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## Article

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Determinants of farm livelihoods of smallholder farmers in Yayu biosphere reserve, SW Ethiopia: a gender disaggregated analysis

Beneberu A. Wondimagegnhu<sup>1</sup>, Admassu T. Huluka<sup>2</sup> and Sarah M. Nischalke<sup>3</sup>

**Abstract:** Improving food security has remained to be one of the major challenges in Sub-Saharan Africa, where Ethiopia is not an exception. As a result of poor productivity of the farming sector, smallholder farmers in Ethiopia have been strained to have a precarious livelihood. This study aims at analyzing the determinants of farm livelihood of smallholder farmers particularly in the context of Yayu biosphere reserve, where farmers are legally prohibited from expanding farmland and wild animals often intrude into the farmers' field. A household survey was conducted to collect gender disaggregated data from 334 smallholder farmers supported by focus group discussions and key informant interviews. T-test mean comparison was made to compare socio-economic and household characteristics between male and female-headed households. Tobit regression analysis was also employed to capture the probability and extent of determinant variables in predicting the engagement of households in farm livelihoods. The result shows that augmented production factors, particularly farm physical capital and land along with access to credit, yield enhancing inputs and local labor support systems were found to significantly increase the intensity of engagement in farming both in male and female-headed households. Encroachment of wild animals to the farmers' field brought insignificant effects on farm livelihoods. However, it



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### PUBLIC INTEREST STATEMENT

Agriculture is the backbone of the Ethiopian economy and the source of livelihoods for the majority of the population. Although the agriculture sector is the key source of growth, its performance remained underdeveloped and it is dependent mainly on smallholder farming. Smallholder farmers have subsistence livelihoods where they practice farming in traditional way with limited application of agricultural technologies. As a result, farmers have been struggling to meet their food needs and sustain their livelihoods. Understanding and identifying the determinant factors influencing livelihoods of smallholder farmers would be thus imperative towards designing suitable and sustainable livelihood policies. Therefore, the study identified determinant factors influencing the farm livelihoods of male and female farmers particularly from the perspective of livelihoods in Yayu biosphere reserve. The findings of the research could be used as source of information for policy makers and development practitioners in designing appropriate policies and interventions.

brought additional burdens on farmers as they are expected to patrol their fields regularly. The findings implied that farm livelihood is highly dependent on ownership and efficient use of scarce production factors. These call for sustainable and integrated approaches to improve the future productivity of smallholder agriculture in Ethiopia.

**Subjects:** Development Studies; Rural Development; Economics and Development

**Keywords:** farm productivity; farm livelihood; production factors; gender; Tobit regression; biosphere reserve; SW Ethiopia

## 1. Introduction

Smallholder farming is the key driver of many economies in Africa. However, the potentials of smallholder farmers are not often recognized and the farming sector remains vulnerable for various challenges in Africa (DCED, 2012). As the case in many sub-Saharan African countries, Ethiopian agriculture is also among the most vulnerable ones. The majority of agricultural production in Ethiopia is carried out by smallholder farmers. The study from Gebreselassie and Bekele (2013) indicated that about 94% of the food crop production and 98% of coffee production is undertaken by smallholder farmers. The large private and state companies constitute only 6% and 2% of the food and coffee production, respectively. Smallholder farmers in Ethiopia mainly drive their income from agricultural production, which comprises mainly the crop and livestock sectors. Crop production is the dominant sub-sector accounting for about 60% of the agricultural GDP whereas the livestock sector contributes 20% of the agricultural GDP. The rest of the sub-sectors such as fishery, forestry, and hunting contribute to about 20% (Demeke, Guta, & Ferede, 2004). The agriculture sector of Ethiopia, in general, contributes for 38.8 % of the national GDP and the main source of livelihood for 77.3% of the labour force (Zerihun, Wakiaga, & Kibret, 2016).

Although smallholder farmers in Ethiopia are expected to feed the growing population of the country, they are constrained by a number of challenges that hamper their ability to ensure food security for the majority of people. As a result, the country has been regarded as one of the most food insecure countries in the world with some 10.2 million people are food-insecure (FAO, 2016). Various factors have been responsible for the low productivity of the farming sector in Ethiopia. Among the major factors, unprecedented population growth, with an average increment two million people annually, is a great challenge to the economy's ability to feed the population and provide proper services. It is a cause for fragmentation of land holdings and reduction of productivity causing massive underemployment (Teshome, 2014). In addition, land degradation coupled with traditional cultivation practices, erratic rainfall, diseases and pests, mismanagement of land resources and drought have posed a serious threat to households' food security and agricultural productivity in the country. The livelihoods of smallholder farmers depend mainly on small-scale farming where 64.5% of them possess less than a hectare of land (Gebreselassie, 2006). Moreover, smallholder farmers are constrained by low yields, low productivity and lack of access to markets including credit markets. Access to credit has also been among the most important factors particularly for investment in improved agricultural inputs (Mersha & Ayenew, 2018). Smallholder farmers are the primary victims of the challenges. As a result, they are enforced to diversify their income to non-farm sectors to avert the risk of agricultural production and supplement their income to attain food security. However, the existence of limited non-farm opportunities and insufficient income obtained from non-farm activities have made the rural poor more vulnerable. Farming still remains to be a key sector of employment in Ethiopia (Davis & Bezemer, 2004).

Several evidences show that women play a vital role in agricultural production in Africa (DCED, 2012; SOFA & Doss, 2011; Manjur, Amare, Hailemariam, & Tekle, 2014; Ogato, Boon, & Subramani, 2009). Thus, gender differences could also influence farm livelihoods as the choice of livelihoods depends largely on culturally defined roles, social mobility and on access and ownership of capital

and assets. Men and women have different access to inputs, new technologies, education, health-care, and other resources. Furthermore, the productivity of the livelihood options is influenced by who decides what to produce, when to produce and how much to produce. These imply that gender disaggregated approaches have paramount importance to identify the determinants influencing livelihoods among male and female-headed households and target policy interventions accordingly.

