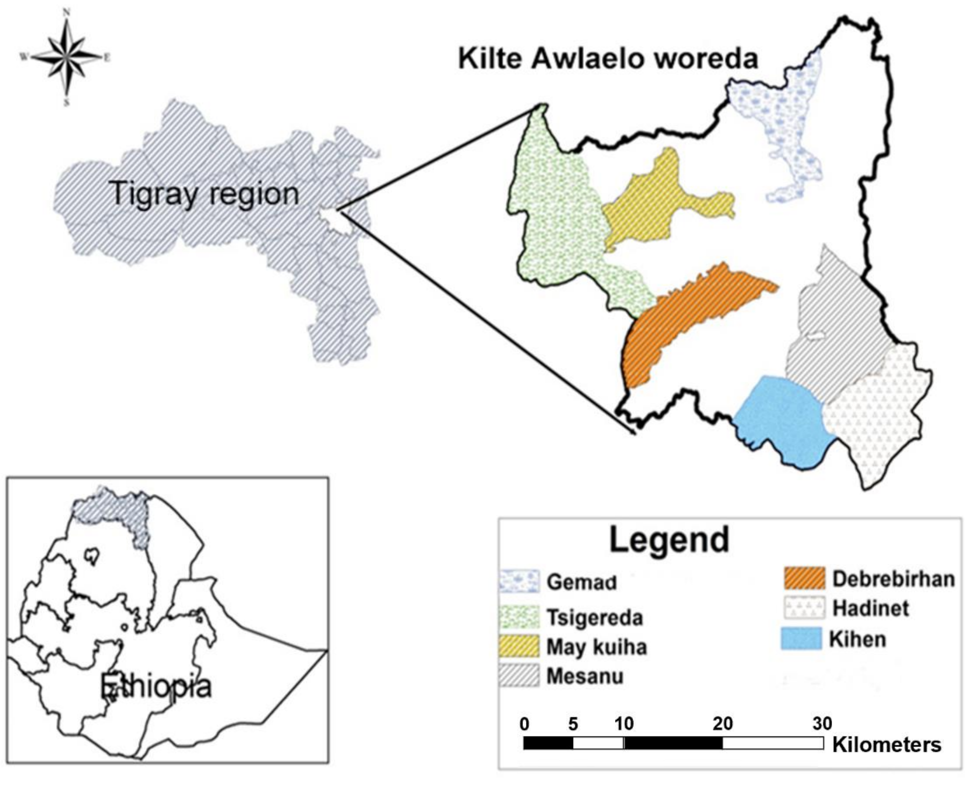

Figure 1. Map of the survey area.

The major economic stay of the Tigray region has predominantly relied on the direct and/or indirect use of the natural resource base, whereby the very basic survival of rural households is closely associated with the productive potential of communal resources such as forest, soil, water, grass, bushes, and shrubs. However, these land-based natural resources, particularly common property resources in the region, has become severely degraded because of the agricultural activities that have been practiced for centuries, unregulated human interventions, and other natural factors [18,19].

As a response, several interventions have been tried to reverse the environmental degradation in the region such as the conservation of communal lands. Community-based watershed development approach is one of the interventions that has received due attention, particularly in the Tigray region [6]. In the entire region, conserving communal resources such as communal forests, grazing lands, and other bio-physical resources is an integral part and parcel of the watershed development initiatives [18,20–22]. These communal resources are an important source of fuel wood, construction material, livestock grazing, bee forage, and other livelihood options. Empirical studies conducted in the region confirm that watershed development contributed to the fertility of farmland and agricultural yield increments [23,24]. Apart from these, many of the previous studies in this discipline are also geared toward the effect of watershed development projects on biophysical resource improvements, particularly on the reduction of runoff, soil loss, groundwater discharge, forest, pasture improvements, and crop productivity [25–27].

The obvious shortcoming in these studies seems to be negligence toward the livelihood effects and benefit-sharing mechanisms of communal resources developed as a result of conservation among the various groups. There is also scant empirical evidence to understand what changes these yield increments and improvements in biophysical resources have resulted in rural households' livelihood status. There is also a need to empirically examine whether the livelihood opportunities created as a result of communal land resources conservation are equally distributed, which has not been adequately addressed in previous studies. Thus, the question is how the food security status of rural households is associated with the utilization of natural resources.

The objective of this study is to examine how the conservation of communal lands affects the food security status and how conservation supports the livelihood of the poor people in the Tigray region of Ethiopia. We predict the relationship between the benefits obtained from conserved lands and the food security status by controlling the effect of other socioeconomic and institutional covariates.

Thus, the current study is innovative in terms of two perspectives. Unlike the previous studies reviewed earlier, the current paper extended the spectrum of its analysis up to the distribution and sharing of benefits harnessed from the communal conserved lands among different classes in a community. The other new insight of the current paper is it addresses the key question of whether or not the collective actions towards communal land conservation support the livelihood strategies of the poor.

The next section describes the conceptual framework of this study. Then, Section 3 explains the study site, the method of sampling and data collection, and the estimation method. Section 4 presents the results of the estimation of the econometric models, which is followed by a discussion in Section 5. Lastly, Section 6 concludes with discussing the relationship between food security and conservation and its implication for policy interventions.

2. Conceptual Framework

The basic theoretical framework for this paper emanates from the concept of sustainable livelihood. A livelihood comprises the capabilities, assets (stores, resources, claims, and access), and activities required for a means of living: a livelihood is sustainable if it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, provide sustainable livelihood opportunities for the next generation, and contribute net benefits to other livelihoods at the local and global levels and in the long and short terms [28]. According to Chambers and Conwa, the sustainable livelihood analytical framework is based on five interacting elements, namely contexts, resources, institutions, strategies, and outcomes. The sustainable livelihood approach provides a framework for analyzing the link between communal land conservation activities, rural livelihoods, and ultimately poverty reduction.

The focus of the current study is on the interaction of community with the communal lands, which includes people and their farming system (including crop and livestock) and interactions with land resources, coping strategies, social and economic activities, and social networks. The intervention in watersheds in rural Ethiopia under the Ministry of Agriculture and Rural Development aims to improve the livelihood of communities and households through comprehensive and integrated natural resource development [21]. In order to understand the complex influence of watershed development interventions, the sustainable livelihood approach provides a strong framework since it includes the contexts in which the people live, resources (natural, physical, social, and financial capitals), livelihood strategies, and the outcomes of the interventions in its analysis [25]. In this paper, the intervention is communal land conservation, and the core aim is to assess how such interventions lead to sustainable livelihood sources and improve the livelihood condition of households. Following Turton [29], we hypothesize that communal land conservation contributes to rural livelihoods with higher food security. This would enable us to give a comprehensive insight by providing detailed empirical evidence on the channels of how communal land conservation influences the livelihood of households.

