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SOCIO-ECONOMIC DETERMINANTS OF SMALLHOLDER FARMERS' COFFEE PRODUCTION IN WOLAITA ZONE, ETHIOPIA

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ABSTRACT

Coffee is the foundation of Ethiopia’s economy with a quarter of the population dependent on coffee production and exports for livelihood. However, most empirical research in coffee production focuses on the productivity factors like yields rather than socio-economic factors that can significantly influence the level of coffee production. Thus, this essay explores the determinants of smallholders’ coffee production in Wolaita zone, Ethiopia by applying the ordered logistic regression model. This model estimates the coffee production status of smallholders by combining the effect of multiple productivity related biophysical and socio-economic factors. Using a multistage sample procedure, two farmers associations from each district were chosen for the research. Overall sample sizes of 250 households were interviewed door-to-door to generate quantitative data. Data was analyzed by using SPSS software and descriptive statistical techniques were applied in order to determine the coffee production status of the farm households. The results indicated that about 88.8% of the smallholder farm households fell under the yield category of ‘low producer’, which is an indicator that numerous variables provide challenges to the smallholder coffee production in the studied area. The results of the regression study showed that of the eighteen variables in the model, seven variables including irrigation access, pruning practice, household farm land size, training access, pesticide utilization, manure application, and cultivated land allocation were discovered to be the important predictors of farm families' coffee production status in the research region. It can be recommended that establishment of government sponsored irrigation systems, empowerment on utilization of appropriate coffee farm technologies and inputs for the areas, enhancing extension services to improve farmers’ skill and knowledge on coffee production system and risk alleviating mechanisms, developing soil fertility mechanisms, establishment of farmers training centers in the vicinities of producers, building capacity of institutions are vital to motivate coffee producers and increase productivity and coffee output in the research area and areas with similar situations.

Key words: coffee, Ethiopia, ordered logit production, yields, smallholder farmers

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INTRODUCTION

Ethiopia, an agriculture-dependent nation, is the birthplace of the world-famous Arabica Coffee and is one of the largest coffee producers [1]. Coffee is the foundation of Ethiopia's economy, with a quarter of the population dependent on production and exports [2]. It represents the major agricultural export crop, providing 20 to 25% of the foreign exchange earnings [3]. The coffee sector contributes about 4 to 5% to the country's Gross Domestic Product (GDP) and creates hundreds of thousands of local job opportunities [4]. Ethiopia is renowned for its wide range of coffee varietals, favourable agro-ecology, and a nation community well-versed in the production and consumption of coffee.

Smallholder coffee production in Ethiopia is a crucial part of the global coffee industry, especially in regions where large-scale production is not feasible [5]. These small-scale farmers, often holding less than two hectares of land, contribute significantly to the production and export of coffee, supporting millions of rural households [6]. Despite its significant contribution to the national economy, rich genetic variety, and ideal climate, the national average yield is 710 kg per hectare of clean coffee [7]. This is very low in contrast to yield levels reported usually in some Latin American countries. The factors attributed to such low productivity include lack of resistant varieties to various diseases and insect pests and poor agronomic practices, access to finance, technical assistance, and market opportunities. Despite facing challenges like poor output, limited resources, and price volatility, smallholders maintain resilience due to their ability to prioritize quality, adapt to market changes, and participate in fair trade initiatives [8].

LITERATURE REVIEW

Smallholder farmers in Ethiopia are known for their family-focused motives, supporting the farm residence system, producing coffee using family labor, and consuming some of the crops for family use [9]. Approximately 95% of the nation's coffee output is held by smallholder farmers with less than two hectares per household, while the remaining 5% is owned by the state [9]. The coffee production system is organic, using no or very small external inputs, and has the lowest yield level per hectare globally.

Numerous studies have explored Ethiopia's coffee cultivation and promotion at national and regional levels, with some focusing on household-level analyses at the regional level [2, 8, 10]. However, these studies often overlook the fact that macro or meso-level coffee production systems do not guarantee household or individual-level production. The available empirical literature on Ethiopia's coffee production system at the household level is limited, addressing issues such as commercialization, technology adoption, quality, diversity, breeding, and the impact of physical barriers like climate change on coffee price, exports, and production. Therefore, these studies cannot serve as a reference for the current situation.