The research was conducted in Yayu biosphere reserve, which is a protected and UNESCO registered biosphere reserve in Ethiopia. Smallholder farmers living in the transition zone of the biosphere reserve have a different scenario in terms of livelihood options compared to other farmers living in other parts of the country. Smallholder farmers in the area are legally prohibited from entering the protected areas of the forest, and thus they are not able to expand their farmland and unable to utilize other alternative livelihood options in the forest. As a result, the available farmland in the transition zone is continuously being fragmented due to the growing population in the area. In addition, the encroachment of wild animals to the farmers' field might have its own contribution in influencing the farm livelihoods. All these factors have created a unique circumstance to identify the actual determinants of farm livelihoods in the biosphere reserve. Very limited empirical studies exist on determinants of farm livelihoods particularly from the context of smallholder farmers residing in and around biosphere reserves. In addition, gender disaggregated analysis for such type of studies is almost nil. Therefore, the study aims to contribute to gender disaggregated empirical analysis on how to farm livelihoods of male and female farmers could be influenced in areas where biosphere reserves exist. Unless location-specific determinants of farm livelihoods are identified at the micro-level, it would also be difficult to design appropriate livelihood policies. Therefore, the study also serves as a research input for designing appropriate policies and strategies that contributes to ensuring sustainable livelihoods.

## **2. Literature review**

### **2.1. Definition of smallholder farmers**

Smallholder farmers could be defined as “those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour”. Smallholder farmers differ from the rest of farmers in the agriculture sector in terms of their limited resources. Smallholder farmers in Sub-Saharan Africa utilize simple and outdated agricultural technologies and cultivate small plots of land (DCED, 2012, p. 1).

### **2.2. Determinants of farm livelihoods in sub-saharan Africa**

The farming sector in Sub-Saharan Africa is one of the mainstay and means of livelihood for the majority of the population. However, the performance of the sector has remained underdeveloped. Almost 33 percent of the population in the region is found to be undernourished (FAO, 2005) and calorie consumption levels are also reported to be the lowest of any other region in the world (Kariuki, 2011). In addition, the agriculture sector is dependent on erratic rainfall and practiced in a traditional way. The report from the International Water Management Institute (IWMI, 2010) indicated that about 95% of agricultural land in sub-Saharan Africa is cultivated using seasonal rain.

There are a number of factors that determine farm livelihoods of smallholder farmers in Sub-Saharan Africa. Poor agricultural yields as a result of declining agricultural performance could be mentioned among the major problems negatively influencing the African smallholder farming (DCED, 2012). There are several determinant driver forces behind these challenges. A number of empirical studies indicated that land is an important production factor determining the farm livelihoods of smallholder farmers in Sub-Saharan Africa. Empirical evidence from Ghana and Uganda by Newman and Canagarajah (2000) confirmed that land ownership had been one of the most important factors influencing the farming livelihoods of smallholder farmers. The same study also found that women farmers were the disadvantaged groups in owning land and as

a result, there has been a tendency of engagement in non-farm livelihoods. Other studies such as Kariuki (2011) also confirmed the strong relationship between farm livelihoods, ownership and entitlement of land in Africa. Yahya and Xiaohui (2014) on their study conducted in east Tanzania confirmed the positive relationship between farm size and food security status of smallholder farmers. A percentage increase in access to resources such as land and physical capital increases the probability of a rural household being food secured by 3.448 times. The same study found that female-headed households were constrained to ensure the food security of their family due to their limited access to land and capital. Another study from Kassie, Kim, and Fellizar (2017) conducted in Gozamin district of Ethiopia found that farmland has a significant and positive effect on agricultural income. The same study found that a 1% increase in the size of land leads to increase of farm income by 0.30%. Similarly, the findings from Kussa (2012) in Amhara, Tigray, Oromiya and SNNP regions of Ethiopia confirmed that land ownership, as well as the fertility of the soil, were among the major determinants influencing agricultural production of smallholder farmers.

A study from Enugu state in Nigeria pointed out that access to credit was determinant in enhancing the productivity of the farming sector through enabling farmers to purchase new varieties and additional farmland. However, the high-interest rate of the loan, the small size of the loan and longer time for processing loans were reported as some of the main challenges of smallholder farmers. Similar studies from Sidama zone of Southern Ethiopia indicated that access to credit was a limiting factor to engage in farming as credit is the source of finance to invest in physical capital. The study found that formal micro-finance institutions are less accessible for the rural community and 50% of sampled households have no access to formal credit services (Yona & Mathewos, 2017). Empirical evidence by Mukasa, Simpasa, and Salami (2017) also shows that about 66.6% of all smallholder farmers in rural zones of Ethiopia were credit constrained depicting the key role of credit in enhancing the productivity of the farming sector considerably.

A study conducted by Ragasa, Berhane, Tadesse, and Taffesse (2012) in four regions of Ethiopia found that agricultural inputs particularly access to synthetic fertilizer and the improved seed has been identified as the main determinants in enhancing farm productivity of smallholder farmers. The findings also indicated that female-headed households have difficulties in accessing agricultural inputs and extension services compared to their male counterparts. In the same vein, Kussa (2012) also confirmed the positive and significant relationships between investment in fertilizer and agricultural production in Ethiopia. A study conducted in four African countries, viz. Burkina Faso, Senegal, Rwanda, and Zimbabwe indicated that productivity of the farming sector in smallholder farmers highly depends on agricultural inputs particularly, on the availability and use of fertilizers, seed, animal traction, and the size of land holdings (Reardon et al., 1997). The same finding was also reported by Yahya and Xiaohui (2014) that fertilizer, seed, and pesticides significantly increased the chance of smallholder farmers being food secured in Tanzania. Similar results were also reported by Abrha (2015) that agricultural inputs such as chemical fertilizers, improved seed varieties and extension services as influential factors determining agricultural production in Northern Ethiopia.