3. Methodology

3.1. Study Site

The study was conducted in Kilte Awlaelo *woreda* (a woreda is the second smallest administrative unit in Ethiopia, equivalent to a district) in the Tigray region of Northern Ethiopia (Figure 1). This district was selected because it is an area where the land degradation has been exacerbated, and it is one of the drought-prone areas in the country [2,12]. The district is characterized by various landscapes ranging from rugged hills to moderately plain areas with midland-dominated agroecology; thus, it is a representative area of the Ethiopian highlands.

The Kilte Awlaelo woreda is administratively divided into 19 *tabias* (a tabia is the smallest administrative unit in the Tigray region, following a woreda.). According to the statistics from the woreda's office of planning and finance, the total population of the woreda is estimated to be 138,705, of whom 51.1% are females, and the woreda covers a total area of 101,757 ha. The altitude of the woreda ranges from 1900 to 2300 m asl. The average temperature of the woreda varies between 17.3 °C to 28.0 °C. The woreda has a very short rainy season (most often mid-June–the end of August) and a very long dry season that stretches from September to June. An unpublished report from the office of agriculture and rural development of the woreda shows that the economic mainstay of the woreda for nearly 95% of its population is agriculture. The existing farming system dominantly depends on erratic rainfall and a subsistence-based production system. Agricultural production is also characterized by low input and output. The farming system in the study areas is mixed farming in which crop production is the dominant livelihood source supplemented by the livestock sector. The staple cereal crops grown in the woreda include wheat, teff, barley, maize, and pulses. The woreda is also known for its successful achievement in watershed development initiatives. More importantly, the communities in Abraha we Atsibiha tabia, which is located in Kilte Awlaelo woreda, are internationally recognized for the remarkable accomplishments made so far in natural resource conservation and sustainable utilization through a community-based watershed development approach.

3.2. Sampling Techniques, Procedures, and Data Collection

The study sites are spatially distributed across seven tabias of the woreda with the intention of capturing the effect of heterogeneity in biophysical resources, institutional factors, social norms, and to some extent socioeconomic conditions on livelihood status. The study sites are also characterized by various climatic and topographic domains ranging from altitude differences to temperature and rainfall variations as well as to some extent cropping patterns.

The paper used a multistage sampling procedure to reach out to the sample respondents. In the first stage, the study woreda was purposively selected for the following reasons. Kilte Awlaelo woreda consists of tabias that are among the drier ones and also highly deteriorated landscapes in the region. Additionally, the woreda is considered to be one of the severely affected parts of the region because of climate change-induced shocks particularly drought, soil erosion, and deforestation. Following these realities, we purposively chose Kilte Awlaelo to examine what the more than two-decades-old communal land conservation initiatives (through a community-based watershed development approach) in the woreda have contributed to the livelihood improvements of smallholder farmers in the face of climate change. In the second stage, seven tabias within the study woreda were randomly selected. These include Kihen, Mesanu, Hadinet, Debrebirhan, Tsigereda, May-Kuiha, and Gemad as shown in Figure 1. Lastly, a total of 689 households were randomly selected from the target population for the household survey. The lists of respondents were obtained from their respective tabia administrations, and the heads of the households were invited for a household survey.

Cross-sectional data were collected from randomly drawn household heads in March 2019. Before the actual survey, a preliminary test was undertaken in all study sites in September 2018 to validate the applicability of the questionnaire, and this was followed by the training of enumerators. We used a structured questionnaire to capture relevant data, which included the socioeconomic status of household heads, participation in communal land resources conservation, livelihood conditions, benefits obtained from communal land conservation, agricultural and nonagricultural economic activities, access to institutional services, and basic infrastructures. The questionnaire was administered by trained enumerators, and a face-to-face interview was used since many of the respondents were illiterate.

The other data collection instrument employed was the key informant interview (KII). For this purpose, a checklist was used to gather data from the key informants. The participants in the KII were development agents and community leaders from the seven tabias included in the study. The key informants were considered to be better informed and could better describe the communal land conservation practices and returns in their localities.

3.3. Data Analysis

The paper employed both descriptive statistics and dominantly econometric models as data analysis methods. The descriptive statistics (mean, standard deviation, and frequency) were used for the preliminary analysis such as to summarize the socioeconomic profiles and community-level data, and the qualitative data obtained from key informants were triangulated to substantiate the empirical findings from the household survey. To present more objective evidence for the objectives of this study, the econometric estimation methods, namely, ordinary least squares (OLS) regression and quantile regression (QR), were used as data analysis instruments. Unlike OLS regression, which gives only a partial view of the relationship between the outcome variable and a set of explanatory variables, the QR enables us to examine the relationship at different points in the conditional distribution of household income status [30,31]. QR thus ameliorates the OLS regression approach.

3.3.1. Ordinary Least Square (OLS) Regression

The coping strategy index (CSI) has been employed as a simple measure of food insecurity status, which affects the sustainable livelihood condition, in previous several studies [32–34]. Following this, the current paper used CSI as a proxy variable to measure the food insecurity status of rural households. CSI combines two important elements: the frequency of each strategy (how many times each strategy was adopted in a specified time) and their severity (how serious is each strategy?) for households reporting food consumption problems. Higher CSI indicates a worse food security situation and vice versa. CSI for each observation (household) was computed based on a self-reported answer to the question of what coping strategies and how often a household employs when the household does not have enough food or money to buy food. The CSI is computed using Equation (1):

$$\begin{aligned} \text{CSI} = [(&\text{frequency of } \text{CS}_1 * \text{severity of} \text{CS}_1) \\ &+(\text{frequency of} \text{CS}_2 * \text{severity of } \text{CS}_2) + \ldots \\ &+(\text{frequency of } \text{CS}_{11} * \text{severity of } \text{CS}_{11})] \end{aligned} \quad (1)$$

Computing the CSI takes into account the frequency of each strategy adopted and the weight (to capture severity) for each adopted strategy. Respondents were asked to state the number of days they adopted each strategy in a week to quantify the frequency of the adopted coping strategy. The weight attached to each coping strategy is adopted from similar studies conducted in similar contexts [33]. Afterward, the coping strategies index was treated as the dependent variable and regressed over the set of independent variables using OLS to examine the determinant factors for the livelihood status of farm households. The prime interest of this paper is to predict the relationship between benefits obtained from conserved lands and food security status by controlling the effects of other socioeconomic and institutional covariates:

$$Y_i = \beta_0 + \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + \ldots \beta_{ni}X_{ni} + \varepsilon_i \quad (2)$$

Y_i denotes coping strategies index score

β_0 denotes constant

$\beta_{1i} - \beta_{ni}$ denote the coefficients of estimates

$X_{1i} - X_{ni}$ denote all independent variables included in the model (economic benefits, livelihood sources, and other covariates to control their effect on food security status)

εi stands for the error term.