It is generally accepted that smallholder coffee production in Ethiopia depends on species/variety, environmental conditions (soil, rainfall, elevation and slope aspects [11], socio-economic issues landholding size, educational level and gender [12] and institutional aspects (access to credit services and access to market information) [13]. These factors can greatly vary from place to place and household to household, and hence contributing to variations in coffee productivity, yields and production [14]. For example, farmers having access to market information are more likely to increase their production when there is enough rainfall and greater land holding. Conversely, women farmers who have no access to credit services are less likely to boost coffee production, particularly when they have poor fertility soil. Coffee production is, therefore, the result of an interaction of these natural and human issues [15].

Although there are several researches conducted on coffee productivity issues like yields alone at household level in different parts of Ethiopia [2, 8, 10], studies that combine socio-economic drivers influencing smallholder coffee production in Wolaita Zone are scant. Addressing such drivers of smallholder coffee production is essential to improve the quality and boost yield of coffee, determine price issues and marketing as well. Therefore, given the potential of the Wolaita zone for Arabica Coffee, the results of this study are of real importance as they shed light on the determinants of the coffee production by smallholder farmers. This study, thus, fills this gap by investigating the determinants of smallholder farmers' coffee production in Wolaita zone of Ethiopia. In doing so, the study provides two important contributions. Firstly, this study is relevant to add value to the existing literature by assessing policy-relevant socio-economic and biophysical variables that influence coffee production status. Secondly, understanding the different drivers of coffee production status in particular can be of great importance in designing sound policies on coffee value chain development.

METHODOLOGY

Study site

This study focused on the coffee-producing smallholders in the Wolaita zone (Figure 1), located 317 km southwest of Addis Ababa, Ethiopia's capital. On average, it has a total area of 4,541 km2. While the mean monthly temperature varies from 11°C in July to 26°C in February and March, the amount of rainfall is bimodal, averaging roughly 1000 mm [16]. High temperature and high rainfall variability contribute to frequent droughts and flooding, leading to acute food insecurity. In addition, soils (mainly Vertisols and Nitosols) vary in PH from 5-6,

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with most of the ground being acidic, which is poor in fertility. As a result, farmers often use different agroforestry and crop diversification practices to enhance soil fertility. The population of Wolaita is about 2,610,760 with a growth rate of more than 3% per year and average population density of 464 people per square kilometre [17].