Although there is limited literature on the influence of wild animals on agricultural production, the encroachment of animals to the field of farmers also has further potential in determining the farm livelihoods smallholder farmers. This is true particularly for smallholder farmers residing closer to forest reserves. A study conducted in Western Ethiopia by Quirin (2005) identified wild animals such as baboons, vervet monkeys, wild pig and porcupine as the main animals responsible for damaging cereal crops and vegetables cultivated in the area. Similarly, a study by Gobosho, Feyssa, and Gutema (2015) in southwest Ethiopia indicated that olive baboon, bush pig, and warthogs, grivet monkey and porcupine were the animals damaging farmers' fields. The same study has also identified that olive baboon was also a predator of chickens and small ruminant animals reared by farmers. In addition, the findings from Ango, Boerjeson, and Senbeta (2017) in Oromiya region of Ethiopia show that crop raiding by wild animals caused farmers to incur



additional costs for guarding their plots and sometimes at the expense of their children's schooling. The study shows that the encroachment of wild animals undermined the willingness of farmers to invest in improved agricultural technologies.

The above evidence shows how the farming livelihoods of smallholder farmers are influenced by various factors. Given the importance of the agriculture sector in Ethiopia, improving the productivity of the agriculture sector in general and the livelihood of smallholders, in particular, is critical for ensuring long term food security and the overall progress of the Ethiopian economy. Therefore, identifying the determinants influencing the farming livelihood of smallholder farmers is a crucial step in this regard and enriches the available literature on the topic.

### 3. Materials and methods

#### 3.1. Description of the study area

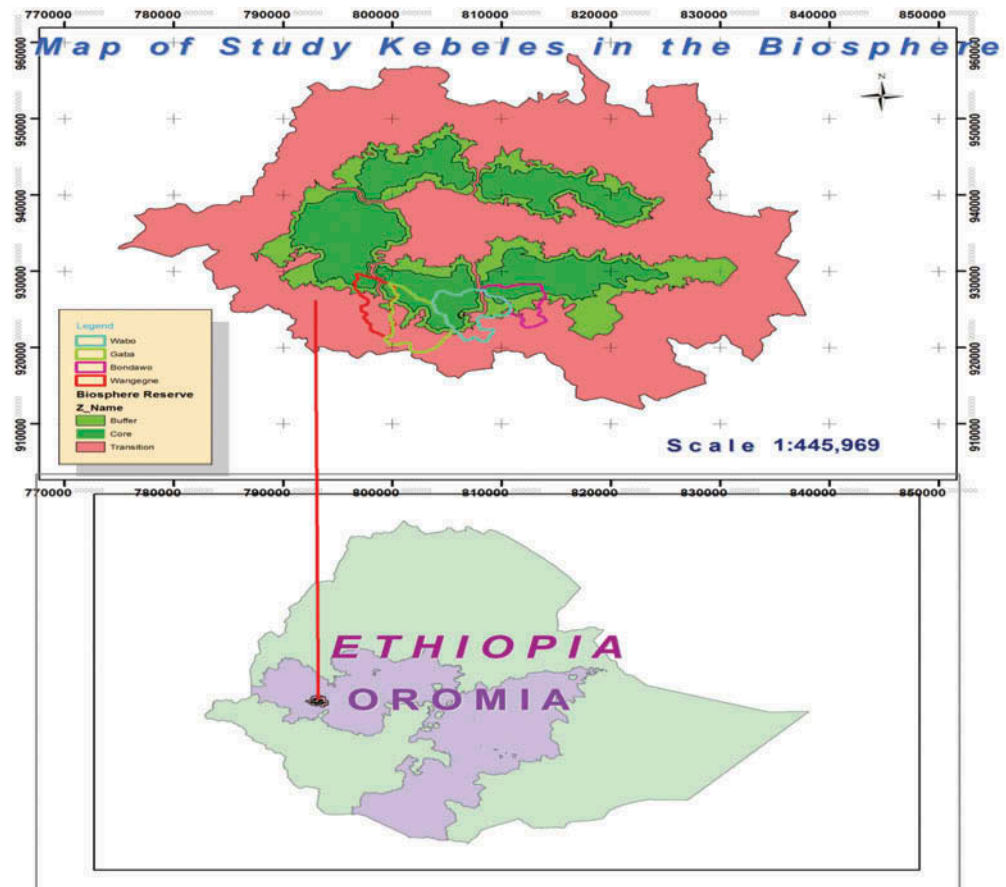
Yayu biosphere reserve is one of the protected reserves in Ethiopia located at Latitude: 8°0'42" N—8°44'23"N and longitude: 35°20'31"E—36°18'20"E in South-West Ethiopia, about 564 Kms away from the capital city, Addis Ababa. The biosphere reserve has been registered by UNESCO and known for its wild coffee growing in its habitat and home for various wild flora and fauna. The total area of the reserve comprises an estimated 167,021 hectares of land, where 117,736 hectares of it belongs to transitional<sup>1</sup> zone, and 21, 552 and 27,733 hectares of the land goes to the buffer<sup>2</sup> and core<sup>3</sup> zones (Gole, 2003). The reserve has a total of six *woredas* (districts) and three of them, namely: Yayu, Hurumu, and Dorenni are known for their immense natural forest reserves where wild coffee also grows under it. The research was conducted in two of the districts, in Yayu and Hurumu as part of NutriHAF<sup>4</sup> project activities in Ethiopia. Specifically, the research was done on Wabo and Bondo Megela *kebeles* (villages) from Yayu district as well as Gaba and Wangegne village from Hurumu district (Figure 1). The study villages are the intervention areas of NutriHAF project. In these villages, human activities and agro-forestry are common. Each of the four study villages has core, buffer and transition zones. As indicated in Table 1, the villages at Yayu district have a higher proportion of the core zone than that of Hurumu district (i.e. about 46% and 33% for Wabo and Bondow villages, respectively).