The full list of independent variables ($X_{1i} - X_{ni}$) is presented in Table 1.

Table 1. Description of explanatory variables included in OLS and QR.

Variables	Expected Relationship with CSI	Description of the Variable
Gender	+/−	Gender of the household head (1 = male, 0 = female)
Age	+/−	Age of the household head in years
Education	−	Years of schooling by the household head
Family_size	+	Family size of the household
Farm_size	−	Total operated farmland in *tsimad* [3]
Cattle_holding	−	Total number of cattle owned by the household in TLU [4]
Training	−	Participated in training/seminars related to natural resources conservation (1 = yes, 0 = no)
Disttabia	+	Distance between residency of the respondent and tabia administration in km
Distworeda	+	Distance between residency of the respondent and woreda center in km
Crdtacces	−	Access to credit (1 = yes, 0 = no)
Irrigation_use	−	Access to irrigation (1 = yes, 0 = no)
Safety_benef	−	Safety net program [5] beneficiary (1 = yes, 0 = no)
Fuel_wood	−	Household collects wood fuel from the conserved communal land (1 = yes, 0 = no)
Animal_fodder	−	Household collects animal fodder from the conserved communal land (1 = yes, 0 = no)
Hillside	−	Household who benefited from hillside redistribution (1 = yes, 0 = no)
Beehive	−	Household owns and uses beehive (1 = yes, 0 = no)
Good_climate	−	Household perceives communal land conservation improved the microclimate (1 = yes, 0 = no)
Water_availability	−	Household perceives communal land conservation improves groundwater availability (1 = yes, 0 = no)
Other_uses	−	Household collects thatch, farm tools, and wild fruits from the conserved communal land (1 = yes, 0 = no)
Crop_income	−	Income earned from crop produce in 2018/19 in ETB [6]
Livestock_income	−	Income earned from livestock and its products in 2018/19 in ETB [6]
Othr_income	−	Income earned from off and non-farm employment, remittance, and aid in 2018/19 in ETB [6]

[3] *Tsimad* is a local unstandardized measurement of the size of farm plots (one tsimad is roughly equivalent to 0.25 ha).[4] According to Weber and Jelsch [35], one tropical livestock unit (TLU) is equivalent to 250 kg live weight, which is approximately one head of cattle, or 10 sheep, 11 goats, and 0.7 camels. [5] Safety net is a food-for-work and social security program funded by the government of Ethiopia and a consortium of international funding agencies aimed at building private and community assets through creating employment for poor households in which the entitled households are supposed to work on watershed development activities. [6] ETB is the currency of Ethiopia. 1 ETB was equivalent to USD 0.0344 in 2019 (World Bank. Open Data: Official exchange rate (Available online: https://data.worldbank.org/ (accessed on 29 September 2022)).

The model scrutinizes the effect of communal land conservation on the food security of households by eliciting the benefits that the community harnesses from communal lands. The major economic benefits of communal land conservation are the collection of fuel wood to satisfy farmers' energy needs, animal fodder (hay), which is an important element for enhancing the productivity of the livestock sector, and bee forage, which contributed to the income of farmers through honey production. The members of a community in a given watershed are allowed to collect dry and fallen branches of trees for fuel wood. They are also given access to wood removed during thinning/pruning operations and are also permitted to gather animal fodder, thatch, and other uses on a first-come-first-served basis on a collectively agreed and predetermined date. In the household survey, the respondents were asked to list the direct and indirect benefits obtained from the conserved and enclosed communal lands in their locality. Following this, we model each stated benefit as a dummy variable in the explanatory variables to observe the relationship between the stated benefits and CSI of the households. The notable direct benefits listed by the respondents are the collection of wood fuels, animal fodder (hay), bee forage, and some other benefits (such as thatch, farm tools, and wild fruit). The most frequent and indirect benefits stated by the respondents were good microclimate and improved groundwater availability around the conserved watersheds. The indirect benefits in fact are perceptions of the respondents towards the ecological benefits as a result of the conservation of communal lands.

The other economic benefits from conserved areas include construction materials (thatch), farm tools, and some wild fruits. Since the benefits seem separately negligible, we merged all these benefits and named them 'other uses.' Regarding the indirect benefits, households were asked about their perception of the ecological benefits of communal land conservation in their locality. We use the two most frequently stated perceived benefits by the respondents, namely, improved groundwater availability and good microclimate. We model these benefits in the form of a dummy (perceived and nonperceived households). The point of interest here is how the perception of rural households toward the increase in water availability and good climate correlates with their income.

We use other demographic and regional variables to control the effect of other socioeconomic variables, such as gender, age, education level of household heads, the total number of family members, the total number of cattle owned by the household, and institutional covariates, such as participation in training or seminars related to natural resource conservation, access to credit, and irrigation. Distance between the residency of the households and the woreda center is used as a proxy variable for market access.

3.3.2. Quantile Regression (QR)

We use the QR model to examine how the economic benefits generated from the conserved communal lands are distributed among various income groups in the study areas. QR is a nonparametric approach that was developed to estimate a full range of conditional quantile functions by minimizing asymmetrically weighted absolute errors [34]. We employ QR to capture the distribution of economic benefits from communal lands across various income quantiles. More importantly, QR can analyze whether or not communal land conservation benefits the low-income group more. The quantile estimator of household incomes also provides a richer characterization of the data, allowing us to study the effect of communal resource conservation on the entire distribution of a household's income status, not only its conditional mean [36].

The model specification of QR is presented as follows:

$$Q_{yi}(\tau/X_i\,,\alpha_i) \;=\; \alpha_i + \mathrm{X}_{\mathrm{i}}'\beta(\tau)$$

where $Q_{yi}(\tau/X_i\,,\alpha_i)$ denotes the τth conditional quantile of Yi given Xi in the interval (0, 1). Following Koenker and Bassett [30], we obtained the estimates by minimizing the following equation

$$\sum_{\mathrm{i}\,=\,1}^{\mathrm{n}} \mathrm{Q}_{\tau}\left(\mathrm{y}_{\mathrm{i}} - \mathrm{X}_{\mathrm{i}}'\beta(\tau)\right)$$

where $0 < \tau < 1$.

