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Determinants of Female Farmers Access to Agrarian Extension Services:

A case study from Ethiopia

by

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This paper aims at investigating the determinants of female farmers access to Agrarian Extension Services in Ethiopia, where extension services represent a critical tool for the development of the agrarian sector. Despite the country's efforts to develop a gender-responsive extension system, several bottlenecks are negatively driving down women's access to these services. By reviewing previous works and employing the Ethiopian Socio-economic Survey from 2018-2019, this research collected a set of determinants that were then tested through a logistic regression. In order to investigate their individual effect on female farmers access to Agrarian Extension Services. Among the eighteenth determinants tested, eight were shown to have significantly affected women's access; respectively, the average of the years of female education and having individual or joint ownership rights over a parcel of land were found to have a significant negative effect on women's access. Meanwhile, access to water service at the community level, use of chemical fertilizers, having access to a credit service, being among the decision-maker for what concerns land-related decisions, the frequency of participation among watershed activities and the cost of going with public transportation to the closest woreda town were found to have a positive significant effect on women's access to agrarian extension services.

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1 Introduction

1.1 Research Problem

Sub-Saharan Africa's developmental path relies significantly on the growth of the agrarian sector, in particular, to eradicate poverty and hunger. Agriculture constitutes, on average, 15% of the total GDP of the continent, and it employs more than half of Africa's labor force (OECD/FAO, 2016). Especially the agrarian sector provides a lifeline to many small-holder farmers, which constitute around 80% of farms in SSA, thus, adding up to 175 million people employed in this sector (OECD/FAO, 2016). Among small-holder farmers, women constitute half of the labor force (OECD/FAO, 2016). Despite the agrarian sector's employment, growth potential and its relevance in policy development, the latter is negatively affected by several systematic issues that reduce its potential role in supporting the African population's attempt at leaving the poverty cycle (OECD/FAO, 2016). Factors such as ineffective and unclear developmental policies, lack of adequate and widespread infrastructures, limited market access, unfavourable terms of trade, and environmental degradation cause harvest losses and drastically reduce farming productivity (OECD/FAO, 2016).

A pivotal element driving down the growth of the agrarian sector is identified in the severe and systemic gender inequalities that affect female farmers' productivity (Shimeles et al., 2018). Although women comprise half of the labor force and are actively engaged in almost every step of the agrarian production cycle, their crops are less productive than men's crops, around 20/30 % less (Un women, n.d.; FAO 2007). The consequences of the gender gap in agriculture play an important role in determining the causes of the poor growth of the agrarian sector (Blackden et al., 2007). The reasons for this productivity gap can be found in gender inequalities between female and male farmers. Indeed, women face several gendered constraints, at a cultural level, such as unequal division of work, discriminatory norms, and lack of decision-making power within the households, which directly affect their access to critical agrarian resources such as land, male labor, climate-smart agriculture, pesticides, technologies, higher profitable crops and to agrarian information such as agricultural extension services (UN Women, n.d.). Often women are considered helpers and not farmers; thus, they are seen as

inferior to men (Diao et al., 2007). All these inputs are critical for women's agricultural productivity and drive the gap between them and male farmers (UN Women, n.d.). Addressing the gender gap in agriculture has the potential to increase total agrarian productivity in developing countries by 2.5/4% and reduce the number of food insecure people by 12/17%, additionally, to significantly reduce poverty by leading many farmers out of the poverty cycle (FAO, 2010/2011; UN Women, n.d.).

Among agricultural resources, agricultural extension services (AES), also identified as advisory services, can play a pivotal role in linking small-holder farmers to markets and boosting farming productivity (Oakley and Garforth, 1985). Extension services offer advice and information to the rural population to smooth their production process and augment farmers' productivity and potential. Extension services can vary from offering insights on technology adoption, sustainable farming techniques, and marketing methods (Abou, 2015).

Additionally, extension services can link small-holder farmers and bigger markets to sustain the agri-value chain in many countries (Abou, 2015). Thus, extension services are meant to support farmers from an economic and developmental perspective.

Female farmers can highly benefit from extension services as it can positively affect their decision-making towards more efficient and sustainable agrarian practices and, as a consequence, benefit their productivity, household health and economic status (Lecoutere et al., 2020; Saito and Weidemann, 1990). Despite the potential of these services for female farmers, the latter need additional support in accessing AES. As mentioned above, female farmers are underrecognized and discriminated against, reducing their access to several agricultural inputs and their visibility as extension services' receivers (Amenyah and Pupilampu, 2013). Thus, it is extremely relevant to understand what factors determine female farmers' access to these services. Understanding these determinants is key to developing gender-responsive extension services (Haile, 2016).

1.2 Research Question and Outline

Several African countries have tried to increase women's inclusion and participation in extension services in the last decades (Haile, 2016). In SSA, Ethiopia's government has progressed in recognizing women as valuable actors within the agrarian production cycle,

especially among extension services (Lemma et al. 2020; Haile, 2016). The Ethiopian government has also recognized the urgency of addressing gender inequalities within these services. However, policy commitment has yet to translate into policy implementation, and Ethiopian extension services still struggle to include women farmers and tackle their gendered constraints (Lemma et al. 2020). Lack of research and local capacity affects gender-responsive development, thus, successful, and inclusive extension services (Lemma et al. 2020). In the fight for gender equality and women's inclusion, it is of the utmost importance to understand and research which factors can positively and negatively affect women's participation in AES. For the reasons mentioned above, this paper will answer the following research question, what are the determinants of female farmers' access to Agrarian Extension Services (AES) in Ethiopia?

This work answers the research question by employing qualitative and quantitative analysis. Section 2 presents a background of the cultural and economic position of women in Ethiopian society, and it additionally provides a brief overview of the actions implemented by the government to develop gender-responsive extension services. Section 3 presents the literature review that collected qualitative data from relevant previous literature. The literature survey is divided as follows; section 3.1 provides an overview of past works on the potential and constraints of women's farmers in Sub-Saharan Africa, section 3.2 collects previous works on extension services programs in SSA, and their outcomes and impediments in various SSA countries. Additionally, it presents good gender-responsive practices among extension systems. Section 3.3 employs relevant literature on female farmers' determinants in SSA, drawing special attention to Ethiopian literature to establish a theoretical framework in Section 3.4. In section 4, a description of the weaknesses and strengths of the dataset collected from the from the Ethiopian socio-economic survey from 2018/2019, will be provided. This section presents an analysis of all the variables employed by the model. In section 5, the research employs a logit regression and the Average Marginal Effects of the determinants to establish the direction and magnitude of the determinants' effect on a woman's probability of accessing AES. Section 7 shows that eight determinants significantly predict women's access to AES: the average level of education, access to water at a communal level, use of chemical fertilizer, ownership rights over a parcel of land, access to credit, decision-making power over land/related decision, frequency of participation among watershed activities and the cost of transportation. The section proceeds to interpret and discuss the results and place them among the previous literature and the cultural and economic background provided on Ethiopia throughout the

research. It also comments on how these determinants align with the Ethiopian government's political commitment to implement gender-responsive extension services. Finally, Section 8 concludes.

1.3 Scope and Limitations

As mentioned above, the scope of the analysis is to investigate the effect of several factors on female farmers' access to extension services in Ethiopia to determine which factors increase women's access to these services and which decreases it. The thesis aims to contribute to the literature by combining socio-economic, institutional, personal, farming and cultural determinants found in previous literature, to create the most complete analysis of female farmers' characteristics, employing quantitative analysis. Additionally, the thesis aims at contextualizing the findings among Ethiopia's extension systems, especially in light of the Ministry of Agriculture and Natural Resources (MoANR) strategic interventions to increase women's access to these services.

This research face several limitations, firstly, related to dealing with such a diverse country as Ethiopia, that presents a multitude of ethnicities, culture and norms. The research is unable to address the cultural heterogeneity among regions and communities, thus, it is a significant limitation to this work. Secondly, there are several determinants potentially affecting women's access to AES that are not taken into consideration in this work. This is due to a matter of time and space, and data availability. Thus, the determinants analyzed are eighteenth among the many that could be driving women's access.

2 Background

2.1 Socio-economic context in Ethiopia

Figure 1. Ethiopia's geographical map



Source: World Atlas, <https://www.worldatlas.com/maps/ethiopia>

Ethiopia is Africa's 10th most populated country, with a considerable diversity of ecosystems, ethnicities and cultures as shown in Figure 1 (Mulugeta and Cherinet, 2003; World Atlas). Ethiopia's growth path has been placed at the center of many studies since its economic sector has been growing significantly, with an average GDP per capita growth of 6.3% between 2000 and 2018, placing the country as one of the fastest-growing economies globally (Africa Check 2019; Rohne Till, 2021).

Its economy has been dominated for years by its agrarian sector, which contributed to 54% of the national GDP in 2003 (Mulugeta and Cherinet, 2003). The service sector has

outperformed the agrarian sector, while the industrial sector has grown significantly only in recent years (Dube et al., 2019). The agrarian sector's role in the country's growth is massive. The latter employs 80% of the total labor force and offers a lifeline to most of the population (Rohne Till, 2021 p. 16). This sector comprises mainly small-holder farmers who use 95% of the total agrarian land made available by the government and produce 90% of agrarian outputs (Rohne Till, 2021 p. 21). Ethiopian small-holder farmers mainly practice rain-fed agriculture, often employing traditional agrarian technology and following a low-input and low-output system of production (Dube et al., 2019 p. 193).

Despite its significant growth, Ethiopia is one of the most food-insecure countries globally. Among its population, 40% of households are food insecure and affected by malnourishment, especially in rural areas (FAO, 2007). Despite the demographic and developmental potential of the agrarian sector, it has yet to perform as a driver of poverty reduction and food security, as expected by scholars and policymakers (Dube et al., 2019).

For these reasons, the Ethiopian government has developed and implemented the Agricultural Development Led Industrialization (ADLI) strategy, which placed agricultural growth and building small-holder farmers' capacity at the center of the agenda and complemented this strategy with several developmental programs promoting extensions services, reduction of rural poverty and social support, among many (Dube et al., 2019).

2.1.1 Women's Role and Activities in Ethiopia

Among Ethiopian small-holder farmers, women constitute half of the labor force and carry out 75% of farm labor. Additionally, contribute to 70% of household food production (Chandel et al., 2022). In Ethiopian rural areas, women are involved in agricultural production, animal husbandry and food production (Chandel et al., 2022). In fact, their daily workload goes above 13 hours, compared to men's, which goes below 13 hours (Kifetew 2006). In agrarian production, women mainly contribute to soil preparation, sowing, weeding, and harvesting (Dicks and Senay Bogale 1995, 95-97). Among agrarian production, using the plow is one of the few activities women do not carry out because it is often considered a man's job. Thus, women need a male counterpart to plow their fields (Dicks and Senay Bogale 1995). In addition, women are also majorly involved in pastoralist activities, such as rearing livestock (Kifetew, 2006; Chandel et al., 2022). In their daily duties, food production also requires them to take care of horticulture, milk processing, milk production, and livestock breeding (Dicks and Senay

Bogale 1995). Additionally, they are also in charge of feeding the other members of the household working in the fields, fetching water, and collecting firewood to use as household fuel (Chandel et al., 2022; Mulugeta and Cherinet, 2003)

Despite the countless activities that women carry out, there is still a significant gender gap between male and female farmers in agrarian production. It varies between 23% and 35%, depending on the research (Chandel et al., 2022; Un women, n.d.). The gender gap in agriculture can be attributed to the societal norms placing women in an inferior role among economic activities, their subsequent lack of access to agricultural inputs such as land, their limited control and decision-making power over their assets and over decisions concerning land-related activities, which limit their potential and their role at a household, communal and national level (Chandel et al., 2022). Additionally, women are targeted less, as a consequence, marginalized by development programs that fail to include a fundamental part of the labor workforce (Amenyah and Puplampu 2013).