The villages at Yayu are closer to the protected core zone of the forest and farther from the main road than that of Hurumu. The villages at Yayu also have a higher proportion of buffer zones. On the contrary, the villages of Hurumu district have a higher proportion of the transition zone than Yayu district (i.e. about 56% and 61% for Gaba and Wangegne villages, respectively). In addition, the villages at Hurumu district are relatively farther from the protected core zone and closer to the main road. Although Gaba is the closest village from the main road, it is relatively farther from the market. A study conducted on the biosphere by Beyene (2014) indicated that illegal deforestation was prevalent particularly in the transition zone of the biosphere in the past where the expansion of farmland, mismanagement of the forest, access to the forest and roads were identified as some of the drivers for forest cover loss. The implementation of the biosphere reserve protection program has been instrumental in reducing the rate of deforestation from 0.29% to 0.16% in the biosphere area. Human activities are strictly prohibited in the core zone of the biosphere. Although farmers are not also allowed to expand land in the buffer zone, they have the right to collect fruits and coffee beans from the natural coffee forest in the buffer zone.

#### 3.2. Sampling and data collection

Both qualitative and quantitative research approaches were followed to explore the determinants of farm livelihoods in the study area. A household survey was conducted and gender disaggregated data were collected from four villages of Yayu and Hurumu districts. Adopting Yamane<sup>5</sup> (1967) formula for minimum sample size determination, 334 smallholder farmers were selected using stratified sampling techniques. The sample was stratified in terms of male and female-headed households for comparison purposes. Further stratification was also done with respect to the study villages to ensure their representation in the total sample. In terms of the household

**Figure 1. Geographical map of the study villages (kebeles).**



composition of the sample, 79% of the respondents are male-headed households whereas the rest 21% are female-headed households, which is proportionate with the total household size in the study area. The study villages, viz. Wabo, Bondomegela (Bondow) Gaba and Wangegne were selected with certain criteria. The villages have a forest-based farming system and they are suitable for multistory cropping systems. Moreover, the proximity of the villages for certain infrastructures such as market access, transportation, agricultural and health extension services, farmers' field school and training centers were found to be supportive for the successful implementation of the project. In addition, the villages are the intervention sites of the local organization called ECCCF<sup>6</sup> so as to facilitate the research process and get permission to conduct research in the area. The sample size was proportionate to population size for each study district and village. Table 2 summarizes the sample size for each study district and village as well as the composition of male and female-headed households in each village. Gender disaggregated, qualitative and quantitative data were collected employing a household survey, focus group discussions and key informant interviews.

### 3.3. Data analysis

Data were analyzed using descriptive and inferential statistics. Gender disaggregated t-test mean comparisons were made to identify the statistical significance of mean differences of household characteristics and socio-economic variables between male and female-headed households. In addition, Tobit regression analysis was employed to analyze the probability and extent of determinant variables in predicting the engagement in farm livelihoods. The Tobit model was selected as an appropriate estimation model given the nature of the dependent variable: continuous and clustered at some upper and lower bounds. Limiting values (i.e. zeros) are taken to account in the Tobit model avoiding biased and inefficient estimation of the



**Table 1. Information on the study villages and zones of Yayu biosphere reserve**

Districts in Yayu Biosphere reserve	Villages	Distance from the protected core zone of the forest (measured from the center of the villages)	Distance from the main road (measured from the center of the villages)	Distance from the market(measured from the center of the villages)	Distribution of land use per each zone (proportion to the total area of the village)		
					Core (%)	Buffer (%)	Transition (%)
Yayu	Wabo	350 m	1.8 km	1.5 km	46.36	26.29	27.35
	Bondo megela/Bondow	650 m	2.5 km	3 km	33.3	29.8	31.9
Hurumu	Gaba	850 m	270 m	4.5	25.65	18.05	56.3
	Wangegne	1.5 km	2.3 km	3	20.29	18.81	60.9

**Table 2. Sample Size Determination For Each Study Sites**

Districts in the reserve	Villages	Total Households (N)			Sample size (n)		
		Male- headed	Female Headed	Total	Male Headed	Female Headed	Total
Yayu	Wabo	194	36	<b>230</b>	34	7	<b>41</b>
	Bondo Megela/ Bondow	451	85	<b>536</b>	83	16	<b>99</b>
Hurumu	Gaba	388	138	<b>526</b>	72	24	<b>96</b>
	Wangegne	418	127	<b>545</b>	74	24	<b>98</b>
Total				<b>1,837</b>			<b>334</b>

Ordinary Least Square estimations (as OLS biases estimates by computing only those observations above the clustered limits, i.e. zeros). The Tobit model helps to determine changes in the probability of being above the limit, and changes in the value of the dependent variable where the values are already above the limit (McDonald & Moffitt, 1980; Wooldridge, 2002). Table 3 summarizes the dependent and explanatory variables used for estimation of the determinants of farm livelihood in the study area.

### 3.3.1. The Tobit model

Following Wooldridge (2012, p. 597), the Tobit model for the latent variable  $y^*$  for the actual engagement in farming, which is right-censored in this research, is given by:

$$y^* = x_i' \beta + u_i \quad (1)$$

Where  $y^* > 0$ ,  $u_i \sim \text{Normal}(0, \sigma^2)$

$$y = \max(0, y^*)$$

And the probability model is given as:

$$P(y > 0 | x) = P(y^* > 0 | x) = 1 - \phi(-x\beta/\sigma) = \phi(x\beta/\sigma) \quad (2)$$

The model for determinants of farm engagement is given by:

$$EFA = \beta_0 + \beta_i \sum_{i=1}^n X_i + \varepsilon_i \quad (3)$$

Where: EFA is engagement in farm activities

$X_i$  = vector of independent variables;  $\beta_i$  = coefficients of independent variables

$\beta_0$  = constant;  $\varepsilon_i$  = error term

## 4. Results and discussion

### 4.1. Description of demographic and socio-economic characteristics

The results of descriptive statistics indicated that both male and female-headed households engage more on farming than other non-farm livelihoods. However, the average proportion of engagement in farming is higher and statistically significant for male-headed households than their female counterparts, i.e. 94% and 89%, respectively (Table 4). The result indicates that farming is the main livelihood strategy for the majority of male and female-headed households.