In this paper, the locations are the first quantile, Q (0.25), the median, Q (0.5), and the third quantile, Q (0.75). The surveyed sample households were divided into the above-stated three cut points based on their annual total income. The full list of explanatory variables along with their operational definition included in QR is reported in Table 1.

4. Results

4.1. SocioEconomic and Demographic Conditions of Sample Households

Table 2 summarizes the key socioeconomic conditions of the respondents. The majority of respondents (77%) were male-headed while the remaining 23% were female-headed households. The average age of the household heads who participated in this study is 47 years. The age of participants covers a wide spectrum that ranges from the minimum of 19 years to the maximum of 91 years old. The average educational attainment was also found to be two years, with higher variance among the participants of the survey since the standard deviation is greater than the mean as shown in Table 2. The average family size of the respondents is six, while it is five for the Kilte Awlaelo woreda as a whole [37]. The descriptive statistics also show that the study site exhibits relatively less endowment of natural capital as compared to the average resource endowment of other districts in the Tigray region in particular and in the country in general. For instance, the average holding of farmland is three tsimad, which is roughly equivalent to 0.75 ha. The average land holding of the surveyed households seems to be a bit lower than the average land holding in the Tigray region which is on average 0.8ha [37]. The small size and fragmented landholding of farmland are reported to be among the causes of food insecurity in the study site in particular and the Tigray region in general. The average cattle holding (physical capital) of the study sites is 2.8 in TLU. The average per capita income of the surveyed households is found to be 6096 ETB (208.8 USD) (with a standard deviation of 5377 ETB (185.0 USD) signaling a significant variance within the sample.

Table 2. Socioeconomic condition of sample households.

Socioeconomic Variables	Mean (n = 689)	Standard Deviation	Minimum	Maximum
Gender of the respondent (1 = male)	0.77	0.41		
Age of the respondent (years)	47	13.4	19	91
Educational attainment (years of schooling)	2.2	2.9	0	13
Family size	5.55	2.23	1	12
Farm size (in tsimad)	3.41	1.73	0	15
Cattle holding (in TLU)	2.8	1.8	0	14.7
Per capita income in 2018 in ETB (values in USD in parentheses)	6096 (208.8)	5377 (185.0)	207.0 (7.1)	43,232 (1487.2)

4.2. Communal Land Conservation and Food Security

The OLS regression results on the factors affecting food security in general and the association between benefits obtained from communal land conservation and the food security status of farmers in particular are presented in Table 3. As indicated earlier, the paper considers the coping strategies index (CSI) as a proxy variable to measure the food security status of rural households. A higher CSI implies less food security, whereas lower CSI indicate more food security, which does mean a better livelihood condition. The next paragraph presents the linkage between food security status and communal land conservation using community-level data and then proceeds to the household-level regression results.

Table 3. Tabia-level data on the relationship between food security and the conservation of communal lands.

	Study Tabia						
	Kihen	**Mesanu**	**Hadinet**	**Debrebirhan**	**May Kuiha**	**Tsigereda**	**Gemad**
Participation in free labor contribution (% of the total population)	10.7	9.2	12	9.2	11.05	6.6	11.3
Total communal land conserved (% of total area)	15.5	30.9	19.2	35.4	25.9	17.4	29
Coverage of soil and water conservation (% of total area)	41	32	36	65.3	33	55	28.9
Landholding (ha/household)	0.81	0.56	0.79	0.87	0.56	0.8	0.5
Cattle holding (TLU/household)	3.4	2.4	3	3	2.6	2.6	2.8
Average CSI	24.4	21.9	20.06	20.7	20.06	19.4	17.5

The results presented in Table 3 are predominantly community (tabia)-level data that were computed from the raw data obtained from the Kilte Awlaelo woreda office of agriculture and rural development. Kihen tabia is the least food secure since it has the highest CSI of the seven study tabias, while Gemad tabia is found to be the most food secure since it has the lowest CSI. The reason for such discrepancy in CSI across tabias could be associated with variations in the effectiveness of the conservation of communal lands. Socioeconomic conditions and natural and physical capital endowments such as farmland and cattle holdings are the key variables that could explain the variation in the livelihood condition of farmers. However, the results of this study do not support this argument since no significant differences in the socioeconomic variables are observed. The community (tabia)-level data show that Kihen tabia is characterized by relatively better land and cattle holdings yet still a high CSI (Table 3), which conflicts with the assumption that households with larger farmland holding equates with food security. On the other side, the tabia that is found to have the lowest CSI (which is Gemad) from the household survey is also reported to have relatively smaller land and cattle holdings, but a larger proportion of its communal land falls under conserved/protected area than in Kihen tabia. As shown in Table 3, Kihen, the least food secure tabia, has the smallest percentage of conserved communal land: Only 15.5% of its total area falls under conserved communal land, while nearly 29% of the total area of Gemad falls under conserved communal land.

It can, therefore, be argued that despite there being significant differences in physical capital endowments (such as per capita farmland and cattle holdings) across tabias, the variation in food security status among study tabias does seem to be related to variations in effective communal land conservation. This is because higher investment and efforts in the conservation of communal lands may lead to enriching the productive potential of natural and physical capitals such as soil, water, forest, pasture, and other communal resources, all of which could enhance the productivity of the agriculture and livestock sector. This in turn could have brought variations in the food security status of households participating in the current study. In effect, the link between a low CSI but at the same time better performance in the conservation of communal lands suggests that effective communal land conservation is one of the channels for addressing food security problems in rural households. Therefore, the factors that determine the food security status, in this case, could probably be discrepancies in the participation in and effectiveness of communal land conservations.

Table 4 presents the OLS results. The explanatory variables included in the model were the socioeconomic condition of respondents, institutional factors, physical capital, and benefits from conserved communal lands. The paper initially proved whether the data fulfilled the basic assumptions of OLS before executing the regression. After conducting the required diagnostic tests, it was confirmed that the model satisfies all the assumptions except the heteroscedasticity problem. This problem was treated through robust regression. As indicated earlier, the primary interest here is to observe the relationship between food security status and economic benefits obtained from conserved communal lands by controlling the effect of other socioeconomic and institutional covariates. The result of OLS regression shows that 11 explanatory variables had a significant relationship with the food security status measured as the CSI. In what follows, the paper presents and interprets the covariates that were found to be statistically significant.

Table 4. OLS regression results on determinants of food insecurity status.