Lastly, the trading sector employs many women, especially in cities and urban areas. However, due to a lack of formal education and widespread illiteracy among women, they are often not part of the formal workforce and do not earn a wage (Dicks and Senay Bogale 1995). Thus, women are over-represented in the informal sector and underrepresented in high-income and higher-status professions (Dicks and Senay Bogale 1995). In addition, the proportion of political participation of the Ethiopian female population is still very low (Chandel et al., 2022).

2.1.2 Cultural context

Understanding the cultural and institutional context among which gender dynamics originated and interact is important to understand the cultural context in Ethiopia. The state is multicultural, with various cultures and ethnicities interacting within customary and statutory norms, often negatively affecting women's societal roles. Due to the variety of ethnicities and cultures, it is impossible to draw general conclusions for the whole country. However, some characteristics can be found among the regions and societies.

Generally, Ethiopia can be considered a patriarchal society, where women are considered inferior and expected to depend on their husbands (Lailulo, 2015). Additionally, Ethiopian society can be generally considered a "role-oriented society," which determines the status and value of an individual based on the societal roles that are attached to their identity

(Bekana, 2020; Freeman, 2002; Dicks and Senay Bogale, 1995 p. 89). For these reasons, women's role as child bearers and mothers often limits their societal values to their reproductive roles rather than their productive activities(Bekana, 2020; Freeman, 2002; Dicks and Senay Bogale, 1995). These ideologies result in women being considered helpers to their male counterparts and not farmers (Diao, 2007).

Additionally, women are generally considered weaker on a social and economic level. The reasons are several, both cultural and institutional. From a young age, girls are taught the art of womanhood and to be dependent and obedient to their husbands, these norms, start shaping already their roles in society (Lailulo 2015). When reaching adulthood, less is expected of girls' development and future attainment than men (Dicks and Senay Bogale 1995, 89; Kifetew, 2006). Additionally, cultural norms such as harmful traditional practices, including domestic violence, rape, abduction, FGM, scarification, forced marriage, early marriage, sexual harassment, are still practiced despite being banned by the Ethiopian government, affecting women's security, self-esteem inside and outside the household, and adding gender burdens to their lives (Smith 2013, 174-177).

These cultural norms and gendered practices, combined with a lack of educational infrastructures, especially in rural areas, augments the gender disparities in education. Illiteracy levels in Ethiopia are high, with an average of 74%, respectively, 54% for males and 75% for females (Mulugeta and Cherinet, 2003). As educational levels rise, the gap between men and women increases, with fewer women being professionals. Gender inequalities in education significantly affect women's status and future possibilities. Additionally, women are also considered landless due to the gender division of labor, which hampers their access to agrarian resources and affects both their participation in agrarian activities and their status (Kifetew, 2006). Additionally, despite efforts from the Ethiopian government to recognize women's land rights as equal to men, customary discriminatory practices still affect their access to land and tenure security (Teklu, 2005). Women's lack of land access and the consequent lack of decision-making power over land impact women's status and cultural identity. As Verma states, "Without access to land, women are, in reality, nobody" (Verma, 2007 p. 45). These gender constraints aggravate women's weaker position within society.

Despite these cultural constraints, throughout history, women have found their own significant way of raising their voices and unifying against gender discrimination (Semela et al.,2019). Women's joint action has been a powerful means for women to increase their political

influence and push for gender improvements. Additionally, women have also been fighting the adoption of harmful traditional practices such as FGM (Smith 2013). Seemingly, the government in Ethiopia has been addressing the issues affecting female farmers' participation in agrarian activities to promote gender equality and support women's empowerment (Semela et al., 2019).

2.1.3 Gender Action in the Ethiopian Agrarian Extension System

As mentioned above, the Ethiopian government has been following and implementing an Agriculture Development-Led Industrialization (ADLI) strategy, among which extension services are central and critical developmental tools (Ministry of Agriculture and Natural Resources, 2017). In fact, agrarian extension services are recognized as valuable and effective means to link small-holder subsistence farming to the market and additionally incentivize commercial agrarian production through the spread of yield- and quality-increasing agricultural technologies (Ministry of Agriculture and Natural Resources, 2017). Extension services can foster food security and reduce poverty when implemented efficiently.

AES approaches have dynamically changed in Ethiopia, following the Growth and Transformation Plans (GTP I and II) and the creation of agencies aimed at developing strategic interventions, such as the Agricultural Transformation Agency (ATA) (Lemma et al., 2020). Nevertheless, a top-down development approach dominated by the public sector has been maintained (Lemma et al., 2020).

In 1995/1996, the Participatory Demonstration and Training Extension System (PADETES) approach was adopted, which employed a technology-driven extension policy to improve the productivity and income of small-holder farmers (Tsigie et al., 2019). The current Participatory Agricultural Extension System (PAES) has been established based on reassessing the previous PADETES approach (Lemma et al., 2020). The current extension strategy has placed youth and women among the new extension user groups (Lemma et al., 2020). Additionally, it includes the organization of farmers in development units and networks (Ministry of Agriculture and Natural Resources, 2017). It focuses on “agro-ecology-based diversification and specialization, market orientation and value addition, scaling of good practices, farmer training, household and watershed-based full package and a good practices package” (Lemma et al., 2020 p. 2).

The main extension tools at the moment are Farmer Training Centers (FTCs) matched to farmer groups and development units. The training centers assisted by the agents and farmer groups provide farmers with agricultural extension services and sustainable new practices (Ministry of Agriculture and Natural Resources, 2017). However, the extension system in Ethiopia includes different approaches and methods of advisory services' provision, following the rationale that a pluralistic system can better satisfy the heterogeneity among Ethiopian farmers (Lemma et al., 2020). The pluralistic system includes individual and group visits, organized meetings, using model farmers, networks of farmer development groups and demonstration plots (Lemma et al., 2020). Lastly, the potential of the extension system is impressive, given that it is one of the densest AES, with 21 development agents (DAs) per 10,000 farmers and even more in high-potential areas (Ministry of Agriculture, 2017).

However, despite the policy commitments and the development and creation of quality-improving technologies, the latter are not reaching small-holder farmers (Lemma et al., 2020; Ministry of Agriculture and Natural Resources, 2017). Thus, the benefits of agrarian information are not trickling down to the population; consequently, the agrarian sector is not achieving its full potential (Lemma et al., 2020; Ministry of Agriculture and Natural Resources, 2017). Among issues to be addressed, the creation of gender-responsive extension services has been placed at the centre of the agenda. In fact, among the nine pillars of the new extension system, Pillar 5 focuses on Gender, youth, and nutrition mainstreaming. In recent decades, the Ethiopian government has formally committed to reducing gender inequalities and applying a gender mainstreaming approach in agricultural programs (Lemma et al., 2020). The ministry has identified the main bottlenecks hampering the efficient implementation of the gender-political commitment. Firstly, lack of female participation and recognition in the planning of the programs, which results in poor interventions that lack specificity and fail to address specific gendered issues. Consequently, women are often excluded from the implementation of the programs. Secondly, there is a lack of sex-disaggregated data, which inhibits gender-specific investigations and gender-responsive policies. Thirdly, as mentioned in the section above, women face gendered constraints that limit their access and also their active participation during the meetings. Lastly, lack of health extension was also identified as a major bottleneck.

2.1.3.1 Strategies and Interventions Developed

The strategies put in place to overcome these bottlenecks include, firstly, generating gender awareness at the community and at the national level, especially at the provider of advisory services level. In fact, it is mandatory that both the community and the providers of

these services are aware of the gender constraints limiting and affecting women's access and participation. Secondly, the Ministry of Agriculture and Natural Resources (MoANR) promotes the strengthening of gender mainstreaming actions by creating clear goals to assess gender inequalities and build gender capacity for extension staff. The goal is to increase awareness and positive communication among the development agents (DAs) and female farmers. Lastly, assigning a gender-focal person at all levels of the organization can ensure the respect and the implementation of gender awareness. Thirdly, the MoANR directly plans to increase female participation by strengthening women's groups as a means to share information and support the creation of networks where female farmers do not face discriminatory practices and can access technologies more easily. Lastly, spreading gender-friendly agrarian technologies can reduce women's work burden and increase women's participation by targeting their needs directly and reducing their mobility constraints. Furthermore, increasing the resources allocated to female farmers' activities can enhance the effective implementation of gender-specific extension programs. Empowering women at the household and communal level has also been identified as a strategy to close the gap in participation. When women enjoy the same rights over resources, assets, and time, then they can improve their economic and social status. Lastly, extension services should include health services to support and promote nutrition. Following these interventions, positive outcomes have been recorded from gender-specific extension programs that have been promoted (Beijing+25, 2019). For instance, FTCs have provided extension activities related to gendered technologies aimed at reducing the timing of household activities, thus, reducing women's burden (Beijing+25, 2019). The outcome was higher participation of women farmers.

In conclusion, the Ethiopian government has implemented several positive policies and strategies to include female farmers among AES, placing this matter at the centre of its extension agenda. Despite the positive outcomes of gender-specific FTCs, the national, regional, and local capacity to implement these strategies effectively is still weak, and the outcomes of these good practices are constrained by the lack of "accessible and useable formats" at the popular level (Lemma et al., 2020 p. 12-13; Cohen and Lemma, 2011; Beijing+25, 2019). The top-down structure of the Ethiopian extension service should be complemented with "responsiveness to bottom-up demands for services, planning, and management" (Cohen and Lemma, 2011 p. 2). Understanding what constraints or fosters female access to these services it is indeed pivotal for the development of inclusive and demand-driven extensions that meet the needs of the local population.

3 3. Literature Review

In order to contextualize this research and its relevance among the international academic debate, a literature review of relevant previous works will follow.

3.1 Women Farmers in SSA

3.1.1 Women's potential in agrarian activities

In Sub-Saharan Africa, women have a multidimensional role in the agrarian sector. Indeed, as the Montpellier Panel (2012 p. 4) highlighted, women in SSA can be "farmers, mothers, innovators and educators." Seemingly, there is a consensus among academics that women contribute and are often responsible for the majority of agrarian activities, thus, are active in almost every step of agrarian production (Gladwin et al., 2001; Chandel et al., 2022; Amenyah and Pupilampu, 2013). Women contribute to the most tiring and time-consuming activities, such as soil preparation, sowing, weeding, and harvesting (Tsige et al. 2020; Dicks and Senay Bogale 1995, 95).

Nevertheless, as Mehra (1995,3) stated, at the institutional and developmental level for a long time, women were mainly valued and recognized for their reproductive role rather than their economic and productive potential.

Biases against women have affected the policies developed and the action taken by governments and international organizations (Amenyah and Pupilampu, 2013). However, gender-responsive policies have been promulgated in the last decades, and more attention has been given to female farmers' potential and struggles (Amenyah and Pupilampu, 2013). Recent research has additionally shed light on the multidimensional roles that women have, for instance, in carrying out actions against climate change by adopting climate-smart agriculture and using resilience strategies in concerns to seed variety and their sustainable use (Carvajal-Escobar et al. 2008; Hosken 2017). It was shown that rural female farmers are more prone to adopt more attentive behaviors toward environmental hazards (UNDP, 2012 p. 3-4). Moreover,

women have been recognized as pivotal in achieving food security as female farmers in SSA are responsible for around 70% of household food production (Quisumbing et al. 1996). Lastly, women engage in childcaring and house maintenance (Kilic et al., 2015). Thus, there is a consensus across the literature in SSA and Ethiopia that women are involved in vital household, agricultural, and food production activities. These findings further emphasize women's role in achieving many Sustainable Developmental Goals (UN Women).

3.1.2 Constraints to women farmers' Production

Despite women's role in agrarian and food production, female farmers face many challenges in accessing and controlling agrarian resources, thus, limiting their potential in agrarian and food production (Diao et al., 2007). Indeed, Quisumbing and Meinzen-Dick (2001) state that female farmers are found to be the poorest and most food insecure among subsistence farmers in SSA. Among the many causes, women's poor agricultural status has been associated with the significant productivity gap between male and female farmers. Among SSA countries, the productivity gap varies between 4% to 40%, with most of the countries laying between 20% to 30 % (Kilic et al., 2015: UN WOMEN, n.d.).