**Table 3. Definition of hypothesized variables and measurements for determinants of farm engagement**

Variable	Dependent variable	Type	Expected sign
EFA	The proportion of engagement in farm activities. Farm engagement measures how much a household depends on farming and thus the percentage of income derived from farming from the total income. 100% engagement means that a household entirely engages in farming, and thus the entire household income is derived from farming.	Continuous, ranging from 0 to 100%	
AGE	Age of the household head in years.	Continuous	+
EDUC	Education level of household head.	0 = illiterate, 1 = can read and write, 2 = primary (1–4), 3 = junior (5–8), 4 = secondary (9–12), 5 = Tertiary (college diploma and above)	+
NFA	The value of non-farm assets a household owns in ETB	Continuous	+
EHHA	The proportion of engagement in household activities calculated from hours allocated per day	Continuous, ranging from 0 to 100%	-
IFERT	The investment made on fertilizer in Ethiopian Birr	Continuous	+
IIMSEED	The investment made on improved seed in Ethiopian Birr	Continuous	+
DEPEN	Number of dependents in a household	Continuous	-
PHYCAP	Value of farm physical capital a household owns in ETB	Continuous	+
CLAND	Coffee land (land suitable for coffee production) in hectares	Continuous	+
NCLAND	Non-coffee farmland (land allocated to produce crops other than coffee)	Continuous	+
CREDIT	Access to credit	Dummy, 1 if a household has access to credit, 0 otherwise	+
IRRIG	Access to irrigation	Dummy, 1 if a household has access to irrigation, 0 otherwise	+
EXPEND	Household expenditures incurred to cover basic consumption goods and services measured in Ethiopian Birr	Continuous	-
WILDAA	The occurrence of damage by wild animals on field crops	Dummy, 1 if a household has encountered incidence of wild animal encroachment, 0 otherwise	+
PDINFEST	The occurrence of diseases and pest infestation	Dummy, 1 if a household has encountered incidence of pests and diseases, 0 otherwise	+
DEBBO	Number of days a household obtain labor support (“Debo”) by the community during peak agricultural seasons	Continuous	+

**Table 4. Summary of descriptive statistics**

Variables with units of measurement	Male-headed households			Female-Headed Households			
	Obser	Mean	SD	Obser.	Mean	SD	t-test mean difference
<b>Proportion of Farm engagement</b> (0 to 100%)	263	93.61	16.89	71	89.31	22.81	4.3** (2.44)
<b>Age of HH head</b> (in years)	263	40.81	13.47	71	48.01	11.88	-7.2*** (1.758)
<b>Family size</b> (no. of individuals)	263	4.49	1.98	71	3.32	1.47	1.17*** (0.253)
<b>Education level of the head</b> (0 to 5; 0 is illiterate and 5 is tertiary level)	263	2.19	1.35	71	0.54	1.07	1.65*** (0.173)
<b>Agricultural productivity</b> (farm output in Ethiopian Birr per hectare of land)	259	9313.84	12,140.08	69	8818.92	7976.42	494.92 (1544.13)
<b>Non-farm asset ownership</b> (valued in Ethiopian Birr)	263	53,557.89	92,039.8	71	30,214.37	24,373.65	23,343.52** (11037.08)
<b>Engagement in Household activities</b> (average hours allocated per day)	263	5.63	10.08	70	33.87	23.75	-28.24*** (1.892)
<b>Investment on fertilizer</b> (in Ethiopian Birr)	263	857.29	941.94	71	494.55	567.51	362.74*** (117.21)
<b>Investment on improved seed</b> (in Ethiopian Birr)	263	109.5	244.28	71	59.97	144.31	49.53** (30.34)
<b>Number of working labor</b> (no. of individuals)	263	3.17	1.45	71	2.56	1.32	0.61*** (0.19)
<b>Number of dependents</b> (no. of individuals)	263	1.32	1.41	71	0.76	1.09	0.56*** (0.18)
<b>Farm income</b> (in Ethiopian Birr)	263	15,396.66	17,737.1	71	11,535.07	13,365.36	3,861.59** (2261.52)
<b>Non-farm income</b> (in Ethiopian Birr)	263	368	1211.28	71	421.03	834.8	-53.03 (152.76)
<b>Farm physical capital</b> (valued in Ethiopian Birr)	261	6673	11,620.32	70	3022.2	6044.81	3650.8*** (1439.5)
<b>Coffee land</b> (in hectare)	263	0.96	1.04	71	0.59	0.82	0.37*** (0.133)

(Continued)

**Table 4. (Continued)**

Variables with units of measurement	Male-headed households			Female-Headed Households			t-test mean difference
	Obser	Mean	SD	Obser.	Mean	SD	
<b>Non-coffee farmland</b> (in hectare)	262	1.25	1.66	71	1.11	1.65	0.14 (0.222)
<b>Access to credit</b> (1 if have access; 0 otherwise)	263	0.43	0.5	71	0.31	0.47	0.12** (0.065)
<b>Access to irrigation</b> (1 if have access; 0 otherwise)	263	0.16	0.36	71	0.11	0.32	0.05 (0.047)
<b>Household expenditure</b> (in Ethiopian Birr)	206	8480.08	6864.05	66	4629.52	3938.66	3,850.56*** (889.03)
<b>Incidence of wild animal encroachment</b> (1 if encountered incidence, 0 Otherwise)	262	0.45	0.5	71	0.37	0.49	0.08 (0.066)
<b>Incidence of pest and disease infestation</b> (1 if encountered incidence, 0 Otherwise)	263	0.2	0.4	71	0.23	0.42	−0.03 (0.054)
<b>Number of support days from Debo</b> (no. of days)	263	2.99	6	71	1.06	1.54	1.93*** (0.719)

\*\*\*, \*\* significant at  $P < 0.01$ ,  $P < 0.05$  and  $P < 0.1$ , respectively Standard errors in the parenthesis Data source: Own household survey

The mean age of a male and female head of household is 41 and 48, respectively with statistically significant mean difference. With respect to the educational attainment of sampled households, the average male head of a household has a primary education level whereas the average head of a female-headed household lies between illiterate and literate (just can read and write) group with a statistically significant mean difference. This implies that women are less educated than their male counterparts which might be connected with gender bias with access to education.