Explanatory Variables	Coefficient (Dependent Variable: CSI)	Standard Error	*p*-Value
Gender (1 = male)	−0.65	1.97	0.74
Age	−0.15	0.07	0.02
Education	−0.01	0.36	0.97
Family_size	1.7	0.40	0.000
Farm_size	1.07	0.69	0.12
Cattle_holding	−0.10	0.77	0.88
Training	−10.12	1.96	0.000
Disttabia	−0.017	0.04	0.66
Distworeda	0.27	0.10	0.009
Crdtacces	−2.43	1.96	0.21
Irrigation_use	2.77	3.9	0.47
Safety_benef	−3.5	2.16	0.10
Fuel_wood	20.48	5.85	0.001
Animal_fodder	−0.31	2.48	0.9
Hillside	−1.23	4.06	0.76
Beehive	−1.16	4.7	0.8
Good_climate	8.01	2.31	0.001
Water_availability	−4.54	2.16	0.03
Other_uses	20.37	3.7	0.000
Crop_income	−0.0002	0.00008	0.02
Livestock_income	0.00002	0.0001	0.89
Other_income	−0.0002	0.00008	0.01
Constant	15.4	7.02	0.02
Model summary	R^2 = 40.5	Prob > F = 0.000	Number of Obs. 689

The age of the household was found to carry a negative sign, which indicates an inverse relationship between age and CSI. An increase in the age of the household head by one year reduces the CSI by 0.15 ($p < 0.05$) holding other factors fixed. The negative relation between the two variables indicates that elders are more food secure than their younger counterparts. The possible reason for this could be the fact that the physical and natural assets are mostly owned by elders, who have accumulated wealth over time.

Family size was found to have a positive relationship with the CSI. Other factors holding constant, for every additional person, the CSI increases by 1.7 ($p < 0.01$), meaning that households with a larger number of members are less food secure. It is obvious that more members of a given household mean more mouths to feed, which in the absence of sufficient resources could cause food shortage and deprivation.

Participating in natural resources management-related training is negatively associated with CSI. The CSI for individuals who received training is on average lower by 10.2 ($p < 0.01$) than that of those who did not get training if other factors remain constant. According to the KII informants, the topics that the training addressed included the conservation of natural resources, particularly awareness creation on the advantages of hillside and communal land conservations, tree plantation, and soil and water conservation to mention the major ones. The possible reason for this positive effect of training on the food security status of rural households could be through the channel of enhancing the awareness of individuals regarding natural resource management (particularly water, soil, and forest resources) and ultimately could enhance the productivity of land resources.

As shown in Table 4, the CSI increases by 0.27 for an additional km increase in the distance between the residency of the respondent and the woreda center (which is also by default the woreda-level market) ($p < 0.01$).

Households that were entitled to the safety net program were also found to have lower CSI than those who were not entitled to the program. As presented in Table 4, the CSI of safety net beneficiaries is lower by 3.5 ($p = 0.1$). This study confirms that the safety net program is one of the contributing factors to ensuring the food security of rural households through the channel of creating additional employment opportunities for the poor and thereby increasing the income of households. However, it is strange that safety net beneficiaries were found to be more food secure compared with those who do not since the program inherently targets the poorest households. The reason for this odd finding could be either because of less well-targeted safety net beneficiaries against the criterion of the poorest of the poor or because individuals who were once eligible are no longer graduating from the program even if their households show a significant improvement in their food security status.

The OLS regression results regarding the association between communal resource use and the livelihood condition of households are presented in Table 4 and discussed here below. In fact, we will confine our discussion (in the next section) to these covariates, particularly the variables that are related to benefits from conserved communal lands to address the association between food security status and the land conservation.

Households that collect wood fuels from the conserved communal land were found to have higher CSI, meaning they are less food secure than households that do not collect wood. As presented in Table 4, the CSI of households that collect wood fuel is on average higher by 20.48 than that of households that do not ($p < 0.01$), ceteris paribus assumption. This result indicates that relatively food insecure households are more likely to collect firewood from conserved communal lands (the main energy source in rural areas) than the relatively food secure households, which might be able to afford to buy various energy sources including wood fuel from the market, or else they can have their own tree plantation for the purpose of energy and rarely rely on communal land to fetch fuel wood. These findings are also supported by the KII participants. The key informants disclosed that only a few individuals (those who do not have other options) tend to use firewood from the communal land when pruning of trees is undertaken. Similarly, households in the community are allowed to collect small dried bushes but for energy purposes but are not allowed to cut live trees. Thus, it can be argued from the finding that effective communal land resources management can really be achieved if the low-income groups in the community are provided with alternative energy sources to reduce their demand for wood fuels from the communal forests and other communal lands.

Animal fodder was also one of the economic benefits of the conserved communal lands that were included as explanatory variables. Initially, it was expected that a household that collects hay from conserved communal land could be more food secure as it would enhance the productivity of livestock. However, despite the negative relationship between animal forage and CSI, our analysis does not show a statistically significant effect, as shown in Table 4.

Households that obtain other benefits (see the operational definition given for other uses in Table 1) had higher CSI compared with those who do not use. The CSI of households that obtain other uses from the conserved communal land is on average higher by 20.37 than that of those who do not obtain other uses ($p < 0.01$) holding other factors fixed. The OLS result indicates that it is the less food-secure people who are highly dependent on communal land resources for house construction and farm tools.

As part of the survey, households were asked about their perception of the ecological benefits of communal land resources conservation. In this regard, households that perceived that communal land conservation improves groundwater availability had a lower CSI by on average 4.5 in CSI compared with that of those who did not perceive it ($p < 0.05$) when other factors remained constant. In other words, households that perceive communal resources conservation enhances groundwater availability are more food secure than those households that do not have that perception. The possible reason for this could be that individuals who have built positive awareness regarding the ecological benefits of watershed development could implement various land management practices on their own farmlands, backyard, and plantation sites and thus improve their food security status.

CSI was negatively but weakly correlated with different kinds of income including crop, livestock, and off/nonfarm employment incomes. The income from crop production was negatively associated with CSI, which supports the hypothesis presented in Table 1 and also implies a household's greater capacity to withstand shocks. Table 4 depicts that as crop income increases by one ETB, the CSI of the household decreases by 0.0002 ($p < 0.05$) other factors being fixed. Higher income does apparently mean more food security as indicated by our findings. Similarly, other income sources (non/off-farm employment income, remittance, and aid) were found to have positive roles in terms of ensuring the food security of rural households.

4.3. Distribution of Economic Benefits across Various Income Groups

The other key objective of this paper was to examine how the economic benefits (i.e., total incomes) generated from the conserved communal lands are distributed among various income groups in the study areas. Table 5 shows the associations between the various economic benefits obtained from conserved communal lands and the income status of rural households by controlling other socioeconomic covariates. We attempted to interpret only the coefficients of economic benefits from conserved communal lands-related covariates in the QR (Table 5) since that is the prime interest of this paper.