Much research has explained the driver of this productivity gap in SSA. Kilic et al. (2015) and Amenyah and Puplampu (2013) identified women's lack of access to agrarian inputs as a significant driver of this gap. Similarly, Amenyah and Puplampu (2013) identify access to land as a crucial means to unlock women's access to other agrarian inputs such as credit, technology and extension services. Both researches stress that having access to those inputs can unlock female farmers' potential in the agrarian sector and support them in employing their agrarian skills and abilities. Kilic et al. (2015) stress that access to these resources subsequently affects women's decision-making abilities over land-related matters. As shown above, women are prone to employ sustainable practices and adopt environmentally conscious behaviors. However, without access and control to these means, the benefits of these skills are massively limited.

The African Development Bank Group (2019) and Lastarria-Cornhiel et al. (2014) find women's constraints in access to resources to be significantly caused by the land tenure systems in SSA that, especially at the customary level, still discriminate against women and limit their access to land. However, while access to land has been identified as a major constraint, Nadasen (2012) argues that gender disparities come into play also when access to land is granted.

Seemingly, Lastarria-Cornhiel et al. (2014) and Bekana (2020 p. 314) stress that strengthening women's tenure security is pivotal. Nevertheless, it does not grant women equal use and control over the land. The brief from UN WOMEN highlights several constraints relative to agrarian labor and crop production. It highlights that in Tanzania, the whole productivity gap can be explained by a lack of access to agrarian male labor in the case of women that cannot rely on their husbands or do not have extra income to hire external labor. In Ethiopia's case, this factor explains 45% of the gap, thus, presents a significant driver. Similarly, the research highlighted that women's lack of cash income also affects the purchase of modern and quality-increasing technologies.

However, beyond women's constraints in agrarian production, there are institutional barriers affecting women's role in the agrarian sector. Nadasen (2012) argues that the low level of education among women farmers remains the biggest obstacle to women's empowerment. Through education, women can adopt new practices and methods, access higher jobs and access labor-saving technologies (Lopez-Claros & Zahidi, 2005). Among other institutional barriers, Kilic et al. (2015) highlight that it is common for females to struggle to access markets and financial services such as credit (Kilic et al. 2015). Additionally, although women participate significantly in agrarian production, they often do not access the markets themselves but are limited to the most strenuous field work such as agriculture, manufacturing (clothing and textiles) and services (UN WOMEN, N.D.; Kevane & Gray, 2008).

Lastly, all the authors stress the importance of recognizing the cultural norms and traditions that come into play in the agrarian sector and among SSA societies. Cultural norms define women's duties within and outside the household and their access to education, land, and agrarian inputs (Kilic et al., 2015). On the cultural level, Diao et al. (2007) mention that women are often considered helpers and not farmers; thus, they are seen as inferior to men in agrarian activities. For these reasons, female farmers are often not granted access to agricultural inputs such as land, credit, technologies, extension programs, and fertilizers (Diao et al., 2007). UN WOMEN also shows that women's gendered role as food makers and household carer defines their crop choices. Often women cultivate subsistence crops rather than high-value crops as their male counterparts. Several authors agree that these gendered constraints affect women's agricultural productivity, hamper their recognition within agrarian production and impede their empowerment (Tsige et al. 2020; Smith, 2013; Bekana, 2020).

Although gender affects the division of labor and women's position in agrarian activities, Amenyah and Puplampu (2013) emphasize that other socio-economic characteristics affect women's labor allocation and duties in production, such as age, status, labor available, and technologies. Similarly, Beneria and Sen (1982) and Martinez (2012 p. 102-103) have highlighted that gender in SSA should be seen as a dynamic and fluid concept, as the outcome of much more complex socio-economic factors intertwining (Beneria and Sen, 1982; Martinez, 2012 p. 102-103). Additionally, Chu (2011 p. 37-36) has stressed that women in SSA have agency of their own and can access resources through informal and unconventional channels. Thus, it is pivotal to regard women farmers in SSA as dynamic actors and gender as "contingent on available and emerging opportunities" (Amenyah and Puplampu, 2013 p. 17).

Finally, previous literature has clarified the importance of women in agrarian practices and sustainable development. Research has also highlighted the gendered and socio-economic factors hampering women's access to resources and limiting their potential in food, agrarian and sustainable production. Given that the research aims to analyze the determinants of extension services, the next chapter of the literature review will analyze the strengths and weaknesses of these services by presenting previous research in SSA. Additionally, a paragraph will be dedicated to emerging gender-responsive extension programs in SSA.

3.2 Extension Services among Sub-Saharan Countries

3.2.1 Strengths and Weaknesses

Extension services in developing countries, especially in SSA, are crucial in agricultural policies and development (Taye, 2013). Agrarian extension services, called agrarian advisory services, have been central to many developmental programs. Extension services can significantly contribute to achieving food security by adopting and introducing new technologies, reducing poverty and social inequalities, and supporting sustainable agrarian practices and anti-climate change strategies while promoting inclusive and participatory development (Oladele, 2011). Oladele et al. (2004) additionally stress that extension services can link small-holder farmers to the market through a demand-driven approach and support farmers in being competitive, diversifying their production, reaching niche markets and producing higher/value crops. Furthermore, River and Qamar (2003) highlight the contribution

of AES to the health sector, especially in the battle against the spread of HIV. During extension meetings, development agents can increase awareness and spread health advice to the rural population (River and Qamar, 2003; Abou, 2015).

Extension packages vary across countries, and their format and provision have evolved as the agrarian paradigm has shifted throughout the decades. As Taye (2013) and Oakley and Garforth (1985) demonstrate, agrarian services were seen in the past as a linear model of technological transfer from the agent to the farmer. On the other hand, extension services are nowadays seen as a collaboration between the farmers and the agents (Cristóvão, Koutsouris & Kügler, 2012). Previous models envisioned extension services through the lenses of the agents teaching the farmers. However, as Abou (2015) shows, when the green revolution in Africa failed, a new learning paradigm was introduced, which accepted a technological transfer from the farmers to the agents and vice versa. Farmers' knowledge of their profession is more rigorous and proficient than scientists or other practitioners (Abu, 2015; Van Asten et al., 2009).

Despite the positive perception of the literature on the potential of extension services, their impacts on SSA countries are still ambiguous (Cristóvão, Koutsouris & Kügler, 2012; Taye, 2013; Van Asten et al., 2009). Although their potential can increase productivity, the agrarian sector in SSA has not experienced a massive productivity increase, raising general doubts about the effectiveness of Agrarian Extension Services (AES) (Feder, Birner and Anderson 2011; Rivera and Qamar, 2003)

In Uganda, Benin et al. (2007) have found that the Uganda National Advisory Service (NAADS) bettered the quality and availability of the services. However, there was no positive outcome on yield growth. Davis et al. (2010) have found that in Kenya and Tanzania, the field farmers school (FFS) increased the productivity and income of farmers. However, no positive effect of this approach was found in Uganda. Similarly, ECON Analysis (2005) found that the provision of AES significantly increased crop production in Mozambique. However, in Mozambique, several smallholder farmers were eventually displaced by large-scale farms and big corporations (Zwane and Chauke, 2015). In Ethiopia, two studies have found contradictory results, Ayele et al. (2005) and IFPRI (2008) found that extension programs have had positive outcomes, while the EEA/EEPRI (2006) showed that extension services had no significant outcome on various dimensions of development such as food security, farmers' income, poverty and productivity. These works suggest that the effects of extension services are context-specific, and it is impossible to assume a one-size fits all approach. Additionally, Taye (2013)

and Zwane and Chauke (2015) both argue that it is extremely challenging to assess the impact of extension services due to a lack of data, reliable samples and lack of an internationally recognized and implemented extension systems.

Within the literature, several challenges can be identified affecting the implementation and efficiency of extension services. Oladele (2011) and Zwane and Chauke (2015) have identified a need for more effective policy development as one of the main challenges. In fact, without sound and clear policies, it is difficult to implement effective programs. Abu (2015) highlighted a need for more participation and inclusiveness among the many issues identified. The author stresses the need to develop programs that are responsive to the needs of the rural population, especially, of the most vulnerable side of the societies, such as female farmers and the youth.

On the other hand, extension services have often been found to exacerbate equity issues rather than tackle them. Seemingly, Rivera and Alex (2004) stress that for AES to provide the services expected, there must be special attention to women farmers' needs and gendered struggles. As shown in the section above, women are important in food and agrarian production, and thus, they are crucial actors to be integrated into the extension programs. Understanding what stands in the way of equitable service provision is a key challenge in developing and efficiently implementing extension services (Abu, 2015). Lastly, these findings resonate with the situation in Ethiopia, shedding light on similar systemic barriers and bottlenecks among countries, ultimately stressing the importance of gender inclusiveness among Sub-Saharan countries' extension strategies.

3.2.2 Emerging Gender Inclusive Practices in AES

Among the various policies promoting female access to extension services in East Africa, as of 2019, local governments and non-governmental organizations implemented novel policies to expand their effect on female agricultural participation (Ayele, 2019). The policies implemented education, health, and training initiatives designed to elevate female participation in agricultural practices, while providing valuable instruments to reduce the livelihood of marginalized female farmers. Studies on their impact, however, demonstrated that although these initiatives could protect female farmers' property rights, their implementation tends to fade (Ayele, 2019).

On the opposite side, positive impacts were recorded from the Women in Agriculture (WIA) Extension Program in Nigeria, which focused on creating units of trained female extension agents that were directly interacting with female farmers in order to create a gender framework that considered their needs in regard to technology and information. The creation of these farmer's groups both benefitted the development of inclusive extension policies and the socioeconomic status of the farmers by reaching them with agricultural innovations and farming practices (Onyibe, 2001; Odurukwe et al., 2006). Seemingly, farmers' groups have also been employed in Tanzania (Mattee and Lassalle, 1994 cited in Mbo'o-Tchouwaou and Colverson, 2014), additionally, the mixed gender nature of the groups promoted positive communication among male and females by creating a common ground and interests. These strategies align with the guidelines identified by Kiptot & Franzel (2012) implemented to counteract the social norms inhibiting the successfulness of agroforestry extension programs in Africa. Additionally, the guidelines include increasing the reach of the extension services by organizing remote meetings for farmers who cannot participate. Lastly, extension services are directed at targeting more women enterprises. Although these policies show promise to be effective, the determinants that lead to the extension services are not discussed, nor have they been measured to comparatively wider samples (Kiptot & Franzel, 2012). Outside of the SSA geographical area, a recently successful case study comes from the Self-Employed Women's Association (SEWA) in rural India. Herbel (2010) and Gale et al. (2013) argue that this approach is innovative as it enables self-help groups to be assisted by the SEWA organization to tackle their constraints and empower women through their own means, thus, empowering them outside and inside the households.

The literature confirms the relevance of gender issues in extension services internationally, and not limited to the Ethiopian context, confirming the motivation behind developing this research. Furthermore, the international political effort to include women in extension services stresses further the importance of understanding the factors reducing female farmers' participation and inclusiveness among AES.

3.3 Determinants of female farmers' Access to SSA

Several factors contribute to determining farmers' access to extension services. As mentioned above, it is pivotal to understand which characteristics affect female farmers'

participation in AES, given their central role in agricultural policies. This section of the literature review will present previous works that have studied female farmers' determinants of access to agrarian extension services to determine a theoretical framework to use as a guideline for the following quantitative analysis.

Nkebe et al. (2012) have divided the determinants of farmers' access to extension services between personal and household attributes, farm/plot characteristics, and socioeconomic and institutional factors. Furthermore, Miju Swachu (2020) included a category that considers cultural factors affecting women farmers' participation in agricultural activities. As the previous sections of this thesis highlighted, female farmers face additional gender constraints that policy developers have often overlooked (Amenyah and Puplampu, 2013; Tsige et al., 2020; Diao et al., 2007). Thus, this literature review will also consider female empowerment and intra-household dynamics determinants.