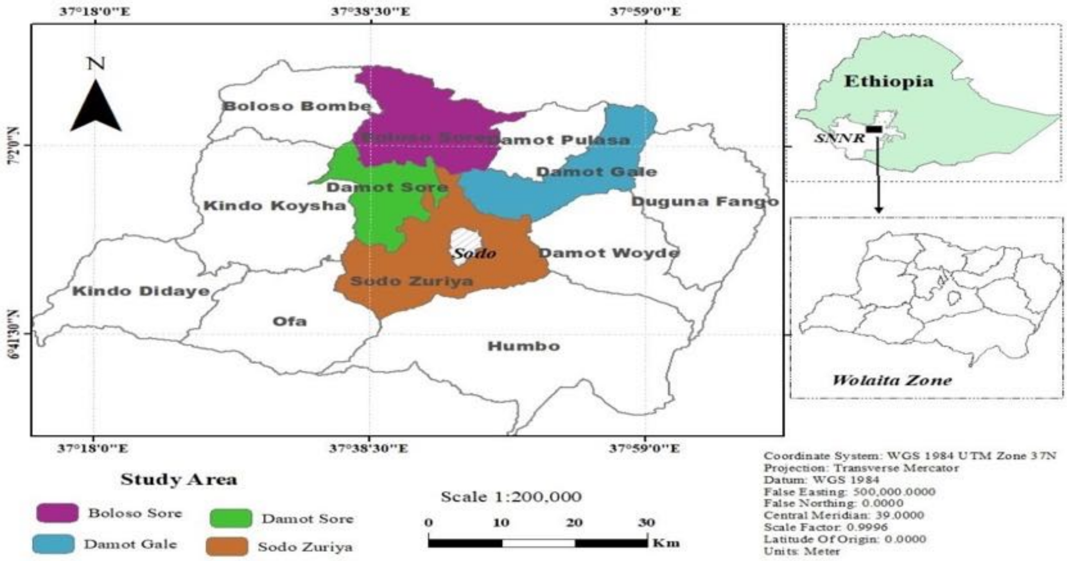

Figure 1: Study Area Map
Source: GPS Map: May, 2020

The Wolaita zone is separated into three agro-ecological zones: *Woina Dega* (mid-altitude, 1500–2300 m), Kola (lowland <1500 m), and *Dega* (highland, >2300 m). According to Ferde *et al.* [18], most of the region is in the mid-altitude zone. In each agro-ecology, coffee is mainly grown by smallholder farmers through a mixed farming system, which accounts for 90% of coffee production [19]. Coffee produced by small-scale farmers typically yields 500 to 600 kg per hectare, while commercial plantations and state farms can yield up to 1200 kg per hectare. Only five per cent of coffee production is grown on modern plantations owned by private investors or the government. The rest is produced by smallholder farmers, and about half of that production is in backyards or gardens. In both cases (modern plantations as well as smallholder production), coffee is generally grown under shade [19]. The biophysical and socioeconomic characteristics of the study districts is described as follows (Table 1)

Sampling technique
The study employed a multi-stage sampling method. Districts were selected purposely in collaboration with zonal and district agricultural and natural resource management offices based on coffee production potential. Among the 12 districts in the zone, four were selected based on the amount of coffee production per year

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(Table 1), the number of smallholder coffee producer households and the participation of farmers in coffee marketing. The districts were selected from higher (1,800–2,000 masl) and lower altitude coffee growing districts (1,200–1,800 masl) [19]. Then, two *kebeles* (peasant associations) were selected from each district (Table 2). The last stage involved a random selection of farmers from each kebele. A total of 250 farm households were drawn from a list comprising small scale-coffee producing farmers as provided by the respective *kebele* offices which formed the sampling size. The sample size was determined using a published table by the University of Florida [20] as the scientific strategy to determine the sample size. Then, the sample size of each *kebele* was determined by dividing the total number of 11764 households producing coffee in the *kebele* by the total number of households producing coffee in the total kebeles and multiplying it by the sample size of the study area (Table 2).

Data collection methods

The questionnaire was pre-tested and validated before the inception of actual work. General information of the respondents like sex, age, marital status, educational level, family size and number of family members engaged in agriculture; crops grown in the study area; coffee production system like varieties produced and experience of implementing improved practices, area covered by coffee crop; coffee production problems like biotic factors such as disease, insect pests, vertebrate animals, common and invasive weeds, abiotic (environmental factors) such as drought, rainfall, soil fertility, wind, flooding, et cetera technical constraints and their management techniques were collected. Trained enumerators administered the survey, and the researcher supervised the fieldwork daily to ensure enumerators' compliance with established survey procedures. The field survey occurred within three months, from April to July 2020. Secondary data were collected from unpublished and published documents of zonal and district agricultural and natural resource management offices.

Analytical framework

Field-based coffee yield estimations

Various methods have been applied to estimate coffee yield in smallholder farmer's contexts [21]. Self-reported measures of coffee yield estimations are usually collected pre-harvest (farmer predictions) or post-harvest (farmer recall), with most statistical systems in sub-Saharan Africa relying on the latter. Inherently subjective and conditional on farmers' experience and education, this method is also susceptible to recall bias [22]. Such methods may lead to over or under-estimating actual coffee yields per hectare or plant. This study, therefore, employed the field-based coffee yield estimation based on farmer recall using previous yield information on coffee post-harvest. However, every precaution was taken to

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address these possible drawbacks. The research participants i.e. the farmers as well as the extension agents who served as data enumerators were trained so that they would have adequate orientation about the research objectives and procedures prior to the field survey. All of these steps were taken with the utmost care to maintain fair accuracy in the data collection and assessment process. Model farmers were chosen based on their relative knowledge, previous engagements in action research, experience, and precision in yield estimation.

Model specification

Several econometric models have been applied to predict the determinants of production status of coffee [19]. Notable ones are binary logit models and multinomial logistic models when there are two or more categories. In our case, however, the level of coffee production has the ordered category. Hence, we applied ordinal logistic regression (OLR) by assuming ordered categories of average coffee yield points per *quintal* as low, medium, and high.