Table 5. Quantile regression results (values in parentheses are standard errors).

Explanatory Variable	Coefficient (Dependent Variable: log(total_ income))		
	QR_25	QR_50	QR_75
Gender (1 = male)	0.175 * (0.099)	0.190 ** (0.089)	0.264 *** (0.055)
Age	−0.000 (0.003)	−0.004 (0.003)	0.006 *** (0.002)
Education	−0.013 (0.014)	−0.011 (0.013)	−0.014 * (0.008)
Family_size	0.013 (0.018)	0.004 (0.016)	0.001 (0.010)
Farm_size	0.112 *** (0.024)	0.138 *** (0.022)	0.087 *** (0.013)
Cattle_holding	0.191 *** (0.022)	0.150 *** (0.020)	0.148 *** (0.012)
Training	0.392 *** (0.085)	0.287 *** (0.076)	0.133 *** (0.047)
Disttabia	0.005 (0.005)	0.012 *** (0.004)	0.009 *** (0.003)
Distworeda	0.005 (0.005)	−0.000 (0.004)	−0.001 (0.003)
Credit	−0.280 *** (0.078)	−0.267 *** (0.070)	−0.247 *** (0.043)
Irrigation_use	0.011 (0.129)	0.028 (0.116)	0.033 (0.071)
Safety_benef	−0.042 (0.082)	−0.169 ** (0.074)	−0.095 ** (0.045)

Table 5. *Cont.*

Explanatory Variable	Coefficient (Dependent Variable: log(total_ income))		
	QR_25	QR_50	QR_75
Fuel_wood	0.065 (0.250)	−0.143 (0.225)	−0.39 *** (0.138)
Animal_fodder	0.067 (0.099)	0.051 (0.089)	0.072 (0.055)
Other_uses	0.24 ** (0.106)	0.227 ** (0.096)	0.179 *** (0.059)
Water_availability	0.075 (0.089)	0.036 (0.08)	0.026 (0.049)
Good_climate	0.206 ** (0.102)	0.228 ** (0.091)	0.376 *** (0.056)
Hillside	0.119 (0.171)	0.151 (0.154)	−0.005 (0.095)
Beehive	0.104 (0.128)	0.159 (0.116)	0.225 *** (0.071)
Constant	8.427 *** (0.292)	9.2 *** (0.263)	9.693 *** (0.162)
Model summary	Pseudo R^2 0.337	Pseudo R^2 0.319	Pseudo R^2 0.32

***, **, * denotes values significant at 1%, 5% and 10% level of significance.

The first economic benefit of communal land conservation is the collection of fuel wood to satisfy farmers' energy needs. As shown in Table 5, the collection of fuel wood was negatively associated with the income of the upper quantile. Households that use fuel wood from the communal lands were found to have 39% lower income compared with those that did not use fuel wood from the conserved communal lands ($p < 0.01$) in the relatively higher income group. However, there were no significant differences between households that do and do not collect firewood from conserved communal lands among the lower and median income earners.

The second notable economic benefit from the conserved land is animal fodder (hay), which is an important element for enhancing the productivity of the livestock sector. The QR result shows that there is no significant difference between the average income of farmers who collect animal fodder from the conserved communal lands and that of farmers that do not collect across all quantiles. The third economic benefit is bee forage, which contributed to the income of farmers through honey production. The study shows that the effect of owning a beehive on income is much higher in the upper quantile. The annual income of households that operate beehive is higher by 22.5% than those that do not operate in the higher income groups but no significant difference in the lower and median quantiles (Table 5).

As reported in Table 5, the annual income of households that collected other uses was higher by 24%, 22.7%, and 17.9% than that of households that do not obtain a benefit in the lower, median, and upper quantiles, respectively. The result indicates that the effect is much higher in the lower quantile and observed relatively low in the upper quantile. This finding confirms that the low-income earners highly depend on the direct use of natural resources generated in conserved communal lands.

The income of households who perceived communal land conservation improved groundwater availability in their locality does not significantly vary with the income of households who did not perceive it across all quantiles. Nevertheless, the income of households that perceived improvement in microclimate varies across the quantiles as compared with that of those who do not perceive the benefit. Table 5 shows that the income of households that felt conserved communal lands improved the microclimate was higher by 20.6%, 22.8%, and 37.6% compared with that of those who did not perceive in the lower, median, and upper quantiles, respectively.

We also attempted to support the findings of the QR using graphs (Figures 2 and 3) to illustrate the benefit sharing across various income groups and for the sake of better understanding regarding which income group/quantile benefited what. The shaded areas show 95% confidence limits of the estimates. In addition, the graphical analysis is more explanatory for comparing the quantile estimates with the OLS estimates and along with OLS confidence intervals. In the graphs, the horizontal dashed lines are the OLS estimates, which are constants, and hence, do not vary with the location on the x-axis (income group). The confidence intervals also appeared as point lines in each graph.