3.3.1 Personal and household attributes

The personal and household attributes include factors such as education, age, marital status, family size and whether a woman is the head of the household. Several studies have highlighted the role of these factors in determining female farmers' access. A study from Ghana identifies aged square as a proxy for old age as a significant determinant, highlighting the mechanism that makes older female farmers more likely to access extension services due to long experience and factors accumulation (Abdul-Hanan and Awal 2016). Accordingly, a study from Ethiopia shows that as age increases, women are more likely to participate in extension services (Haile 2016). These findings align with the national panel in Uganda that has highlighted that young female farmers face additional obstacles in accessing agricultural resources (Leon-Himmelstine et al., 2021). On the contrary, a study from poultry producers in Ethiopia shows that age negatively affects access to AES, implying that young females better understand the benefits of joining these services than older farmers (Atsbeha and Gebre, 2021).

Education has been identified as a potential constraint to female farmers' access to AES. However, the results are often contradictory. In two studies in Ethiopia and one from Ghana, education was found to have a negative effect on the probability of a woman accessing AES (Sitachew et al., 2018; Abdul-Hanan and Awal, 2016; Atsbeha and Gebre, 2021). Abdul-Hanan and Awal (2016) have suggested that formal education might not be a mandatory credential to access AES in Ghana. Nonetheless, in all three works, education did not statistically determine

their access to AES. On the contrary, in the study from Haile (2016) in Ethiopia, education is a determining factor in accessing AES in the Dendi district. Haile (2016) highlights a potential mechanism implying that as education increases, the level of education decreases, suggesting that women with more education can access better jobs and do not need to rely on AES. Additionally, marital status and family size were identified as significant determinants of AES access in Ethiopia's Dendi district and among female poultry producers (Haile, 2016; Atsbeha and Gebre, 2021). Miju Swachu (2020) argues that the marital status of women can affect their access to AES because of their responsibilities based on their marital situation.

Another personal attribute that plays a significant role in determining farmers' participation is whether the latter is the spouse or the head of the household. Abebe and Yazie (2019) and Sitachew et al. (2018) found that in Ethiopia, females in male-headed households face additional struggles in accessing these services because they are not the primary decision-makers and the holders of the households' resources. Instead, they are the ones that are in charge of most household activities. Conversely, Berger et al. (2014) argue that female heads of households are worse off because of the additional workloads on their shoulders. Additionally, they often have fewer sources and less labor available to take time off and attend extension meetings.

3.3.2 Farm and Plot Determinants

This section will analyze the farm and plot determinants of female farmers' access to AES. In the Oromia region and the Yilmanadensa District in Ethiopia, farming experience was identified as a positive driver of female participation, as farmers with longer experience are more prone to adopt new technologies and to see the benefits deriving from participating in the AES (Sitachew et al., 2018; Abebe and Yazie, 2019). On the contrary, as a study in Ghana shows, an increase in farming experience slows participation in AES, as more-experienced farmers only perceive the benefits of AES later. Similarly, Hailu(2016) and Sabo (2006)found that more-experienced farmers in Ethiopia's Dendi district and Nigeria tend to invest and participate in more lucrative activities than AES.

The size of the plot was also identified as a key determinant. In Ghana, plot size significantly increases female participation in AES. Accordingly, Sitachew et al. (2018) and Abebe and Yazie (2019) find that possessing more irrigable and farming land in Ethiopia increases women's access to extensions.

Access to resources also plays a determinant role in women's participation in AES. In Ethiopia, it was found that distance to a water source significantly determines female participation in AES, as it determines the opportunity cost of investing in agricultural activities. Being far from a water source reduces the chances and the incentives to produce a better yield, and thus, it significantly reduces the incentives and benefits of AES participation (Sitachew et al., 2018).

As mentioned above, access to land is also critical in agricultural activities and can unlock several agricultural inputs, including extension services (Amenyah and Puplampu, 2013). Without access to land, farmers lack the primary goods that allow them to implement the knowledge acquired during extensions trainings. However, access to land not only possesses an economic value by providing the farmer with a stable income and production source but also defines the farmer on a social and communal level (Verma, 2007). The cultural importance of land for extension services will be explored in more detail in the upcoming section.

Access and knowledge of agricultural inputs such as fertilizer were also positive determinants for Ghana's female farmers' access to AES. The study suggests that extension officers will more likely select farmers that can easily access these inputs as it smoothens the transition of knowledge and agricultural practices (Abdul-Hanan and Awal 2016).

Lastly, a study in Tanzania also highlights that crop choice affects farmers' involvement in AES. Female farmers often engage in home plot production of vegetables that are irrelevant to mainstream AES services. Thus, female participation is considered less relevant to extension services (McCormack 2018).

3.3.3 Institutional Determinants

The socioeconomic and institutional factors include access to credit as a determinant in Ethiopia and Ghana. Credit access can help farmers buy and access agricultural inputs such as improved seeds and new technologies, thus facilitating farmers' access to AES (Sitachew et al., 2018; Atsbeha and Gebre, 2021).

Additionally, being a member of a group cooperative was also found to be a positive factor in determining female access to AES. Cooperatives provide women with information on extension services and how to access the latter, thus, creating an informal network that can

incentivize and facilitate women's access to AES. Evidence from Ghana and Tanzania show the significance of these mechanisms (McCormack 2018; Abdul-Hanan and Awal 2016). On the contrary, farming membership did not significantly impact farmers' access in the Dendi District in Ethiopia (Haile, 2016).

Another determinant of access to AES through the channel of information sharing was found in women's access to mass media. It was shown that in Nigeria, print and visual media are the main source of agricultural knowledge (Lawal et al., 2016). In Uganda, several initiatives have been raised to share extension content directly to women through mobile phones and other social media means, believing that mass media can significantly share agrarian knowledge and include most of the population (Campenhout et al., 2016). In Ethiopia, access to mass media, especially the radio being the most popular and accessible means of information, is assumed to significantly affect females' access to agricultural activities and technologies (Miju Swachu, 2020).

Among the institutional factors, the interaction between farmers and extension agents also plays a critical role in determining the accessibility of those services. Cultural norms and bias can affect the behavior and availability of male officers towards female farmers, seeing them as inferior and, thus, less able to grasp and benefit from extension services (Razzaghi Borkhani and Mohammadi, 2018 p. 196; McCormack, 2018). For instance, Razzaghi Borkhani and Mohammadi (2018) stress that in Ethiopia, development agents are often allowed to talk only with the decision-maker of the households. Additionally, women are often not allowed to talk with other men; thus, they do not receive the information directly but only through their husbands (Ministry of Agriculture and Natural Resources, 2017). In Tanzania, it was shown that female farmers face gender bias in their capability to grasp and apply the knowledge provided during their extension meetings (McCormack, 2018). Seemingly, in the Oromia region in Ethiopia, it was found that interacting with a female extension agent increases women's probability of accessing the service (Abebe and Yazie, 2019). The research suggests that female agents have a better understanding of the cultural struggles affecting women, thus, are more capable of helping them. Nevertheless, the findings are contradictory, as, in Uganda, there was no evidence of differences in participatory outcomes between female and male agents (National Gender Profile).

Lastly, in Ethiopia, distance to a market can affect female farmers' participation in agricultural activities since it provides them with information on market prices and enables them to create networks and access agrarian information (Miju Swachu, 2020; Haile, 2016).

3.3.4 Social and Cultural Factors

Among the social and cultural factors, it is pivotal to shed light on the role that gender norms play in determining female access to AES. Gender norms affect female farmers' expected and accepted role in their households and community, affecting their image as extension services customers (McCormack, 2018). Among East African countries, a farmer's position in the agrarian community is strongly defined by its access to resources such as land (Verma, 2007). Thus, a key factor in determining access to agrarian services is the tenure security of the farmer. Seemingly, Miju Swachu (2020) identified owning or holding land as affecting female farmers' access to agrarian activities. Previous literature showed that women are often discriminated against due to gender norms, and often, women's lack of tenure security and decision-making power over land-related decisions determine their role as helpers rather than farmers (Verma, 2007). These constraints undermine their potential as extension service targets and negatively affect their access to these services (McCormack, 2018, p. 63; Abebe and Yazie, 2019). For instance, extension agents tend to communicate and share useful information only with the landowner (Razzaghi Borkhani and Mohammadi 2018). Additionally, women's decision-making ability over land-related decisions was a critical element affecting women's participation in extension services in Tanzania (McCormack, 2018). The lack of female agency in farming decisions portrays women as less relevant recipients of agrarian knowledge, as unable to decide on the farming land.

Gender norms also determine women's time spent on domestic activities, such as food production, childcaring and household maintenance. In addition, to the other agrarian activities that women are engaged in. Two studies in Ethiopia show that as domestic activities increase, the probability of accessing AES diminishes, given the time constraints many female farmers face (Abebe and Yazie, 2019; Sitachew et al., 2018).

Furthermore, female farmers often face additional mobility constraints, such as expensive transport costs, lack of mobility means and the inability to leave the house without the husband's permission (Abebe and Yazie, 2019; Sitachew et al., 2018). In Uganda and Nigeria, transport costs were identified as a significant barrier to women's access to AES

(Lawal et al., 2016; Leon-Himmelstine et al., 2021). Additionally, given women's additional time burden, they often do not have the time to leave the household and the money to afford transportation to the extension meeting.

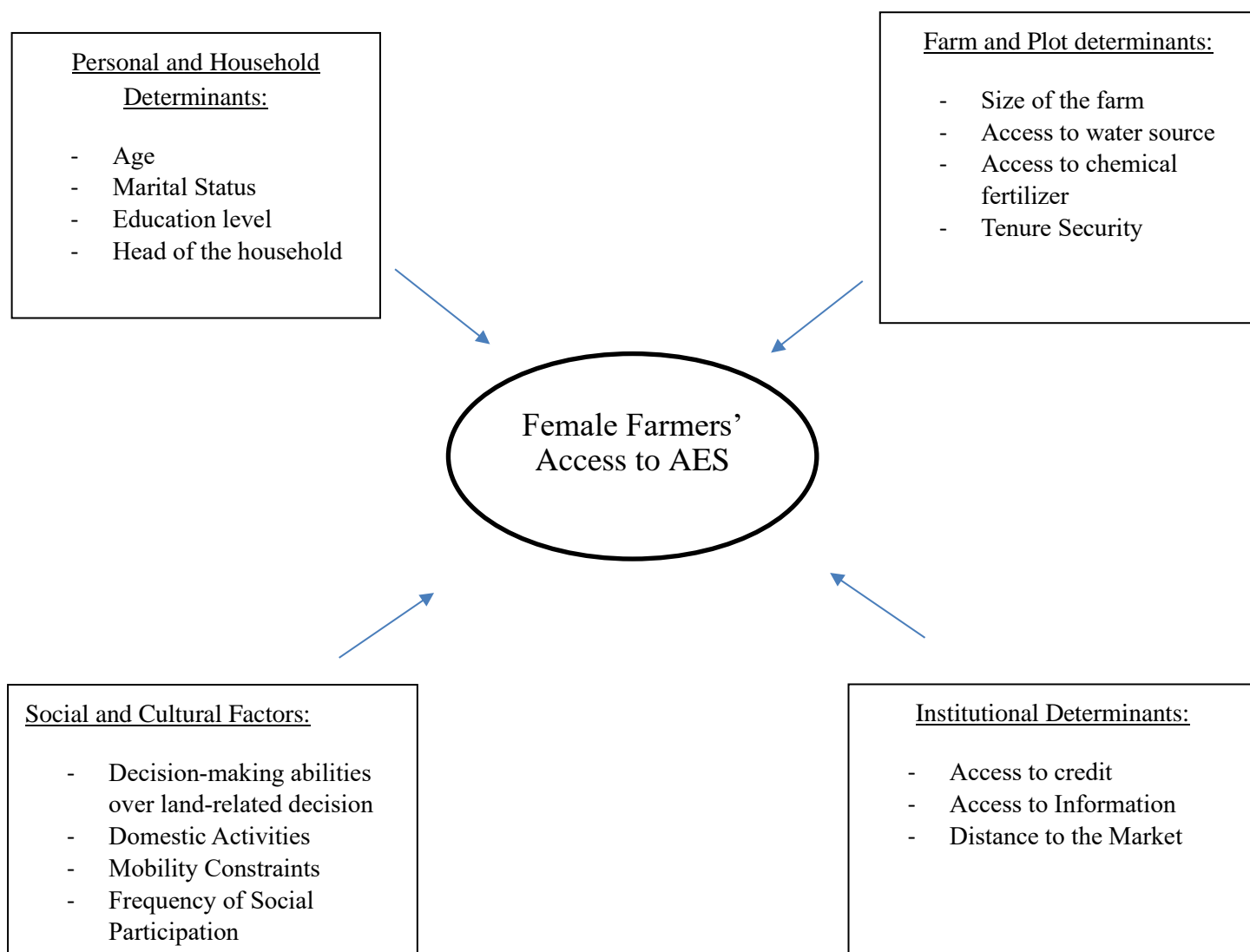
Female participation in communal activities was also presented as a positive driver of women's access to extension services (Miju Swachu, 2020; Temesgen et al., 2015). Farmers more involved in their communities have better access to agrarian information, thus, more knowledge and possibilities of being included and willing to participate in AES in Ethiopia (Miju Swachu, 2020; Temesgen et al., 2015). In this realm, Temesgen et al. (2015) contribute to the literature by finding evidence that the frequency of women's participation in communal activities was a significant difference between female participants and nonparticipants in extension trainings. Thus, for social participation to be a significant driver, it must be frequent and active.