Following Gujarati [23], the functional form of the ordered logistic regression model is specified as given in Equation 1 as follows:

$yi *= \beta xi + \varepsilon i - \infty < yi^* < -\infty$...1

Where;
yi^*: household coffee production status
βi: Vector of parameters that should be estimated
x_i: Observed vector of non-random explanatory variable which shows the characteristic of the household
ε_i: Residual error, which is logistically distributed.
y* = is unobserved and thus can be thought of as the underlying tendency of an observed Phenomenon. ε = we assume it follows a certain symmetric distribution with zero mean such as normal or Logistic distribution. What we do observe is:

$y = 1$ if $y^* \leq \mu_1$ (=0) 2
$y = 2$ if $\mu_1 < y^* \leq \mu_2$
$y = 3$ if $\mu_2 < y^* \leq \mu_3$
$y = j$ if $\mu_{j-1} < y^* \leq \mu_j$
Where y is observed in j number of ordered categories, μs were threshold parameters separating the adjacent categories to be estimated with βs.

The general form for the probability that the observed y falls into category j and the μs and the βs are to be estimated with an ordinal logit model is:

$$\Pr ob(y = j) = 1 - L\left(\mu_{J-1} - \sum_{k=1}^{k} \beta_k \chi_k\right) \quad \text{...3}$$

Where L (.) represents cumulative logistic distribution.

The dependent variable included in the model in this study was coffee production status of smallholder farmers in the study area which was obtained from the survey data collected. This study analyzed smallholder coffee production status over three years, using the median as a better indicator of central tendency in a skewed distribution [24]. The interquartile range, a skewed distribution, is used to classify data into quarters (Q1, Q2, and Q3), with the lowest quarter in Q1 and the highest in Q4 [25]. The study uses a skewed response variable and classifies coffee production in the area as low, medium, or high, with values below the median indicating low production in Q1, medium production in Q2, and high production in Q3. The study categorizes coffee varieties into low, medium, and high yield levels, aiming for optimal production statistics in the study area, as widely applied in agricultural production and yield estimation research [26]. The independent (explanatory) variables were obtained from the survey data (Table 3).

RESULTS AND DISCUSSION

Demographic and socioeconomic characteristics

The results of farmers' socio-economic and demographic characteristics show that from the total 250 farm households interviewed in the districts, 83.2 % were male-headed whereas 16.8 % were female-headed (Table 4). This difference may be attributed to cultural norms which give family leading roles to men and child care and house chores to women.

The vast majority of counts with sex, total 222 (or 88.8%), fell under the 'low' producing category. But, the comparison within the sex of the farm households with respect to their coffee production status indicated that there is a relative difference between the two sexes. Male headed households did overweigh upon their counterparts portrayed with considerable value differences of (8.4%) and (16.8%), respectively. The result of this study is in agreement with the results of the previous researcher [27]. The possible implication for this may be, in most cases, male-headed households have better access to agricultural information and are more likely to adopt new technologies for coffee production than the females. Women farmers are often forgotten in official agricultural statistics.

Regarding the distribution of coffee production status with respect to the age of the farm household heads, the median value of 4.80 in the box plot (Figure 2) represents the middle point of the distribution of coffee production status across the continuum of indices ranging from the highest to the lowest values.

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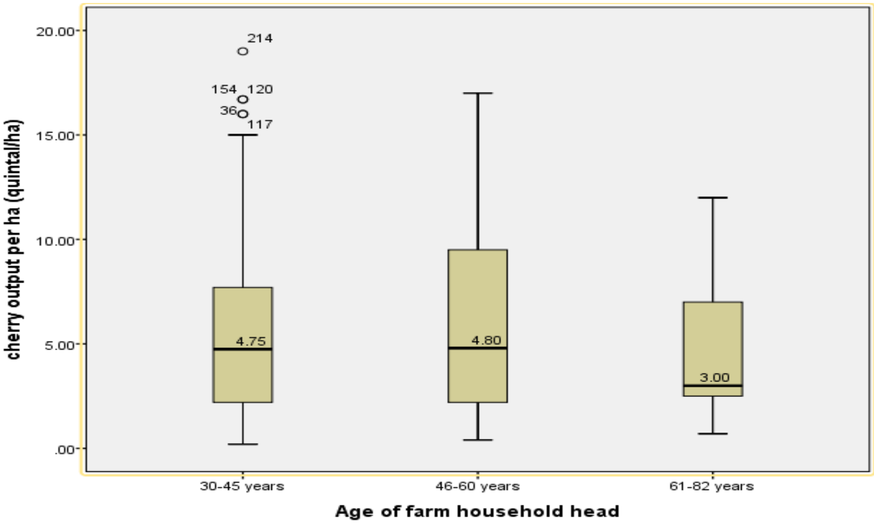

Figure 2: Age distribution of respondents with their coffee production status

Coffee production status is the highest for household heads aging from 46 to 60 years, followed by 35 to 40 years old, and by 61 to 82 years as the last category, with median values of 4.80, 4.75 and 3.00, respectively. This indicates that more than half of the farmer participants of the study was in a productive age range.