The number of working individuals and the number of dependents is found to be higher and statistically significant in male-headed households (3.17 and 1.32, respectively) compared to female-headed households (i.e. 2.56 and 0.76, respectively). This might be in line with family size, where male-headed households on average have significantly larger family members than their female counterparts. The results imply that male-headed households have a larger amount of labor in the family, which is an important production factor that may contribute to increased production. In addition, the average number of days male-headed households get support from *Debo*<sup>7</sup> is also three times higher than that of female-headed households, where the mean difference is statistically significant. This might be due to the fact that male heads spend ample time outside their homes and thus have better social networks than their female counterparts. Female heads are burdened with domestic activities with little time to network with friends.

With respect to ownership of land, male-headed households possess on average 1.25 and 0.96 hectares of non-coffee<sup>8</sup> and coffee land, respectively whereas female-headed households have a smaller amount of both types of land than their male counterparts (on average 1.11 and 0.59 hectares for non-coffee and coffee land, respectively). The average land holding in male-headed households is not very far from the national average, i.e. 1.37 hectares (CSA & The World Bank, 2013). The mean difference between male and female-headed households in terms of coffee land ownership was found to be significant. The result clearly shows female farmers are disadvantaged groups in terms of land ownership, which is an important indicator of wealth in the study area. Other related studies in Sub-Saharan Africa in general and Ethiopia, in particular, have found similar results that female-headed households in rural regions of Ethiopia possess smaller land plot than their male counterparts (CSA & The World Bank, 2013; Newman & Canagarajah, 2000). Moreover, the average proportion of engagement in household activities<sup>9</sup> was found to be higher and statistically significant for female-headed households whereas the average male-headed household spends less time on household activities. Household activities are not usually valued and the burden on women has also reduced the time to network with friends outside their home. Moreover, male-headed households have better access to credit than their female counterparts, on average. This implies that male-headed households have a better capacity for investment than their female counterparts. In line with this result, the average investment made on agricultural inputs (fertilizer and improved seed) are much higher and significant for male-headed households compared to female-headed households. On average, investment in fertilizer and improved seeds are 857 and 110 ETB<sup>10</sup>, respectively for male-headed households; whereas 495 and 60 ETB, respectively for female-headed households. In addition, a male-headed household has on average a farm physical capital valued for 6,673 ETB, which is more than double of physical farm capital owned by female-headed households (which is valued to be 3,022 ETB). As a result, the average farm income is found to be significantly higher among male-headed households than that of female-headed households. The results imply that female-headed households possess limited farm production factors that negatively affect production and thereby income obtained from farming. The finding is supported by Kasa, Abate, Warner, and Kieran (2015) who found clear gender gaps between male and female-headed households in possession of natural, financial and human capital that restrict female-headed households from using agricultural inputs. In addition, the same study identified that female-headed households possess a significantly lower proportion of livestock, particularly oxen and equines, than the male heads. Oxen and equines are used as draught power for the cultivation of land and transportation of goods, respectively in Ethiopia.



The average household consumption expenditures were also found to be higher among male-headed households than their female counterparts, with a statistically significant mean difference. This might be in line with the total income households obtained, where male farmers obtain higher income than female farmers. Similarly, male-headed households own more non-farm assets than female-headed households (valued at 53,558 and 30,214 ETB for male and female-headed households, respectively). The mean difference between male and female-headed households in terms of non-farm asset ownership is found to be significant. The findings clearly imply that female-headed households have fewer factors of production and income than their male counterparts, indicating the need for targeting and gender intervention so as to enhance the production capacity of women farmers.

#### **4.2. Determinants of farm livelihoods**

The findings of the survey and focus group discussions held in the study area indicated that farming is the major livelihood option for smallholder farmers. Although engagement in non-farm activities is also a common practice in the study area, it has been an alternative livelihood option particularly for poorer households with limited production factors such as land and capital. Better-off households consider non-farm activities as an activity practiced in off-seasons to cover some minor expenses of their family. Engagement in farming livelihoods have been influenced by a number of factors. As indicated on the marginal effect estimation results in Table 4, every one year increase in the age of household heads leads to a 0.93% increase in the probability of engagement in farming until the age of 56 years. The comparison between male and female-headed households indicated that engagement of farm livelihoods of older female-headed households was lower by 0.24% compared to their male counterparts.

##### **4.2.1. Production factors and agricultural inputs**

The marginal effect estimation indicates that the probability and intensity of engagement in farming increased by 2.2 % for every one percent increase in the values of farm physical capital, depicting that farm physical capital is determinant to enhance the engagement of rural households in farming (Table 5). This implies that physical capital ownership is one of the vital determinants that encourage households (especially female-headed households) to engage more in farming. Reardon et al. (1997) also identified that possession of physical capital particularly animal traction enhanced land and labor productivity and thereby increased yield in the farming sector in Sub-Saharan Africa. In addition, Yona and Mathewos (2017) in their study on Southern Ethiopia have found similar results that lack of physical capital is one of the restraining factors to engage in farm activities. The findings from Smith, Gordon, Meadows, and Zwick (2001) in their results of a survey conducted in Uganda confirmed that rural households who are better-off in terms of capital stock stick more to farming and were found to have less diversified livelihoods than their poor counterparts.

The probability of engagement of rural households in farming increases by 2.45% on average for every additional hectare of coffee farmland a household owns. Coffee is one of the major sources of farm income in the study area. Coffee land, which is suitable for coffee production, has a higher market value than any other non-coffee land that rural households possess. The finding is consistent with several research findings including Reardon et al. (1997); Kariuki (2011); Kussa (2012); Kassa (2014), Yahya and Xiaohui (2014), (Abrha, 2015) and Kassie et al. (2017) depicting a direct linkage between land ownership and engagement in agriculture. Focus group discussions held with male and female groups also asserted that land is one of the scarce resources rural households have and it is one of the reasons for landless and for farmers possessing smaller plots of land to diversify their livelihoods to non-farm activities. Per capita land ownership has been fragmented with respect to increasing in family size and it has become one of the determinants that influence the amount of farm production and household consumption.