In conclusion, the findings from previous literature demonstrate that each category of factors can play a significant role in determining women's access to AES. Following previous research, the determinants will be placed among these categories: personal and household characteristics, farm and plot characteristics, institutional factors, and social and cultural factors. The variety of results found in previous literature demonstrates that every case study is context-specific and that it is not possible nor correct to draw general conclusions and hypotheses on female farmers' determinants in SSA, and Ethiopia. However, the literature review also proves that gender analysis is a powerful means to investigate thoroughly the mechanisms and effects of these determinants, with the goal of promulgating inclusive and realistic policies. Additionally, additional research is needed to cover different dimensions. Thus, this research is intended to contribute to this vital field of investigation by presenting an analysis that attempts to control for multidimensional factors affecting female farmers, from socio-economic to gendered characteristics. Lastly, this research will employ the dataset from the Ethiopian-socio economic survey (2018/2019) which has not yet been used by the literature previously mentioned that investigated determinants of AES in Ethiopia.

3.4 Theoretical Framework

Based on the findings from the literature review and employing the theoretical categories previously identified by Nkegbe et al. (2012) and Miju Swachu (2020), the following research will investigate these categories; Personal and Household Factors, Farm and Plot determinants, Institutional Determinants and Social and Cultural Factors, as shown in Figure 2. Although the literature review has attempted to highlight the most significant findings, it is pivotal to acknowledge that other factors potentially affecting farmers' participation, such as psychological/behavioral factors (Miju Swachu,2020). Additionally, it is important to mention that, due to the available data, it will not be possible to quantitatively analyze factors such as farming experience, profitable crops, cooperative membership and contact with extension agents. Thus, the lack of these variables of interest will be considered a research limitation when drawing conclusions.

Figure 2. Theoretical framework



Source: own elaboration from literature review, drawing from Nkegbe et al. (2012) and Miju Swachu (2020) framework.

4 Data Description and Analysis

This research has gathered data from the Ethiopian-socio economic survey (ESES) 2018/2019, which is the result of a collaboration between the Central Statistics Agency of Ethiopia (CSA) and the World Bank. The Ethiopian Socio-economic survey from 2018-2019 is the fourth wave of this initiative and has collected information from all the nine regional states in Ethiopia, the followings are Tigray, Afar, Amhara, Oromia, Somalia, Benishangul Gumuz, SNNP, Gambela, and Harar. Additionally, the survey has incorporated the same information from the two administrative cities of Addis Abeba and Dire Dawa. For the purpose of this study, the fourth wave of the ESES was deemed the most apt as it reflects the most recent policies of the Ethiopian agrarian sector.

As part of the selection process, the survey responses chosen for this research are filtered to only include women participants which were at the time either head of the households or the spouses. Moreover, only responses from rural areas were selected in the following geographical regions; Tigray, Afar, Amhara, Oromia, Benishangul Gumuz, SNNP, Gambela, Harar and from the administrative city of Dire Dawa.

4.1 Strengths and Weaknesses of the Dataset

The ESES 2018/2019 was selected because it allows to carry out a sex-disaggregated analysis among rural households. In fact, Doss et al. (2018) consider this dataset among the initiatives that goes beyond broad generalizations on gender in Africa and can thus contribute to developing a deeper and more nuanced understanding of the roles, resources, and limitations that exist within different contexts for both men and women. Among the four waves of the sample, the 2018/2019 survey was selected for three reasons, firstly, it is the more recent work thus provides more reliable data (The World Bank, Microdata Library). Secondly, this is a new panel, meaning that is not a follow up of the previous three waves but a baseline for upcoming waves. Thirdly, compared to the previous waves this survey is representative also on a regional level, additionally, this survey was specifically adapted to be consistent with countries current

policy, sustainable development goals and existing survey. Lastly, and most importantly for this research, this wave in partnership with LSMS plus (+) added new sections on individual-level disaggregated data in order to track changes in SDGs indicators and other economic dimensions within the household.

Although this dataset, and more precisely the 2018/2019 wave, seem appropriate to carry out gender research, they also present several limitations. Firstly, investigating only one year can limit the external validity of the results as it does not allow to infer a pattern across time, thus, it cannot be assumed that these results will hold in a different time spectrum. Additionally, every Ethiopian region presents diverse socio-economic and cultural characteristics which, however, due to limited data and time constraints will not be controlled for as would be ideal. Given the various cultural, social, and geographical subnational characteristics, caution is necessary when interpreting the results in order to avoid the cultural and historical compression of regional differences. Lastly, the data availability does not allow to statically control for every determinant identified by the literature, thus, some factors have been analysed only from a qualitative perspective. Taking into consideration these limitations, this work will attempt at providing the most reliable analysis, based on relevant past literature, and applied to the right context.

4.2 Description of the determinants

4.2.1 Dependent Variable

Table 1. Summary of the dependent variable.

Code	Dependent Variable	Type of Variable	Description of variable
advisory_service	Access to AES	Dummy Yes: 1 No: 0	Answer to the question: Do you get advisory services?

Source: own elaboration.

The dependent variable of the study is advisory_service which asks the respondent whether she/they have received advisory services (AES), as shown in Table 1. Among a sample of 1126 respondents, around 40% did not receive access to extension services whilst 60% did.

Thus, the sample is relatively balanced between those who access and who did not access the service. One caveat of the variable is that it doesn't allow for a specific analysis of the type of advisory services or the sources of the advisory service. As seen in the background section, the Ethiopian extension system is pluralistic. Thus, access to the advisory service could represent access to a multitude of services such as Farming Training Centers (FTC) or to a farmer organization, or a private, group meeting with a Development Agent (DA), among the many approaches. Indeed, the dependent variable does not capture the differences across the types of extension packages. Future studies should delve more on the effects of different typology of extension providers and methods on farmers' access to AES. Investigating more in depth the providers and the type of extension method can support the evaluation and later implementation of gender-responsive actions at the provider level and improve the specific service. These limitations will be addressed when drawing final conclusions. Nevertheless, the variable `advisory_service` is valid for the scope of this research.

4.2.2 5.2.2 Determinants

Based on the framework, the determinants were categorized in 4 dimensions: personal and household attributes shown in Table 2, farm and plot determinants shown in Table 3, institutional determinants shown in Table 4 and the social and cultural factors shown in Table 4.

Table 2. Personal and household attributes

Code	Independent Variable	Type of Variable	Description of Variable
age	Age	Continuous	Answer to the question: How old is [NAME]? (COMPLETED YEARS)
head_household	Head of the household	Dummy	Takes value of 1: Head of the household Takes value of 0: Spouse
avgyears_education	Years of Education	Continuous	1=Tigray = 2.98 2= Afar= 1.43 3= Amhara= 2.4 4=Oromia= 2.01 6=Benishangul gumuz= 2.69 7=SNNP= 2.45 12=Gambela= 5.56 13=Harar= 4.48 15=Dire Dawa= 4.17
marital_status	Marital Status	Discrete	1. Never Married 2. Married (monogamous) 3. Married (polygamous) 4. Divorced 5. Separated 6. Widowed 7. Co-habiting

Source: own elaboration.

The determinants age is a continuous variable with an average of 37 years and the minimum age of 11 years and a maximum of 75.

Secondly, the model will control whether the respondent is the head of the household or the spouse, in fact, based on the literature we assume that there might be significant differences in the access to AES between female spouses and female head of the household.

One concern might be found with the variable head of the household since it could also capture the status of jointly headed households thus, where both a man and a woman have the headship. However, in this research we are interested only in the headship status of a woman, so it should not present any caveat for the scope of this research.

In lack of precise educational data, the variable `avgyears_education` represents the average level (in years) of female education per region, these data are from the Global Data Lab and were then plotted and matched with the region of the respondent indicated in the survey. These data are proxies then for the level of education. The average of the years of education among all nine geographical areas is extremely low, around three years. This proxy, however, does not allow for individual data meaning that it should not be considered a reliable indicator of individual education. However, these findings are in line with Mulugeta and Cherinet (2003), that argue that the illiteracy rates in Ethiopia are extremely high, especially among women. Thus, this proxy can be considered valid for the scope of this research.

Lastly, marital status contains the four categories shown above. Among the sample of 1126 respondents around 87% are part of a monogamous marriage, with only 1.25% being polygamous, whilst 8% of the respondents are widows. These data can be considered reliable given that they ask straight forward question to the respondents and present direct evidence of their personal attributes. However, a report from the DHS in 2011, shows a national average in polygamy of 12 %, thus, much higher than in our sample. This could mean that polygamy is underrepresented in this sample.

Nevertheless, all the data are reliable and valid for the research. Additionally, based on the literature, we expect all three determinants to have a significant effect on access to AES. However, due to the contradictory findings among case studies, it is not possible to hypothesize the direction of the effects.

Table 3. Farm and plot characteristics

Code	Independent Variable	Type of Variable	Description of Variable
number_of_fields	Proxy for size of the farm	Discrete	Answer to the question: What is the number of Fields in this [Parcel]?
water_access	Proxy for access to Water Source	Dummy Yes: 1 No: 0	Answer to the question: Is there water service in the community?
usechemical_fertilizer	Access to Chemical Fertilizer	Dummy Yes: 1 No: 0	Answer to the question: Do u use chemical fertilizer in this crop?
user_rightss	Proxy for tenure Security	Dummy Yes: 1 No: 0	Answer to the question: Do you hold use rights for this [PARCEL], either alone or jointly with anyone else?
ownership_rights	Proxy for tenure security	Dummy Yes: 1 No: 0	Answer to the question: Do you own this [PARCEL], either alone or jointly with someone else?

Source: own elaboration.

The data for farm and plot characteristics attempt at providing the most possible information about the characteristics of the field/ type of production that can affect farmers' participation in AES. As a proxy for farm size, this research will use the variable number_of_fields which controls for the number of fields that a parcel has. Among the 1126 female respondents, 53% of the sample has between 1 and 4 fields.

Secondly, the variables water_access is a proxy for access to water . This variable represents the availability of a service at the community level; thus, it does control for the effect of living in a community where these services are provided. However, it does not consider whether the woman per se accesses these services, nevertheless, the research assumes that

having this services at a community level already positively trickles down to women farmers as it reduces the time constraints to reach and use these resources.

The variable `usechemical_fertilizer` is more reliable since it asks directly to the respondents if she/they use chemical fertilizers in their crops, so it establishes that this input is used by the farmer itself.