Another social characteristic of the farmers that worth noting about is their educational status. As the result shows (Table 5), the vastest majority of the farmers are literate with 128 (51.2) out of 250 having schooling status up to ‘primary school’, and 55 (22%) educated up to ‘secondary school and beyond’; totalling 183 (73.2%) of the sample farmers were educated. This finding opposed to what [28] reported in his study. But, still considerable size (67 (26.8%)) of the farm household heads were found illiterate. Thus, these group of the household heads should be given due attention as a low educational status is among the factors limiting farmers’ production capacity and efficiency.

With respect to the association between land ownership and farmer’s coffee production status, the results indicated that the largest portion of farm households (68.8%) who were having the smallest land size (ranging from 0.1-0.5 ha) were found to be with the lowest production status. Furthermore, there is a highly significant difference in coffee production status (P=0.000) within the farmers holding different ranges of land size for home garden coffee production in the study area. Results of this study (Table 6) endorsed this fact in that the mean farm land holding of the households was 0.48 ha. Adesiji *et al*. [29] have reported an average land size of small-scale farmers in Nigeria is as low as 1 hectare.

Coffee varieties and farmers’ agronomic practices

Regarding the agronomic practices of coffee production management, the farmers were asked various questions. The results indicated that the major coffee varieties being grown in the study were *Moriya, Mikiya, Arumya, Gassa* (local names for Arabica Coffee Varieties) due to their production potentials, marketability, their flavour or taste and resistance to major coffee diseases. However, the majority of the farmers (67.2%) were still dependent on the traditional varieties *Arumya* and *Moriya* that are relatively better yielding and susceptible to the major coffee diseases. From the two, *Moriya* is more disease susceptible as compared to others under similar management and weather conditions friendly.

A high proportion of farmers (59.3%) had practiced a change of cycle on their coffee trees in the last ten years. Annual coffee pruning was a popular practice adopted by 98.4% of the farmers but tree capping was not a common practice as only 15.4% of the farmers were practicing it. The vast majority of the farmers (94.4%) maintained 2 heads per stem as recommended. Regarding their pruning techniques, it was responded that, if it is stumping of aged trees, it is once a year after complete harvesting of fruits. Other routine pruning types can be done as per needed and two/three times a year. Half of the farmers practice stumping each year.

According to the key informants, coffee is a perennial tree crop with biennial bearing habit, particularly homestead coffee trees are characterized by such bearing type-one-year high yield, then another year low yield. It was also reported that in *Qolla* agro ecological zone of Wolaita, the production system is characterized by coffee-fruit crops- tree due to: moist and warm climate, the practices of planting different multipurpose trees which are used as coffee shade and fruit trees are very common; in *Woyna dega* and *dega* agroecology mainly *enset*-Coffee-Tree and *enset*-tree system is practiced because, *enset* provide source of food, coffee for income /cash/, cassava and taro supplement the household food consumption and also it has economic, cultural and environmental benefits.

Factors affecting farmer's coffee production status

Diagnostic Tests

Goodness of Fit and Deviance: Table 7 details model fitting quality, detecting model failures using a goodness of appropriate test. The data shows the saturated model's best fit, a complex model with distinct parameters for each observation.

According to the statistically significant Chi-square statistic ($p<0.001$), the ultimate model significantly outperforms the baseline intercept alone model. This indicates that the model's predictions exceed those made using the outcome categories' marginal probabilities as a guide.

Econometric results

Table 6 presents the determinants of home-garden coffee production among small-scale producers. The coefficients are discussed using the ordered logit model, with p-values indicating significance level. Sign and category interpretations are used to interpret the coefficients, with positive coefficients enhancing the likelihood of high production status.

The logit regression analysis shows a significant positive relationship between seven variables: irrigation schemes, pruning coffee trees, training access, pesticide use, organic fertilizer use, land allocation, and farm household ownership.

Irrigation access (IRRIG): based on the results presented in Table 4, Irrigation practices like ponds and river diversions significantly improve coffee yields per hectare, with a 36.72% increase in annual production. Farm households with access to water sources and irrigation facilities are more productive in home-garden coffee production. This is due to the ability to adapt to climate variability and higher frequency of coffee productions. This aligns with Kamau *et al.* [30] findings that water access points and irrigation utilization are essential for coffee-producing farmers in Kenya.