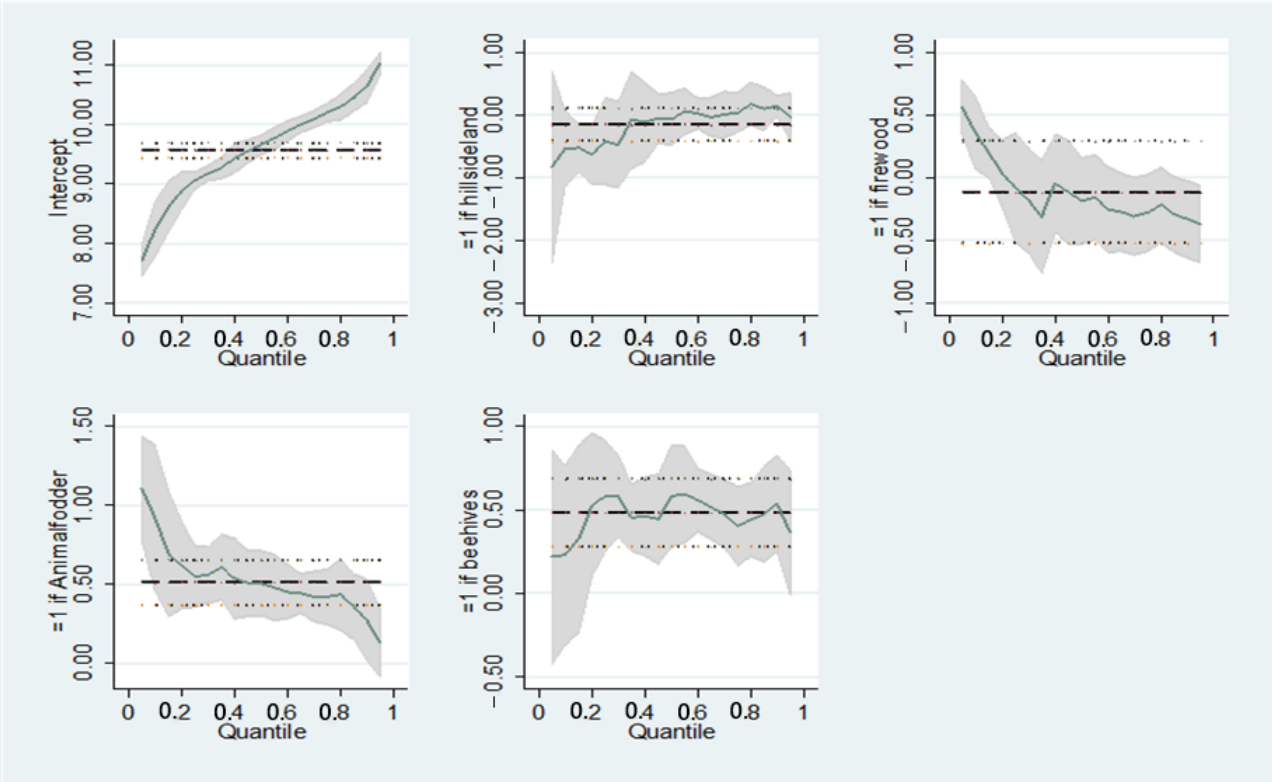

Figure 2. Distribution of economic benefits generated from conserved communal lands across various income quantiles.

As shown in Figure 2, the households in the upper quantile receive more benefits from the hillside distribution. Moreover, households in the median and the upper quantiles tend to engage in beekeeping compared with the households in the lower quantile. On the other hand, households in the lower quantile receive more benefit from the collection of fuel wood and construction materials (thatch), which by extension implies higher reliance on the direct use of CPRs. The firewood is obviously collected to satisfy the energy demand of the households, and thatch is dominantly collected for the purpose of roof cover for both families and cattle as poor people cannot afford to buy iron sheets for roof cover when building a house or building shade. Similarly, regarding the use of animal fodder, the graph shows that despite some variation exhibited around the origin of the graph (lower quantile), a uniform distribution can be observed across the median and upper quantiles, which implies a fair and equitable sharing of the benefit of hay generated on conserved communal lands.

Figure 3 illustrates the relationship between the income of households across all quantiles and their perceptions of the environmental/ecological benefits of the conservation of communal lands. Regarding water availability, the bottom 20% of income earners are found to have a better perception that the conservation has improved the water availability in their locality, while the graph does not show any significant variation in the respondents' perceptions of whether or not conservation has resulted in good microclimate across all the quantiles. Nevertheless, the overall implication of the graph is that there is no significant variation among the respondents regarding the perceived ecological benefits generated from conserved communal lands across all income groups.

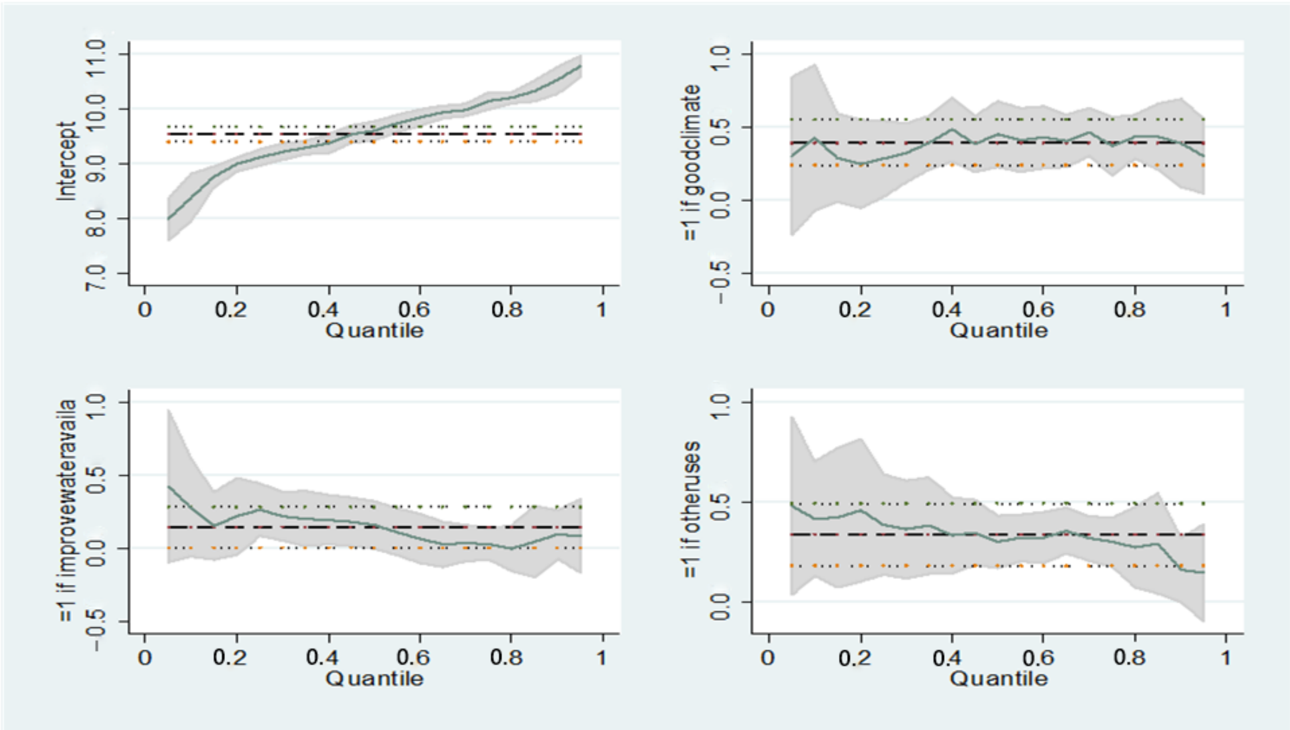

Figure 3. Perceived ecological benefits generated from conserved communal land across various income quantiles.