The variable `user_rights` and `ownership_rights` are both proxies for tenure security since they control for whether the farmer holds user and ownership rights. It is important to control both types of tenure security since having user rights is different than owning a parcel of land, thus, they might have different effects on the participation of the farmers. In Ethiopia, as envisaged under Article 40(3), (7) of the Federal Democratic Republic of Ethiopia (FDRE) Constitution, ownership of land is vested in the state and the people (*Land Rights in Ethiopia* /, n.d.). What this means is that the land is owned by the government and private ownership is prohibited (Ambaye, 2012). However, the government provides the farmer with ownership rights which do not include the ability to sell and mortgage the land. The farmers are allowed to rent it to fellow farmers, use the land for agriculture production, have full ownership of the harvests produced, lease it to investors, and inherit and donate the land to members of the family (Ambaye, 2012). These rights technically increase the tenure security of the farmers against expropriations and violations, thus, should reduce the vulnerability to losing access and control over their land (Ambaye, 2012). Additionally, user rights allow the farmers to benefit from the land by cultivating it, living on it or using it for specific purposes, however, they are based on the agreement established by the two parties and do not grant the same rights as owning the land. Thus, tenure security might be more vulnerable (Ambaye, 2012). It is pivotal, however, to mention that land rights in Ethiopia are a complex and historical matter that present many facades and dimensions. It is impossible to reduce the Ethiopian land tenure to two types of tenure security. Additionally, one caveat with these two variables can be that they do not separate between individual and co-joint tenure security, thus, there might be a different effect if the tenure is individual. Nevertheless, the scope of this research was to control for tenure security, thus, should not represent a caveat. Although, future studies could take this difference into account.

Based on the literature, we expect the size of the farm, and access to water and access to chemical fertilizers to significantly increase women's access to AES. Seemingly, the literature stresses that tenure security should potentially increase women's access to AES.

Table 4. Institutional determinants

Code	Independent Variable	Type of Variable	Description of Variable
access_credit	Access to credit	Dummy Yes: 1 No: 0	Answer to the question: do you get credit services in this agriculture season?
radio_household	Proxy for access to information	Dummy Yes: 1 No: 0	Answer to the question: Does your household own any [ITEM]?
distance_majorurbancenter	Access to the Market	Continuous: In Kilometers	Answer to the question: How far is it to the nearest major urban center?

Source: own elaboration.

The institutional variables include access to credit, access to information and access to the market. The variable access to credit takes the form of a dummy variable. This variable estimates the direct effect of a farmer accessing a credit service. However, if feasible, future research should consider the different providers of the credit services, as it might influence and give a clearer indications of which provider can boost female's participation. Based on the literature, we expect this variable to have a positive effect on women's participation in AES.

Secondly, as a proxy for access to information, the variable radio_household is employed. In fact, the literature highlighted that radios are among the most popular means to access information in Ethiopia. We expect this variable to increase the probability of receiving advisory services.

Lastly, the distance_majorurbancenter variable controls for the distance in kilometers from the community the nearest major urban center. This variable is a proxy for access to market, in lack of available data for the direct distance from the community to the market. This research assumes that the distance to a major urban center does also imply distance to the market. Thus, this variable is a reliable and valid representation of distance to markets. Based on the literature we expect the coefficient of this variable to be negative, meaning that as the distance decreases the probability of receiving advisory services increases.

Table 5. Social and cultural factors

Code	Independent Variable	Type of Variable	Description of Variable
empower_land_decision	Decision-making abilities over land-related decisions	Dummy Yes: 1 No: 0	Answer to the question: Are you among the decisionmaker(s) across the PARCEL on this [PARCEL] regarding the timing of crop activities, crop choice, and input use?
empower_investland	Decision-making abilities over land-related decisions	Dummy Yes: 1 No: 0	Answer to the question: With regard to this [PARCEL], are you among the individuals who have the right to make improvements/invest it, even if you need to obtain consent or permission from someone else?
need_permissioninvest	Decision-making abilities over land-related decisions	Dummy Yes: 1 No: 0	Answer to the question: Do you need permission or consent from anyone else?
mobility_costtransportation	Proxy for mobility constraints	Discrete In Birr	Answer to the question: What is the cost of the total fare to go by public transportation from here to the woreda town even if one has to change means of transport en route?
frequency_community	Proxy for Social Participation	Continuous: Number of days	Answer to the question: For how many days have you participated in the watershed activities?
time_fetchingwater	Proxy for domestic activity	Discrete: In Hours	Answer to the question: How many hours did [NAME] spend fetch water from natural or public sources for use by the household Yesterday?
time_firewood	Proxy for domestic activity	Discrete: In Hours	Answer to the question: How many hours did [NAME] collect firewood or other natural products for use as fuel

			by the household Yesterday?
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Source: own elaboration.

As part of the social and cultural factors two proxies for female empowerment or land-related decisions will be considered. The variable `empower_land_decision` directly controls for the effect of a female farmer deciding on a variety of land-related activities. The variable `empower_investland` instead controls for the right of a female to invest and make improvements on the land. Thus, they are both proxies for female decision-making power over land-related investments, however, `empower_land_decision` implies that the woman does not need permission or consent. For these reasons, the variable `need_permissioninvest` is added because it accounts for whether the respondent needs permission from anyone else to carry out land-related investments. This variable is more reliable because if the respondent answers no, then it holds full decision-making power on the land related activities. Thus, it is a more reliable proxy for women empowerment.

As a proxy for a mobility constraint, the variable `mobility_costtransportation` will be employed. This variable controls for the price in Birr of public transportation to the closes woreda town. This proxy represents the cost of transportation, which was previously highlighted by the literature as a barrier to female farmers participation in AES. Nevertheless, this variable captures only one of the dimension of mobility constraints but leaves out cultural mobility constraints such as needing the husbands' permission or more practical barriers such as lack of means of transports. However, since the variable accounts for the cost of public transport it already assumes that most female farmers might lack access to private means of transports such as cars. Thus, although it does not account for the multidimensionality of mobility constraints it still present a reliable and valid estimate of transportation costs.

The variable `frequency_community` is a proxy for social participation. This variable does not only control for the respondent's participation in communal activities, but, following the findings from Temesgen et al., (2015) controls for the frequency of the participation over a week. Based on the literature, we expect this variable to have a positive effect on the dependent. However, `frequency_community` only accounts for women's participation among watershed activities, which clearly do not represent the whole number of activities happening in a community. Thus, the explanatory power of this variable is limited to its context. Nevertheless, the variable is valid for the research since it offers the direct effect of the frequency of

participating in a communal agrarian activity. As mentioned in the background section, some extension packages offer water-shed activities, creating a potential problem of correlation among the dependent and the independent. However, a correlation test on the Stata statistical program and the Variance Inflation Factor (VIF) shown in Table 6 (Section 5) shows that the two variables are not multicorrelated to each other. The research thus proposes that it is reliable to employ frequency_community as a proxy for social participation. Additionally, research shows that watershed activities can significantly impact crop production and incentivize sustainable agriculture which can bring benefits to farmers and rural areas (WWF and ABInBev, 2017). As it was observed in the case of using chemical fertilizers, participating in these activities can increase farmers incentives in accessing AES by spreading knowledge on sustainable practices and, at the same time, increase women's recognition and value as extensions' targets. Thus, this variable is valid for the scope of the research.

Lastly, the variables time_fetchingwater and time_firewood are both proxies for women's time spent on domestic activities. In fact, these two variables illustrate the amount of time that a woman spends on fetching water and collecting firewood to use as fuel which can be considered time consuming domestic activities since they serve the household and both support food production and childcare. Especially, these activities are considered gendered since women are the ones usually taking care of these needs of the household in Ethiopia (Mulugeta and Cherinet, 2003 p. 16). These variables are thus representative of the time women spend on taking care of crucial household activities, and how the latter can affect their participation in AES. Nevertheless, these variable do not directly account for the other dimensions of food production and childcare, thus, it is important to consider the limitations of the explanatory power of these proxies.

Based on the literature, we expect the two variables empower_land_decision and empower_investland to have a positive effect on women's access to AES. Given that the variable need_permissioninvest takes value of 1 if the woman needs permission, we expect this determinant to have a negative effect on access to AES. Secondly, we expect the variable mobility_costtransportation to have a negative effect on access to AES. On the other hand, based on the previous theory we expect frequency_community to have a positive effect on access. Lastly, we expect time_fetchingwater and time_firewood to negatively access to AES, since they are the two proxies for domestic burden.

5 Empirical Methodology

To carry out the empirical analysis, this research will employ a logistic regression model. The reasons to employ a logit model are several, firstly, the main dependent variable of this study, *advisory_services*, is of dichotomous nature which takes a value of 1 if the respondent has accessed advisory services and 0 otherwise. The Logit statistical model is specifically designed for dichotomous dependent variables, such as *advisory_service* (Stock and Watson, 2003). In this case, a nonlinear probability model such as the logit makes the predicted values lie in between 0 and 1 because its logistic cumulative distribution function (c.d.f.) produces only probability between 0 and 1 (Stock and Watson, 2003). Secondly, the previous literature identified in this research, similarly employed logistic regressions to investigate the determinants of female's participation in AES. Thus, it can be considered the most suited model for this kind of analysis (Sitachew et al., 2018; Abdul-Hanan and Awal, 2016; Atsbeha and Gebre, 2021).

Before using the logit model however, it is important to control for multicollinearity and high correlation across the explanatory variables (Atsbeha and Gebre, 2021 p. 4-6) For this reason, the Variance Inflation Factor (VIF) test was carried out. In fact, if there is high correlation among and between variables then the assumption of the covariance to be equal to zero would be violated and the estimates would not be reliable (Atsbeha and Gebre, 2021 p. 4-6). If there is high multicollinearity among variables, then we cannot assume that the explanatory variable separately contributes to the changes in the dependent variable (Atsbeha and Gebre, 2021 p. 4-6). If the VIF value is above 10, then there is a serious problem of multicollinearity and these variables must be omitted from the model, in order to reduce the biasedness of the results (Atsbeha and Gebre, 2021 p. 4-6).

Table 6. Variance Inflation Factor (VIF) with all the determinants

	VIF	1/VIF
age	1.227	.815
2.marital status	<u>44.685</u>	.022
3.marital status	5.583	.179
4.marital status	<u>11.616</u>	.086
5.marital status	4.724	.212
6.marital status	27.054	.037
7.marital status	1.352	.74
head household	3.274	.305
avgyears education	1.146	.873
water access	1.042	.96
number of fields	1.076	.93
usechemical fertil~r	1.131	.884
user rightss	1.258	.795
ownership rights	1.179	.848
access credit	1.088	.919
distance majorurba~r	1.258	.795
empower investland	2.363	.423
empower land decis~n	1.271	.787
need permission	2.381	.42
frequency community	1.061	.942
mobility costtrans~n	1.21	.826
time firewood	1.056	.947
time fetchingwater	1.036	.965
radio household	1.045	.957
Mean VIF	5.005	.

Source: own elaboration.

Table 6 shows that the VIFs values of the categories of marital status are much above 10, thus, present a significant problem of multicollinearity. For these reasons, the variable marital_status will be omitted by the main model. This research is aware of the limitations of not including this determinant, as it was identified by previous literature as a significant determinant of female farmers access to AES. Nevertheless, for the purpose of a more transparent quantitative analysis, we proceed with the model without marital_status. By looking at Table A.1. in the Appendix, it is visible that by carrying out the VIF test without marital_status, we do not encounter any multicollinearity issue and the mean VIF drops to 1.279.

5.1 Logit Model

The general model of the logit is the following:

$$\Pr[y = 1|X] = F(x'\beta)$$

Where $\Pr[Y=1|X]$ is the predicted probability of the event of interest Y to occur (being equal to 1); in this case, a woman accessing advisory services, conditional to X which is a matrix of independent variables (determinants)

F () is the logistic function, which as mentioned above, changes the linear combination of the independent variables and their coefficients into a probability of the event to occur between 0 and 1.

β represents the vector of the coefficients associated with each independent variable. These coefficients quantify the effect of each independent variable on the log-odds of the occurrence of a woman accessing advisory service to occur (Y=1).