Pruning (PRUNN): The study found that pruning significantly increases coffee cherry production in the study area. Pruning is crucial for proper development of fruit-bearing branches. A unit increase in coffee pruning experience increases home garden coffee production by 17.11%. This aligns with previous studies indicating that basic-shaped pruning, including topping and eliminating dead branches, leads to increased cherry production [31].

Land size (LANDSIZTOT): The study reveals that a 59.52% increase in coffee production can be attributed to a hectare increase in farmland size. This is because larger land sizes can allocate more land to coffee production, leading to increased productivity and adoption of new technologies. However, studies have found that land size negatively impacts coffee and maize productivity. Additionally, land tenure and ownership also have a positive impact on coffee productivity [32].

Training access (TRAINING): Access to training on coffee agronomy and marketing significantly impacts household annual coffee production. Better training leads to increased home-garden coffee production, enhancing efficiency by 18.3%. This finding aligns with previous studies showing that training positively affects smallholder farm households' productivity [9].

Pesticides (PESTICIDE): The study confirms that pesticide application on agricultural coffee plants significantly influences coffee production. A 1% increase in pesticide application would increase annual coffee production by 11.58%. This is

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due to the ability of smallholder farmers to manage pest risks, leading to increased productivity. This aligns with previous research on coffee disease protection, as proper pesticide application also contributes to yield increment [9].

Manure (MANURE): Most farmers do not adopt recommended rates for coffee production efficiency, but most have no significant effect on productivity except for manure and pesticides. This is due to their focus on output maximization. Organic manure significantly increases coffee productivity by increasing plant height and stem thickening. Organic soil fertility management improves soil properties, moisture retention, and microbial activity. However, inappropriate application rates can negatively affect maize productivity [33].

Cultivated land allocation of coffee plants (COFFELAND): The study found that farm size significantly influences household coffee production. A 1 hectare increase in coffee land size increased output by 30.19%. This indicates that farmers with larger farms are more likely to produce coffee, confirming the importance of land size in agricultural production. This supports the study by Karthikeyan [34], which suggests that land size is a crucial factor for household coffee production.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

This study examines factors affecting coffee production status of smallholder farming households using an ordered logistic regression model. Based on the study findings, several factors found to have a significant effect on smallholder coffee production status. The null hypothesis that access to irrigation water does not affect coffee yields per hectare was rejected, and the alternative hypothesis of a significant effect of irrigation water on the probability of improving coffee yields was tested. The results showed that the use of pesticides, pruning, and organic manure is likely to improve farmers' coffee yields. Farmers who use pesticides and adopt different pruning systems along with the application of organic manure are more likely to improve their coffee yields. Hence, our findings support the hypotheses that the use of pruning, organic manure, and pesticides has a positive and significant effect on the likelihood of improving coffee yields.

The study also explored the effect of total cultivated land size on the coffee production status of farming households. The null hypothesis that there is no significant effect of increased landholding on the coffee production status was rejected, and the alternate hypothesis that there is a significant and positive effect of increased land size on the probability of coffee production status was tested. Farmers with large cultivated landholdings are more likely to improve their coffee production status compared to farmers with smaller landholdings. Hence, the

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findings support the hypothesis that increased landholding is more likely to increase coffee yields.

Implications of the study include the promotion of irrigation water as a priority to improve coffee yields per hectare in Wolaita, maintaining stable and sustainable production on coffee plantations by meeting crop water requirements. Additionally, the use of organic manure, pesticides, and pruning has a significant and positive effect on improving coffee yield per hectare.

This study has focused on the effect of multiple socio-economic and biophysical variables on coffee yield as a sole production factor. This study did not analyze how coffee yields are determined by environmental issues like rainfall and droughts that determine the yields per hectare. The study categorized yield measures into many different categories based on the defined criteria. The study did not analyze how the discrete value of the coffee yields per hectare against the predefined variables. This might have drawbacks for the quality of results obtained through model estimation. Despite such drawbacks, the study provided sufficient evidence to establish conclusions based on the research findings and draw implications. Further research may be needed to elucidate the effect of demographic variables such as gender and social participation on coffee production status.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Table 1: The biophysical and socio-economic setting of the study districts in Wolaita zone