The estimation result showed that every 100 ETB investment on improved seeds leads female-headed households to engage more in farming by 3% compared to their male counterparts. This depicts that investment in agricultural inputs motivates female-headed households to engage

**Table 5. Determinants of farm livelihoods in the study area (Tobit estimation)**

Variable	Determinants of farm livelihoods	
	Coefficient	Marginal Effect (dy/dx)
Age	2.573** (1.236)	0.926
Age square	−0.023* (0.013)	−0.0082
Education	−0.011 (1.585)	−0.004
Total working labor	−1.982 (1.556)	−0.713
Total number of dependents	−1.711 (1.431)	−0.616
Engagement in household activities	−0.023 (0.172)	−0.008
<sup>a</sup> Value of non-farm assets	−0.324 (1.982)	−0.117
Investment on fertilizer	0.004 (0.002)	0.0014
Investment on improved seed	0.0004 (0.007)	0.00014
<sup>a</sup> Physical capital	6.17*** (1.564)	2.22
Coffee land	6.81** (2.963)	2.45
Non-coffee Farmland	−1.63 (1.115)	−0.6
<sup>b</sup> Access to credit	12.79*** (4.126)	4.4
<sup>b</sup> Access to irrigation	4.313 (4.762)	1.44
<sup>a</sup> Household expenditure	−4.956* (2.744)	−1.78
<sup>b</sup> Incidence of wild animal encroachments	6.9 (4.610)	2.56
<sup>b</sup> Incidence of pest and disease infestation	8.21* (4.960)	3.36
Support from “Debo”	0.95* (0.492)	0.34
Interactions: Age*Female HH	−0.67* (0.370)	−0.24
Engagement in household activities*Female HH	0.56** (0.240)	0.2
Investment on improved seed *Female HH	0.07** (0.027)	0.03
<sup>b</sup> Incidence of pest and disease infestation*Female HH	−20.87* (11.967)	−9.85
Cons.	26.32 (37.882)	
Sigma	22.45 (2.391)	
Number of observation = 266		
F(35,231) = 1.9, prob>F = 0.003***		

\*\*\*, \*\*, \* significant at  $P < 0.01$ ,  $P < 0.05$  and  $P < 0.1$ , respectively Robust standard errors in the parenthesis <sup>a</sup> values of the variables are transformed to natural logarithms <sup>b</sup> dy/dx is for discrete change of dummy variable from 0 to 1

more in farming. The result is also supported by the findings of the focus group discussion made with female participants.

-headed households are constrained by financial resources limiting the amount of investment made on yield enhancing agricultural inputs, and thereby reducing their engagement in farming. Although investment on chemical fertilizer produced insignificant effects on farm livelihoods, other similar studies from Ragasa et al. (2012) in rural Ethiopia found that synthetic fertilizer has significantly enhanced farm productivity and the rate of fertilizer use among female-headed households was significantly lower than male heads. The same study also found that the plots of male-headed households are planted with an improved and higher quantity of seeds than their female counterparts.

#### 4.2.2. Credit services, household expenditure and social capital

As hypothesized, households with access to credit were found to be more engaged in farming by 4.4 % than those households without access to credit. Credit is a source of capital that boosts the capacity of rural households to purchase yield-enhancing agricultural inputs and has remained to

be a shortcoming for poorer households in intensifying the farming sector. Consistent with this finding, Miriam, Patrick, and Divine (2014) found that both formal and informal credits have been instrumental in creating the capacity to purchase new varieties, rent plot of land and thereby enhance farm productivity and engagement in the Enugu state of Nigeria. Similarly, Kassie et al. (2017) pointed out that access to credit enables rural households in Ethiopia to shift from off-farm to farm livelihoods by enhancing their capacity to purchase improved technologies. Another study in Ethiopia confirmed that farm productivity would increase by 60% in Ethiopia if the credit constraints of farmers are alleviated (Mukasa et al., 2017). The same study pointed out that female-headed households hardly access the available credit services due to very high interest rates of lenders and the fear that they would be unable to repay it. Focus group discussions made with both male and female farmers showed mixed results. On the one hand, some groups emphasized how access to credit improved their livelihoods. On the other hand, some groups complained that they are discouraged from taking loans as a result of repayment burdens. A male discussant from Wabo village described his view on local credit providing institutions as:

*They (creditors) still ask for loan repayment even in conditions where coffee production is low. They often threaten borrowers that they would sell their houses and other resources if they do not repay on time.*

The marginal effect estimation results show that a unit increase in household expenditures has reduced the engagement of farming by 1.78 %. If expenditures of households are increasing, farming could not always provide an immediate solution to the demand of cash. Farming is made seasonally and smallholder farmers need to wait until harvests are ready and sold to the market. Therefore, farmers could diversify their livelihoods to other non-farm livelihoods to supplement their income.

The study identified that households in the study area have traditional social capital where they network and support each other particularly during peak agricultural periods. One of the main labor supporting systems is *Debo*. Every additional support obtained from *Debo* increased the extent of engagement in farming both among male and female-headed households by 0.34%, depicting that social capital plays a vital role in determining farm livelihoods of smallholder farmers. The importance of *Debo* for rural livelihoods is also supported by the findings from Regassa, Mengistu, and Yusufe (2013) and Bekele, Negera, and Wondimagegnhu (2019). Regassa et al. (2013), in their research in southern Ethiopia, found that *Debo* has been playing a key role in supporting households particularly during cultivation and harvesting periods. The same study found that *Debo* increased productivity of households, save time of labor and strengthen team work and social bonds. In addition, Bekele et al. (2019) found that local institutions in southwest Ethiopia improved the food security status of rural households. The findings show that participation in *Debo* increased the food security of households by a factor of 3.94.