Applying the general logit model to the research specification:

$$\begin{aligned} \Pr(Y = 1|X) = & F(\beta_0 + \beta_1 \text{age} + \beta_2 \text{headhousehold} + \beta_3 \text{avgyearseducation} \\ & + \beta_4 \text{numberoffields} + \beta_5 \text{wateraccess} + \beta_6 \text{usechemicalfertilizer} \\ & + \beta_7 \text{userrights} + \beta_8 \text{ownershiprights} + \beta_9 \text{accesscredit} \\ & + \beta_{10} \text{radiohousehold} + \beta_{11} \text{distancemajorurbancenter} \\ & + \beta_{12} \text{empowerlanddecision} + \beta_{13} \text{empowerinvestland} \\ & + \beta_{14} \text{needpermissioninvest} + \beta_{15} \text{mobilitycosttransportation} \\ & + \beta_{16} \text{frequencycommuniy} + \beta_{17} \text{timefetchinwater} + \beta_{18} \text{timefirewood}) \end{aligned}$$

The second step of the methodology will be to calculate the average marginal effects (AME) of the determinants. In fact, due to the non-linear nature of the logistic distribution, it is challenging to interpret the magnitude of the coefficients on their own, rather, they can be useful to determine the direction and the significance of the predictors on the binary dependent variable. For these reasons, the average marginal effects are employed in logistic regression.

The average marginal effects can provide an easier interpretation to the results, as they represent the change in the probability that the outcome occurs as the explanatory variable

changes by 1 unit, while holding all the other explanatory variables constant (Norton et al., 2019). Thus, this approach will be employed to interpret the magnitude, significance, and direction of the effects of the predictors on access to AES.

6 Interpretation and Discussion of the results

6.1 Logit Estimations

The results of Table 7, indicate that there are 8 significant determinants, respectively; the average of the years of female education, access to water service at the community level, use of chemical fertilizers, having individual or joint ownership rights over a parcel of land, having access to a credit service, being among the decision-maker for what concerns land related decisions, the frequency of participation among watershed activities and the cost of going with public transportation to the closest woreda town.

Table 7. Model (1): logistic regression on dependent variable access to advisory services

advisory_services	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
age	-0.008	0.007	-1.29	0.197	-0.021	0.004	NS
head_household	0.025	0.218	0.11	0.909	-0.403	0.453	NS
avgyears_education	-0.228	0.115	-1.99	0.046	-0.453	-0.004	**
water_access	1.132	0.174	6.50	0.000	0.791	1.474	***
number_of_fields	.002	0.012	0.15	0.884	-0.021	0.025	NS
usechemical_fertil~r	1.183	0.144	8.20	0.000	0.9	1.466	***
user_rightss	0.158	0.335	0.47	0.636	-0.498	0.815	NS
ownership_rights	-0.368	0.155	-2.37	0.018	-0.671	-0.064	**
access_credit	1.276	0.306	4.18	0.000	0.677	1.875	***
distance_majorurba~r	-0.002	0.002	-1.07	0.283	-0.005	0.001	NS
empower_investland	-0.184	0.236	-0.78	0.437	-0.646	0.279	NS
empower_land_decis~n	0.276	0.166	1.67	0.096	-0.049	0.601	*
need_permission	0.249	0.214	1.16	0.245	-.171	0.669	NS
frequency_community	0.023	0.004	5.19	0.000	.014	0.032	***
mobility_costtrans~n	0.006	0.003	2.04	0.041	0.000	0.012	**
time_firewood	0.067	0.068	0.98	0.326	-0.066	0.199	NS
time_fetchingwater	0.026	0.054	0.48	0.629	-0.08	0.133	NS
radio_household	-0.231	0.167	-1.38	0.168	-0.559	0.097	NS
Constant	-0.214	0.535	-0.40	0.69	-1.261	0.834	
*** $p < .01$, ** $p < .05$, * $p < .1$							
Mean dependent var		0.631	SD dependent var			0.483	
Pseudo r-squared		0.151	Number of obs			1126	
Chi-square		223.564	Prob > chi2			0.000	
Akaike crit. (AIC)		1296.670	Bayesian crit. (BIC)			1392.172	

Source: own elaboration.

When looking at the personal and household determinants; the determinant `avgyears_education` shows that an increase in the average years of education reduces the probability of accessing advisory services. Among the farm and plot characteristics, the determinant `water_access` and `use_chemicalfertilizers` show that access to these two inputs increase the probability of accessing advisory services. On the contrary, having individual or joint ownership rights decreases the probability of accessing these services. Among the institutional determinants, having access to credit services increases the probability. When looking at the socio-cultural level, it is possible to observe that being among the decision-makers on land-related decisions increases the probability of accessing advisory services. Seemingly, the frequency of participation also increases the probability of accessing advisory services. Interestingly, the cost of public transportation also increases the probability of accessing advisory services.

6.2 Average Marginal Effects (AME) Estimations

As mentioned in the empirical methodology, using the average marginal effects (AME) allows an understanding of the coefficients' magnitude since it provides a straightforward interpretation of the impact of the predictors on the probability of a woman accessing advisory services.

Among the eighteenth determinants shown in Table 8, eight determinants were found to have a significant effect on the probability of accessing advisory services; the average of the years of female education, access to water service at the community level, use of chemical fertilizers, having individual or joint ownership rights over a parcel of land, having access to a credit service, being among the decision-maker for what concerns land-related decisions, the frequency of participation among watershed activities and the cost of going with public transportation to the closest woreda town.

Table 8. Model (2): Average Marginal Effects of predictors on dependent variable advisory

Average marginal effects

Number of obs = 1,126

Model VCE : OIM

Delta-method						
	dy/dx	Std.Err.	z	P>z	[95% Conf. Interval]	
age	-0.002	0.001	-1.290	0.196	-0.004	0.001
head_household	0.005	0.041	0.110	0.909	-0.076	0.086
avgyears_education	-0.043**	0.022	-2.010	0.045	-0.085	-0.001
water_access	0.215***	0.031	6.960	0.000	0.154	0.275
number_of_fields	0.0004	0.002	0.150	0.884	-0.004	0.005
usechemical_fertilizer	0.224***	0.024	9.310	0.000	0.177	0.271
user_rightss	0.030	0.063	0.470	0.636	-0.094	0.154
ownership_rights	-0.070**	0.029	-2.390	0.017	-0.127	-0.013
access_credit	0.242***	0.057	4.270	0.000	0.131	0.353
distance_majorurbancenter	-0.0003	0.000	-1.080	0.282	-0.001	0.000
empower_investland	-0.035	0.045	-0.780	0.436	-0.122	0.053
empower_land_decision	0.052*	0.031	1.670	0.094	-0.009	0.114
need_permission	0.047	0.040	1.170	0.244	-0.032	0.127
frequency_community	0.004***	0.001	5.410	0.000	0.003	0.006
mobility_costtransportation	0.001**	0.001	2.050	0.040	0.000	0.002
time_firewood	0.013	0.013	0.980	0.325	-0.013	0.038
time_fetchingwater	0.005	0.010	0.480	0.628	-0.015	0.025
radio_household	-0.044	0.032	-1.380	0.167	-0.106	0.018

Source: own elaboration.

6.2.1 Personal and Household Attributes

Among the personal and household attributes, the average years of female education significantly reduced the probability of accessing AES. More precisely, a one-unit increase in the average years of education decreases by 4.3% the probability of accessing AES, ceteris paribus. This determinant is significant at the 5% level. The negative direction of the coefficient is in line with the previous findings by Sitachew et al. (2018) and Atsbeha and Gebre (2021) in Ethiopia, and by Abdul-Hanan and Awal (2016) in Ghana. However, the predictor is significant in the case of this research. Two mechanisms were highlighted by previous research in Ghana and Ethiopia, the former implying that education might not be a formal requirement for access to AES and the latter suggesting that more literate women could access more lucrative professions and be active in other sectors. These two channels might be driving the results in this sample, implying that among the 1126 respondents in the eight geographical areas,

education does not represent a determinant of access to AES. It is pivotal to mention that the variable `avgyears_education` is just a proxy for individuals' education. Thus, the research does not assume that this effect is completely representative of the actual sample. Nevertheless, education remains a critical element to foster rural women's empowerment in Ethiopia (Mulugeta and Cherinet, 2003).

6.2.2 Farm and Plot Characteristics

Among the farm and plot characteristics, having access to a water source at the community level is significant at a 1% level, and it increases by 21,5% the probability of accessing AES, *ceteris paribus*. This finding resembles the research by Sitachew et al. (2018), which highlighted that having easier access to water increases the incentives for accessing AES. The authors highlight two possible channels through which the vicinity of a water source can affect farmers' access to AES; firstly, having easier access to a water source reduces the transaction costs of transporting water, thus, reducing the transaction costs of farming activities. Secondly, by having easy access to a water source, female farmers can be potentially exposed to agrarian information and water-related farming techniques. Both channels can increase the incentives and reduce the opportunity costs of accessing advisory services. Especially in the Ethiopian context, where most agrarian production is rain-fed, and droughts and water scarcity affect the rural population, water availability is pivotal in unlocking access to agricultural resources (WRI, 2021; Mulugeta and Cherinet, 2003). This finding stresses the importance of providing easier access to basic needs such as water to support the rural population and the growth of the agrarian sector, especially for women that are in charge of water collection at the household level.

Another highly significant determinant at the 1% level is access to chemical fertilizer, which increases by 22.4% the probability of accessing AES. This finding aligns with the previous research by Abdul-Hanan and Awal (2016), which found that female farmers that possess previous knowledge/have access to these agrarian inputs are considered easier targets of AES. Possessing previous knowledge of these inputs facilitates the implementation of agrarian practices and the transmission of knowledge through AES. These findings stress the importance of smoothening female access to agricultural inputs, as it can be a powerful means to increase their participation in agrarian programs.

Having individual or co-joint ownership rights significantly reduces the probability of accessing AES at the 5% significance level. More precisely, being a respondent that has ownership rights over a parcel of land reduces by 7% the likelihood of accessing AES, *ceteris paribus*. At first sight, this finding goes against the common conception that stronger tenure security can facilitate access to agrarian services such as AES (Amenyah and Puplampu, 2013). However, the direction of the relationship is positive when looking at the determinant *user_rightss*, although not significant. As mentioned above, tenure security plays a critical role in access to information and agrarian services; perhaps a woman owning land, thus, holding stronger tenure security, might employ different channels. Deininger and Jin (2005) and Holden and Ghebru (2016) argued that certain types of investment may be selected to enhance tenure security rather than as an effect of pre-existing stronger tenure security. Seemingly, in Tanzania, it was found that a group of women perceived extension services as a means to empower themselves (McCormack 2018). An example from Burkina Faso shows that farmers with less tenure security undertook certain land-related investment to enhance their tenure security (Brasselle et al., 2002). Secondly, these findings suggest that a woman owning a parcel of land prefers/can access other services that are considered more profitable rather than a woman holding user rights who might rely more on these services to access agricultural inputs. Seemingly, Deininger and Jin (2005) and Singirankabo and Ertsen (2020) confirm that the impact of tenure security varies depending on the farmer's productivity perception of the investment. Deininger and Jin (2005) suggest that less tenure security might incentivize actions to add productivity while securing property rights, rather than pure productivity-enhancing activities. The women with ownership rights in the sample might access services with different benefits. These theories and previous findings can justify the significant difference in the probability of accessing AES for the two types of tenure security.

Additionally, these findings stress further the importance of promoting extension services that are responsive to the different needs of women farmers, avoiding placing them in the same category. Lastly, AES should put even more pressure on targeting the needs of farmers experiencing less tenure security, such as user rights holders, especially among the most vulnerable individuals. As highlighted by the MoANR (2017), the collection of gender-disaggregated can be extremely important to understand the dimensions of women's tenure security and its implications for extension services.

6.2.3 Institutional Determinants

The determinant access to credit significantly increases the probability of accessing AES at the 1% significant level. More precisely, being a respondent having access to credit service increases by 24,2% the likelihood of accessing AES, *ceteris paribus*. This finding goes hand in hand with Sitachew et al. (2018) and Atsbeha and Gebre's (2021) research that stresses the role of credit in fostering access to AES by facilitating the purchase of agrarian technology and inputs. Women with access to credit can overcome the financial burden limiting their productivity and adoption of technological innovation. Thus, this research confirms the importance of smoothening female access to credit and finance services for the growth of the agrarian sector.