Major features	Study Districts Boloso Sore	Damot Sore	Damot Gale	Sodo zuria
Biophysical				
Latitude (⁰)	7_05_N	7_03_N	7_00_N	6_50_N_
Longitude (⁰)	37_40_E	37_35_E	37_50_E	37_45_E
Altitude (⁰)	1300-2200	1300-2200	1300-2300	1400-2350
Major agro-ecological zone	Sub-humid semi-arid	Sub-humid	Humid and Sub-humid	Humid and sub-humid
Mean annual minimum temperature (⁰C)	13. 79	13	16	18.6
Mean annual maximum temperature (⁰C)	25.07	22	23	24.5
Average *annual* rainfall (mm)	1324	1200	1400	1250
Soil type	Clay soil	Silt and clay loam	Clay soil and humic nitisols	Eutric nitisols
Socio-economic				
Coffee cultivars	Improved	Improved and land race	Improved	Improved
Cropping system	Mixed with enset	Mixed with maize, enset	Mixed with enset, Banana	Mixed with Banana
Pruning practice	Prune	Prune	Not pruning	
Coffee seedling sources	Seedling stations	Seedling stations	Seedling stations	Seedling stations
Disease occurrence	Occurs frequently	Occurs sometimes	Not reported	Occurs sometimes
Time of berry harvesting	Green and red berry	Green berry	Red berry	Green and Red berry
Coffee drying system	Locally by sun and sell wet processing companies	Majority dry locally by sun	Majority sell to wet processing companies	Locally by sun and sell wet processing companies
Coffee marketing	Local market	Regional and national market	Local market	Regional and local market
Total population of the district	279,218	131,078	467,245	200,911

Sources: Office of Finance and Economy, Wolaita zone (2020)

Table 2: Distribution of sample households by peasant association

District	*Kebele*	*Household size*			*Sample size*
		MHHHs	FHHHs	Total	
Boloso Sore	Chama Heimbecho	1500	260	1760	37
	Gurmo Koysha	1303	412	1715	36
Damot Sore	Sunkale	1037	144	1181	25
	Doge Hanchucho	962	184	1146	24
Damot Gale	Kuto Sorfela	1277	168	1445	31
	Tome Gerera	1260	158	1418	30
Sodo zuria	Harto Burkito	1160	171	1331	28
	Buge	1558	210	1768	38
Total		10057	1697	11764	250

Sources: Office of Finance and Economy, Wolaita zone (2020)

Table 3: Description of explanatory variables used in the model

Variable	*Measurement*	*Hypothesis*
Age	Continuous (years)	+ve
Sex	Dummy 1= male, 2= female	-ve
Education	Continuous (school years)	+ve
Family size	Continuous (number)	+ve
Land holding	Continuous (hectare)	+ve
Farm experience	Continuous (years)	+ve
Participation	Dummy 1= if social participation, 2= otherwise	+ve
Labour	Dummy 1= if family labour, 2= otherwise	-ve
Irrigation	Dummy 1= if there is access, 2= otherwise	+ve
Credit	Dummy 1= if there is access, 2= otherwise	+ve
Training	Dummy 1= if got training, 2= otherwise	+ve
Extension contacts	Discrete (frequency of extension contacts)	+ve
Mass media	Dummy 1= if owns radio, 2 otherwise	+ve
Fertilizer	Dummy 1= if introduces chemical fertilizer, 2=otherwise	-ve
Cultivated land	Continuous (hectare)	+ve
Pruning	Dummy 1= if experiences pruning, 2=otherwise	+ve
Manure use	Dummy 1= if utilizes organic manure, 2=otherwise	+ve
Pesticides	Dummy 1= if utilizes pesticides, 2= otherwise	-ve

Source: own observations and empirical literature review

Table 4: Sex of the respondents with household coffee production status

Sex	*f (% of total)*	*Coffee production status*			*Pearson Chi-Squ.*	*p-value*
		Low	Medium	High		
Male	208 (83.2) *	183(73.2)	4(1.6)	21(8.4)	1.219a	0.544
Female	42 (16.8)	39(17.6)	0(0)	3(16.8)		
Total	250 (100)	222(88.8)	4(1.6)	24(9.6)		

*The values in the parenthesis indicate the % of total and % within production status
Source: Own survey, 2020