5. Discussion

The paper finds that there is an association between the food security status (measured in the coping strategy index) and the size of conserved communal lands at the tabia level. More importantly, communal land conservation affects the food security status of households through the channel of enhancing the productive potential of natural capital (soil, water, grasses, and trees) of a community, which in turn contributes to improving the livelihood condition of rural households. Furthermore, the household's food security status was found to be negatively associated with the use of firewood, thatch, and other benefits from conserved communal lands. In fact, the empirical evidence suggests that the contribution of the economic benefits from communal lands to the overall livelihood of rural households remains limited. It is, however, important to note that using the coping strategy index to measure food security is an early attempt, so that it cannot give a complete picture of the food security status of households. Nonetheless, given the stated pitfalls, it is found that poorer households do tend to directly use more firewood and construction materials, while the relatively richer ones do tend to harness more of the indirect benefits generated as a result of the conservation of communal land. The result of the current study is substantiated by the findings of previous research. For instance, a study conducted by Gatiso and Wossen [38] in the Oromia region of Ethiopia finds that poor farmers collect a significant part of their income from the direct use of communal forest resources, in contrast with their better-off counterparts. A study conducted in Colombia by Johnson et al. [39] also supports the finding that communal land conservation improves livelihood options. A similar result has been reported by Pelser et al. [40] where the poor rely more on the direct use of communal resources and also a strong positive correlation between the level of participation of local communities in conservation activities and its livelihood outcomes. On the other hand, a study by Kurian and Dietz [41] reveals that wealthier households benefited more from the management of watersheds when compared with poorer households.

The empirical findings on the distribution of benefits have important implications in terms of understanding the nature of the benefits generated from communal land conservation shared by various quantiles. The nature of benefits received varied across quantiles. For instance, the benefits collected by the households in the lower quantile were more of the direct use of common property resources such as firewood (dried wood of trees) and thatch (for house construction), while households from the median and upper quantile tend to use more communal resources indirectly. The direct use of natural resources that also underpins the livelihood condition could lead to the excessive use of resource rent unless a sustainable utilization policy is implemented. Previous studies reported mixed results in this regard. For instance, in line with the finding in the current study, Gebremedhin et al. [42] reported that cutting and collecting grass for feed and construction is the most common allowed use of resources generated in communal lands for poor households, and Kerapeletswe and Lovett [43] confirm that the poor are more dependent on the direct use of common property resources. On the other hand, households in the upper quantile tend to obtain benefits from the conserved communal lands more through engaging in honeybee production, which in effect promotes conservation rather than constituting direct use. The economic benefits received by the upper-income group do not directly extract the resource rent but promote sustainable development by ensuring economic benefit without resource depletion (meet the twin interests of production and conservation). Contrary to this finding, Narain et al. [44] and Pailler et al. [45] reported that wealthy households benefited more from the direct use of communal resources compared with low earners in India and Tanzania, respectively. Cavendish [46] also reported that poor rural households often derive a significant share of their incomes from CPRs, which is not the case in the current study as the KII informants underlined that the contribution of the benefits from the communal lands to the total income of households remains very minimal. The key informants also disclosed the importance of communal institutions for ensuring proper benefit sharing and conservation of the commons. Practically, however, the already established community bylaws and institutions for managing the communal resources seem to be weak in terms of governing CPRs.

This does not seem to be consistent with the well-known theory of CPR synthesized by Ostrom [13] regarding the role of institutions to govern CPRs, which argues that self-governed communal resources can be managed sustainably, while our study shows the income disparity in the benefits from communal land use. The possible reason for the problem of community bylaws in our study could stem from two possible factors. In the first place, the formulation of community-level bylaws in our study area does not fully comply with Ostrom's [13] principles for managing communal resources prescribed in the theory of CPRs. The second factor is that the applicability of Ostrom's research in contexts other than single resource use is problematic. It is unrealistic to assume that people demand only one use of a resource since rural people tend to collect multiple benefits (such as firewood, feed, and construction materials) from conserved land in the context of our study. The setting in which our study was conducted is different from that of Ostrom's study. That is, much of the empirical work underlying CPR theory, including Ostrom's theory of CPR, has focused on resources that are subject to one single resource use from the pool of communal resources such as forest, fishery, or irrigation. While in our study, multiple resource use from conserved communal lands (mainly fuel wood, livestock feed, and construction materials) was considered.

6. Conclusions and Implications

The household-level data in this study confirm that the food security status of households (measured in CSI) was negatively associated with the use of firewood, thatch and other uses from conserved communal lands. The paper further affirms from community-level data that tabias that are reported to have better performance in communal land conservation were also found to be relatively more food secure. This indicates that the effective conservation of communal lands contributes to enhancing the coping capacity of households towards food and related shortages, which is an early indicator of improvements in the food security status of households. The paper also finds that the nature of the economic benefits received from conserved communal lands varied across various income groups. For instance, the benefits collected by households in the lower quantile are more of the direct use of communal resources such as firewood, animal fodder and other uses such as thatch for house construction and farm tools, whereas households in the median and the upper quantiles tend to engage more in honeybee production (which is an indirect use of the natural resource). Nonetheless, the evidence from key informants shows that the contribution of the benefits from the communal lands to the overall livelihoods of households still remains very minimal and needs some extra years to fully materialize the benefits generated by conservation initiatives.

The results of this study have important policy implications regarding ensuring the sustainable utilization and management of conserved communal lands. The key policy implication is the tradeoff between the consumption and conservation decisions of villagers toward communal resources. The tradeoff in particular is the consequence of the heavy dependence of the poor on the direct use of natural resources and ensuring sustainability by allowing the poor to collect benefits from the conserved lands. On the one hand, the excessive reliance of the local communities on resources from the conserved communal resources may lead to the overexploitation of the resource, making such encroachments ineffective for sustainably conserving the resource. On the other hand, allowing the community to harness the economic benefits generated as a result of conservation may induce people to attach more value to the resource and contribute more to the management and conservation of the communal land-based resources. Moreover, the findings of the current study highlight the path to realizing sustainable governance of the commons. Particularly, our findings give the impression that attaining proper and sustainable benefit sharing of communal resources needs strong community institutions and bylaws as formulated by Ostrom's theory of CPR. It is, however, worth admitting that the contexts in which the theory of CPR works effectively are definitely different from the local conditions in which our study was carried out. For example, unlike the popular theory of CPR, the property right for conserved communal land in our study area is partially defined. Further, the local bylaws established by the community to govern the commons in the study area lack the eight design principles formulated to effectively govern CPRs. As a result, the local institutions are mostly unsuccessful in governing communal resources. Therefore, establishing strong community bylaws and institutions would be a key policy instrument to oversee the governance of natural resources generated from conserved communal lands. This could yield local people more control over resources that are important for their livelihoods and better self-governance. Furthermore, there is a need to implement the proper utilization and management policy of conserved communal lands in such a way that harmonizes the conflicting interests of villagers and eventually ensures a sustainable livelihood.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest: The authors declare that they have no competing interest.

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