6.2.4 Social and Cultural Variables

Among the social and cultural variables, being among the decision-makers on land-related decisions significantly increases the probability of accessing AES at the 10% level. More precisely, being among the decision makers over land-related decisions, increases by 5.2% the likelihood of accessing AES compared to a woman who does not have these decision-making abilities, *ceteris paribus*. Although the significance is low compared to other variables, this finding confirms the importance of intra-household dynamics for the participation and involvement of women in agrarian programs. As confirmed by the research from McCormack (2018) in Tanzania, women's empowerment is a strong driver of access and participation in activities outside the household. This finding confirms the importance and the urgency to carry on the strategies developed by the Ethiopian extension system to support women's socio-economic empowerment to create gender-inclusive extension services. As the MoANR stresses, the main goal is to reach a society where women will enjoy the same control over their resources as men. Seeing already the positive effect, although low in significance, of women's decision-making power among a relatively small sample confirms the vast importance and urgency of these policies.

Secondly, the frequency of participation in watershed activities also significantly increases the probability of accessing AES at the 1% level. A one-unit increase in the days a woman has taken part in these activities increases by 0.4% the likelihood of accessing AES. Although the magnitude of this coefficient is smaller compared to the others, it does align with Temesgen et al. (2015) research, suggesting that female's participation in certain communal activities drives their access to advisory services when is frequent, since women are more

involved and exposed to information and sustainable agrarian practices. This finding also suggests that for women to benefit from communal activities, they should be frequently involved in the latter for the benefits to trickle down to other aspects of their life. This finding confirms the urgency to push for women's active involvement in their communities through women's groups and raising gender awareness among male farmers, which are all strategies mentioned in the extension agenda of the Ethiopian Ministry of Agriculture and Natural Resources (MoANR). As the MoANR mentions, gender bias might also affect women when access to AES is granted by stopping them from sharing their opinions, raising their doubts and concerns, and actively gaining knowledge. Similarly, in Tanzania, McCormack (2018) highlights that although women were participating in the AES, they were not active members. Thus, the benefits from the programs were extremely limited. These findings resonate with the mission of the MoANR (2017) of not only increasing women's participation but the quality of it. Thus, confirming the "transformative power of equal participation" (Un Women, 2021).

Lastly, it was found that the price to go by public transport to the closest woreda town was found to significantly increase the probability of accessing AES at the 5% significant level. An increase in the cost of transportation increases by 0.1% the likelihood of accessing AES. This finding contrasts with the literature found in Nigeria and Uganda (Lawal et al., 2016; Leon-Himmelstine et al., 2021), which have identified the cost of transportation as a main barrier to female farmers' access to AES. Although the magnitude of the effect is very low, this finding suggests that among this sample of respondents, the ones that spend more money on transport are more likely to access AES. Thus, this discovery goes in contrast to the hypothesized effect. This finding could suggest that the respondents that access AES are the ones more willing and with more resources to spend on public transport to travel to the closest woreda town and that among this sample, the cost of transportation does not represent a barrier to women's access to AES.

Additionally, Stifel and Mintel (2017) observe that within North-western Ethiopia, the regional transport costs vary significantly across communities due to the geographical heterogeneity of the region, which is a common characteristic across many regions in Ethiopia. A study in Malawi (Lee et al., 2023) also addresses road placement and condition as a significant determinant of extension services, which can also affect the cost of the transportation. These findings could suggest that if the women accessing advisory services mainly come from communities that meet at least one of these two requirements, they would

be exposed to higher transportation costs regardless of their willingness to pay. These two channels could also explain the significant positive effect of the cost of transportation.

6.2.5 Non-significant Determinants

Among the non-significant determinants, the number of fields in a parcel as a proxy for farming size was hypothesized to have a positive effect on access to AES since farms with bigger sizes are better targets for AES given that production can be bigger, they often possess more resources compared to farmers with less land (Sitachew et al., 2018; and Abebe and Yazie, 2019). In this research, the sign of the relationship is positive. However, insignificant. This finding could be explained by the sample being 53% represented by individuals that possess between 1 and 4 fields.

Seemingly, age has a negative but insignificant effect on access to AES, meaning that a one-unit increase in age negatively affects the probability of participating in AES. Previous works have found age as a significant determinant in both a negative and positive direction. This finding suggests that older women are less likely to access AES in this sample. Perhaps, following Atsbeha and Gebre's (2021) analysis, older women might be more reluctant to adopt new technologies.

Furthermore, the head of the household was expected to significantly affect access to AES, as being a head of the household and being the spouse was found to significantly affect women's access to resources in the previous literature. The relationship is positive, meaning that a woman being the head of the household is more likely to access AES than the spouse. However, when looking at the distribution of these two conditions, it is possible to observe that the respondents' heads of the household are 20% compared to 80% of spouses. This under-representation of the HH might be driving the insignificant results.

Distance to major urban centers, as a proxy to distance to the market, is not significant. However, it does display a negative relationship, as hypothesized. The lack of significance could mean that distance to an urban center is a determinant for other services, banking, employment opportunity, financial institutions (Dorosh and Thurlow, 2014; Mukim, 2016). As mentioned above, this research assumed that distance to a major urban center could be a valid proxy for distance to the market. However, there might be more suitable locations determining female access to AES. However, the insignificant effect of this variable resonates with the cost

of transports positively affecting access to AES, meaning that physical mobility constraints are not driving female access to AES in this sample.

The variables `empower_investland` and `need_permission` are proxies for decision-making abilities over land-related decisions, specifically land-related investments. These two variables display an unexpected direction, although both display insignificant effects. Having the right to decide over land-related investment decreases the probability of accessing AES while needing permission to do so increases the probability. The lack of significance of these two dimensions of female empowerment suggests that these two proxies do not determine female access to AES in this sample. There might be other dimensions of female-decision making abilities that can contribute significantly to the outcome. Lastly, these findings suggest that deciding what improvements to make and how to invest in the land is still an activity where men have more authority (Melesse et al., 2018).

Contrary to their hypothesized effects, the time spent on domestic activities such as fetching water and collecting firewood has a positive effect, although it is insignificant. As mentioned above, these two activities only capture a limited aspect of women's daily life within and outside the household's activities. Thus, they are not relevant determinants of their access to AES. Activities such as cooking and taking care of the children might have a significant impact.

Lastly, opposite to the effect hypothesized by the literature, owning a radio in the household has a negative and insignificant effect on female access to AES. The findings might be explained by the notion that farmers who access information through the radio are then not incentivized to access advisory services. Additionally, the literature mentioned television as another significant determinant. Thus, it might be a better predictor than radio ownership.

7 Conclusion

The Ethiopian agrarian sector contributes significantly to the country's economic growth and employs 80% of the population that relies on it for its livelihood. Most farmers practice smallholder agriculture: among these, women contribute to half the labor force. Despite their contribution to the agrarian sector, the latter are still hampered in their development by socio-economic and cultural constraints limiting their access to vital agrarian resources and programs. Among the agricultural policies promoted by the Ethiopian government, following the Agricultural Development Led Industrialization (ADLI) strategy, extension services play a critical role in fostering the growth of the agrarian sector. However, this system still faces systematic bottlenecks driving down its effectiveness in fostering agricultural productivity, reducing food insecurity, and supporting small-holder farmers' capacity.

Among the various systematic impediments, the Ethiopian Ministry of Agriculture and Natural Resources (MoANR) has highlighted the lack of gender mainstreaming and inclusion in agrarian extension services as a crucial issue to be addressed. Lack of gender responsiveness, sex-disaggregated research and data, and cultural constraints negatively affect women's access to AES. Thus, to develop gender-responsive extension services, it is pivotal to understand what socio-economic and gendered-specific factors affect women's access.

For the above reasons, this research has answered the following question: "what are the determinants of female farmers' access to Agrarian Extension Services (AES) in Ethiopia?"

By employing a logistic regression, this research has found eight significant determinants among four categories: Personal and Household Factors, Farm and Plot determinants, Institutional Determinants and Social and Cultural Factors. Among the personal and household attributes, the average years of education significantly decreased women's access at the 5% significance level, suggesting that education is not a determinant of access to AES among the respondents. This finding has resonated with previous literature arguing that

educated women might access more lucrative services or higher-status activities (Sitachew et al., 2018; Atsbeha and Gebre, 2021; Abdul-Hanan and Awal, 2016; Haile, 2016).

Secondly, among the farm and plot characteristics, having access to water sources and using chemical fertilizer significantly increased access to AES at the 1% significance level. These findings are aligned with the research from Sitachew et al. (2018) and Abdul-Hanan and Awal (2016). Respectively, having relatively easy access to a water source can ease women's constraints in carrying out farming activities and expose them to new technologies and techniques, thus incentivizing their access to AES. Seemingly, when women use chemical fertilizers, they gain previous knowledge of certain farming techniques, facilitating the transfer of knowledge and technologies between development agents and farmers and ultimately increasing access. These findings stress the importance of allocating agricultural inputs among female farmers.

Thirdly, holding individual or co-joint ownership rights significantly reduced the probability of accessing AES at the 5% significance level. On the other hand, holding user rights increase the probability of accessing AES, although not significantly. This finding suggested that tenure security should not be considered a one-way road and that different types of tenure security can affect farming decisions. Following previous research (Brasselle et al., 2002; Holden and Ghebru, 2016; Deininger and Jin, 2005; McCormack, 2018), it can be implied that women holding ownership rights might access different activities. On the other hand, respondents holding user rights might access AES to enhance their tenure security while accessing productive enhancing activities. These findings stress the importance of gendered-focused research, as highlighted by the (MoANR), and the need to target farmers with less tenure security.

Among the institutional determinants, access to credit significantly increased women's access at the 1% level. This finding supports the claims from Sitachew et al. (2018) and Atsbeha and Gebre (2021), highlighting the importance of access to financial services as a channel to allow women to purchase agricultural inputs, ultimately increasing their access to AES.

Among the Social and Cultural Variables, being among the decision-maker over land-related decisions significantly increased access to AES at the 10% significance level. This

finding is extremely important because it confirms the importance of empowering women farmers by giving them control over resources, additionally, proves the importance of this mechanism for agricultural development. Additionally, it valorizes the strategy put in place by the MoANR to focus on increasing women's socio-economic empowerment.

Furthermore, the frequency of participation in watershed activities significantly increased access to AES at the 1% significance level. This finding aligns with Temesgen et al. (2015) research that highlighted the importance of the frequency of women's participation in outside activities. This finding also aligns with the MoANR strategy to focus on increasing women's participation in AES and push for their active involvement. Focusing on increasing the frequency of women's participation can be a potential channel to support women's empowerment.

Lastly, the cost of public transportation to the closest woreda town significantly increased women's access to AES at the 5% significance level. This finding contrasts with the previous literature, which identified transportation cost as the main barrier. A possible explanation for this contradictory result is that the women accessing AES in this sample are more willing to spend on transportation. Conversely, these respondents might be exposed to higher transportation costs due to the geographical location of their community or the road conditions in their communities.

In conclusion, in relation to the determinants found by this work, the gender-responsive strategies implemented by the Ethiopian government tackle thoroughly the determinants related to women empowerment and women's participation outside the household. However, the importance of access to financial support such as credit and agrarian inputs and resources such as fertilizers and water should be tackled more systematically. Lastly, major attention to the implications of women's tenure security could be a valuable addition to the development of context-specific extension systems.

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Appendix A

Table A.1. Variance inflation factor (VIF), omitting marital status

	VIF	1/VIF
need permission	2.37	.422
empower investland	2.358	.424
head household	1.378	.726
empower land decis~n	1.261	.793
distance majorurba~r	1.253	.798
user rightss	1.249	.8
mobility costtrans~n	1.205	.83
ownership rights	1.166	.858
age	1.156	.865
avgyears education	1.141	.877
usechemical fertil~r	1.123	.891
access credit	1.084	.922
number of fields	1.072	.933
frequency community	1.05	.952
time firewood	1.045	.957
radio household	1.037	.964
time fetchingwater	1.033	.968
water access	1.033	.968
Mean VIF	1.279	.

Source: own elaboration.