Table 5: Education level of the farmers with their coffee production status

Educational status	*f (% of total)*	*Coffee production status*			*Pearson Chi-Square*
		Low	*Medium*	*High*	
Cannot read & write	67 (26.8) *	53(21.2)	2(8)	12(4.8)	9.281*
Primary school	128 (51.2)	51(20.4)	0(0)	4(1.6)	
2ndary school & above	55 (22)	118(47.2)	2(0.8)	8(3.2)	
Total	250 (100)	222(88.8)	4(1.6)	24(9.6)	

*The values in the parenthesis indicate the % of total and % within production status
Source: Own survey, 2020

Table 6: Distribution of land size by household coffee production status

Land size (ha)	*f (% of total)*	Mean (SD)	Coffee production status			*Pearson Chi-Square*
			Low	Medium	High	
0.1-0.5	172(70.4)	0.48 (0.46) *	172(68.8)	0(0)	4(1.6)	59.1^{a***}
0.6-1.0	51(20.4)		31(12.4)	4(1.6)	16(6.4)	
1.1-1.5	15(6)		13(5.2)	0(0)	2(0.8)	
1.6-2.0	8(3.2)		6(2.4)	0(0)	2(0.8)	
Total	250(100)		222(88.8)	4(1.6)	24(9.6)	

Source: Own survey, 2020

Table 7: Model fitting information (Omnibus Test[a])

Model	-2 Log Likelihood	Chi-Square
Intercept	486.505	
Final	390.938	95.567***

Link Function: Logit. Source: Survey data (2020)

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Table 8: Parameter estimates of the ordered logistic regression

Variables		Parameter estimates			
		Coefficients	Std. Error	95% Wald Confidence Interval	
				Lower	Upper
status	Low= 1	61.937***	1.1001E5	215561.053	215684.927
	Medium= 2	62.337***	1.1001E5	215560.653	215685.326
co-variants	AGE= 1	-0.097	1.8583	-3.740	3.545
	AGE= 2	0.902	1.7035	-2.437	4.241
	AGE= 3	0[a]	.	.	.
	SEX= 1	-1.372	1.3409	-4.000	1.256
	SEX=2	0[a]	.	.	.
	EDUC= 1	1.148	0.9945	-0.802	3.097
	EDUC= 2	1.310	1.0837	-0.814	3.434
	EDUC=3	0[a]	.	.	.
	FARMEXP=1	19.260	4.1791E4	-81889.662	81928.181
	FARMEXP= 2	16.767	4.1791E4	-81892.154	81925.689
	FARMEXP= 3	16.813	4.1791E4	-81892.108	81925.734
	FARMEXP=4	5.282	5.0402E4	-98781.371	98791.934
	FARMEXP= 5	0[a]	.	.	.
	SOCIAPART= 1	18.076	2.4745E4	-48480.627	48516.778
	SOCIAPART= 2	0[a]	.	.	.
	LABOUR=1	19.226	6.9798E4	-136782.873	136821.324
	LABOUR= 2	0.915	9.8710E4	-193466.644	193468.473
	LABOUR= 3	0[a]	.	.	.
	IRRIG= 1	3.672**	1.9526	-7.499	0.155
	IRRIG= 2	0[a]	.	.	.
	PRUNNG=1	1.711*	1.3770	-0.987	4.410
	PRUNNG= 2	0[a]	.	.	.
	CREDIT= 1	0.496	1.5397	-2.522	3.514
	CREDIT= 2	0[a]	.	.	.
	TRAINING= 1	1.830**	1.1151	-0.355	4.016
	TRAINING= 2	0[a]	.	.	.
	EXTCONT=1	0.120	0.9176	-1.678	1.919
	EXTCONT= 2	0[a]	.	.	.
	MEDIACC=1	0.026	0.9465	-1.829	1.881
	MADIACC=2	0[a]	.	.	.
	PESTICIDE	1.158*	2.1461	8.364	1.048
	MANURE	4.760**	2.1492	7. 52	0.972
	COFFELAND	3.019**	2.3652	4.655	0.617
	FERTLIZAPP= 1	-0.817	1.0214	-2.819	1.185
	FERTLIZAPP= 2	0[a]	.	.	.
	HHNUMB	-0.078	0.1445	-0.361	0.205
	FARMSIZTOT	5.952**	2.4223	10.699	1.204

Note: ***, ** and * significant at 1%,5% and 10% probability levels, respectively. Link function: Logit. [a]This parameter is set to zero because it is redundant. Source: Survey data (2020)

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