#### 4.2.3. Incidence of pests, diseases and wild animals' encroachment

The estimation results also show that every incidence of pests and disease infestation has increased engagement of rural households in farming by 3.36%. The findings also indicated that the engagement of female-headed households in farming has been lower by 9.85% than their male counterparts for every incidence of disease and pest infestation. The result implies that female-headed households are constrained with time and other resources to increase their engagement in their field during the incidence of such problems compared to male-headed households. Incidence of wild animals' encroachment produced insignificant effects on farm livelihoods of households, despite the fact that farmers are complaining that wild animals living in the biosphere reserve often intrude into their farms. However, focus group discussions held with male and female groups identified those wild animals particularly monkeys, porcupine, warthogs, and buffalos have been the main challenges of farming as they are damaging their crops on the field. As the study area is a biosphere reserve where various wild animals reside in, farmers are forced to spend much time and energy in patrolling their farm

areas. Female-headed households are endowed with limited labor and financial resources to employ guards to patrol and protect their fields from wild animal encroachments and also for properly managing their fields to circumvent the infestation of crop diseases and pests. A study done in the same region of South-West Ethiopia by Quirin (2005) identified that baboon, vervet monkey, wild pig and porcupine as the worst destructive pests accounting for a 0.5% loss of total crops grown in the study area. Mojoa, Rothschild, and Alebachew (2015) also found related results in the Guraghe zone of Southern Ethiopia. The authors identified that 93% of surveyed households reported that the incidence of wild animals' encroachments contributed to a shortage of foods and mismanagement of natural resources.

### 5. Concluding remarks and policy recommendations

The study analyzed the determinants of farm livelihoods of rural households in Yayu biosphere reserve of South-West Ethiopia. Farm livelihoods are found to be the main livelihood option in the area. The findings suggest that augmented production factors such as physical farm capital, land ownership and access to credit and agricultural inputs have increased engagement in the farming of rural households. The findings also suggest that a lack of possession of farm inputs is one of the bottlenecks that deter female-headed households from engaging in farming.

Despite the fact that rural households are living in the transition zone of the biosphere reserve, it is possible to deduce that the encroachment of wild animals did not deter rural households from engaging in farm livelihoods. However, it increased the amount of their time devoted to farming as a result of patrolling their fields. Similarly, the incidence of pests and diseases, in general, increased the engagement of rural households in farming. The comparison between male and female-headed households suggested that higher engagement in household activities did not produce a negative influence on farm livelihoods of female-headed households than male-headed households. The findings further suggest that both male and female-headed households engage more in farming if they are supported by a traditional labor support system of the area. The overall findings revealed that male and female-headed households still prefer to engage in farming as their main livelihood option despite the encroachment of wild animals from the biosphere reserve and the legal prohibitions to expand farmland in the reserve. The findings rather confirm that farm livelihood is determined by the possession of certain farm capitals and productivity-enhancing inputs. The findings also confirm that female-headed households could engage in farming in the same way as that of male-headed households if they are equipped with the necessary production capitals.

The study area is located in Yayu Biosphere reserve where wild animals often intrude into farmers' fields. As a result, farmers are devoting ample time to patrol their fields, particularly during peak agricultural seasons. Therefore, there should be effective and participatory wildlife management strategies such as building protected enclosures with a clear boundary between the farmers' village and the wild animals. Compensation schemes should be also in place for farmers whose fields are damaged by wild animals. Such strategies could enhance the farmers' sense of ownership on the biosphere reserve.

Yield enhancing agricultural inputs have been one of the constraints restraining the productivity of smallholder farmers. In addition the inputs are unaffordable for some farmers and they are not delivered in the right time. Given the fact that fragmentation of farm land and capital stock exist in the study area as a result of increasing family size, improved agricultural inputs are among the few options to enhance yield per unit of land. Therefore, strategies need to be designed to improve the agricultural extension services and the availability of agricultural technologies in such a way it meets the needs of smallholder farmers.

Female headed households are overburdened with both agricultural and household activities. Labor saving technologies should be introduced to lessen their household burden and enhance their productive roles.

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#### Notes

1. The transition or cooperation zones covers 70.5% of the biosphere reserve which contains settlement areas, farms and other human activities where local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interests, and other stakeholders work together to manage and sustainably develop the areas' resources (Gole, 2003).
2. The buffer zones are clearly identified areas, and usually surround the core zones. Buffer zones can be used for cooperatives compatible with sound ecological practices, including environmental education, recreation, ecotourism and research (Gole, 2003).
3. The core zones are strictly protected areas for conserving biological diversity. Activities that are allowed in this zone are low-impact uses such as education and ecotourism as well as non-destructive research (Gole, 2003).
4. NutriHAF: Diversifying agriculture for balanced nutrition through fruits and vegetables in multi-storey cropping systems in Africa is a project being implemented in Ethiopia and Madagascar. The project in Ethiopia is implemented in two districts of Yayu biosphere reserve, South-West Ethiopia.

5. Taro Yamane's formula was used to determine the minimum sample size for the research. The formula is given as:  $n = \frac{N}{1 + Ne^2}$  where, n = the sampled households, N = total household size, e is the sampling error (at 0.05).
6. ECCCF is Environment, Climate Change and Coffee Forest Forum, a local organization operating in Yayu Biosphere reserve in Ethiopia.
7. Debo is a traditional labor support and sharing system where a group of farmers gather together and support each other during peak agricultural seasons particularly during cultivation and harvesting seasons. It is a local social capital.
8. Non-coffee farmland, in this research context, is land used for cultivation of cereal crops, vegetables and fruits out of coffee. Coffee land is a land suitable for coffee production and its market value is also higher than non-coffee farmland.
9. Household activities include: food preparation, fetching water and fire wood, taking care of children in the house.
10. ETB (Ethiopian Birr) is the currency unit in Ethiopia. 1 ETB is approximately equivalent to 0.037 US\$.

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