Agricultural extension service accessibility under decentralised governance: Evidence from smallholder sunflower farmers in Dodoma and Singida regions, Tanzania

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ABSTRACT

Despite significant investments in agricultural extension systems in Tanzania, a critical research gap persists regarding the effectiveness of decentralised models for delivering extension services to marginalised smallholder farmers. Drawing on access and decentralisation theories, the study employed a cross-sectional research design to examine agricultural extension services' (AES) accessibility across districts and genders in the Dodoma and Singida regions of Tanzania. The target population comprised smallholder sunflower farmers across selected districts, and a sample size of 385 farmers was selected through multistage sampling techniques comprising purposive selection of districts and random sampling of farming households. Data were collected using structured questionnaires and analysed using descriptive statistics, an accessibility index derived from factor analysis, a χ^2 test, ANOVA and ordinal logistic regression. Findings revealed disparity in AES accessibility across districts, while across sex it was not. Conversely, findings further indicate that farmers' education, farm experience and frequency of extension visits positively predicted AES accessibility, whereas greater distance to extension centres was associated with lower accessibility. The findings suggest that decentralised extension service delivery exhibits uneven outreach of services across districts, particularly those with resource constraints. Hence, it recommends that the government allocate extension agents based on needs to ensure districts with low accessibility receive proportionately greater support, integrate adult literacy programmes within extension frameworks and leverage experienced farmers as peer educators through farmer field schools to promote extension services. This study contributes novel insights into extension service accessibility under decentralised governance structures, as it provides evidence-based recommendations for policymakers and development practitioners seeking to enhance agricultural transformation outcomes in Sub-Saharan Africa.

Keywords: Agricultural Extension Services, Decentralized Governance, Extension Service Accessibility, Smallholder Sunflower Farmers, Tanzania

I. INTRODUCTION

Agricultural extension services (AES) are widely recognised as the key drivers for increasing farm productivity and improving livelihoods, particularly for rural populations. They act as a bridge between agricultural research and farmers by translating scientific knowledge from research institutions into practical and useful information (Adamsone-Fiskovica & Grivins, 2022). Accessing these services empowers farmers to adopt improved farming methods. They help them to make informed decisions regarding seed varieties, input use and pests and diseases management. Additionally, they teach farmers about soil conservation, climate-smart farming and sustainable agriculture, which promote long-term environmental sustainability (Raj & Garlapati, 2020). However, despite the potential benefits of these services, accessing them remains a major and longstanding challenge, especially for smallholder farmers (Khatri *et al.*, 2024). As defined by Arif (2024), accessing AES is all about how easily farmers can reach, receive, and effectively utilise advisory and technical support provided by extension agents. It reflects the availability, affordability, timeliness and adequacy of extension services to meet farmers' needs.

Globally, it is estimated that there are approximately 600 million farms, of which more than 90% are classified as smallholder farms, which collectively produce about 80% of the world's food (Food and Agriculture Organisation [FAO], 2021). However, despite this dominant position in world food production, 75% of smallholder farmers lack reliable access to extension and advisory services (FAO, 2021). In Sub-Saharan Africa (SSA), it is estimated that there are around 33 million small-scale farms, employing about 90% of rural populations and producing around 70% of Africa's food supply (International Fund for Agricultural Development [IFAD], 2021). Yet, smallholder farmers have limited access to AES. According to the World Bank (2022) AES coverage remains highly uneven, with typical farmer-to-extension officer ratios ranging between 1:3000 and 1:10,000, far exceeding the often-recommended ratio of 1:500

farmers. In Tanzania, smallholder farmers account for about 75% of the country's rural population (National Bureau of Statistics [NBS], 2021). AES are provided a pluralistic system that involves multiple actors, including public, private and civil society organisations. However, access to AES remains low. According to the 2019/20 National Sample Census of Agriculture report, out of 7,499,219 crop-growing households in Tanzania mainland, only 520,757 (6.9%) had received any form of extension advice on crop production, a sharp decline from 67% in 2007/08 (NBS, 2021).

In response to the persistent limitations in access to AES among smallholder farmers, various initiatives have been implemented over the past two decades across Sub-Saharan Africa, and Tanzania in particular. These efforts have included, among others, the decentralisation of extension services, the introduction of participatory and demand-driven extension approaches, the establishment of farmer field schools, the use of ICT-based advisory platforms and the partnerships with private sectors and non-government organisations (NGOs) (World Bank, 2022; FAO, 2021). Out of these reforms, decentralisation in the form of devolution (D by D) was one of the most significant policy shifts influencing the management and delivery of extension services in Tanzania since 1998. Under this framework, responsibilities for extension services, including planning, financing and implementing agricultural services, were transferred from the central Ministry of Agriculture (MoA) to Local Government Authorities (LGAs) to bring decision-making closer to farmers and ensure that the extension delivery reflects local needs and priorities (United Republic of Tanzania [URT], 1998).

By decentralising extension services, LGAs were empowered to deploy extension officers at the ward and village levels, allocate budgets and engage farmers in the identification and prioritisation of agricultural interventions. This was anticipated to strengthen accountability, improve responsiveness and promote farmers' participation in extension planning and evaluation. Consequently, decentralisation emerged as a key pillar in the endeavour to improve the accessibility, relevance and effectiveness of AES in Tanzania. However, whether the accessibility of AES has improved remains a critical question that requires investigation. Challenges such as insufficient funding, an inadequate number of extension officers and limited logistical support continue to be reported as constrain in extension service delivery at the local level (URT, 2020; FAO, 2021). This concern is particularly evident in Dodoma and Singida regions, where the majority of farmers are smallholder sunflower farmers due to the agro-ecological zone suitable for sunflower cultivation.

The economic reliance and predominance of sunflower farming in these regions call for LGAs to provide extension services to honour the promise of devolution, that is, increasing service accessibility. However, it remains unclear whether the smallholder sunflower farmers in these regions have access to timely, equitable, and adequate extension services. This is because sunflower production remained low, ranging from 0.8 to 1.2 tons per acre, significantly below the potential of 4.0 tons per acre under effective extension services (URT, 2024). Studies (Kingu *et al.*, 2024; Tibamanya *et al.*, 2022; Mujama & Uchiyama, 2021) have linked the low productivity of sunflower with the limited use of yield-enhancing inputs such as fertilisers and certified seeds and weak extension contact - symptoms commonly associated with inadequate extension coverage. However, to what extent extension services are accessible among smallholder farmers in the study area has not yet been established. There is a gap in understanding the accessibility of AES in these regions, particularly across genders and districts. Literature (Justine *et al.*, 2025; Magesa *et al.*, 2023; Masanja *et al.*, 2023) suggests that accessibility of services often differs based on factors like gender or geographical locations as a result of differences in socio-cultural norms, resource endowments and institutional arrangements. This gap is particularly striking given that national frameworks such as the Agricultural Sector Development Programme Phase II (ASDP II, 2018-2028) and the National Agricultural Policy (NAP, 2013) emphasise inclusiveness in service delivery. Therefore, understanding AES accessibility across genders and districts can reveal disparities in service delivery and inform policymakers and extension service providers on how to enable equitable services to overcome disparities (Kauky, 2024).

In the literature, studies on decentralisation and extension services in Tanzania are adequate. However, most of them have often concentrated on assessing governance and accountability dimensions of decentralised AES delivery. For example, they assessed demand and supply accountability in extension service delivery (Kessy, 2020), upward and downward accountability mechanisms in AES (Lameck & Hulst, 2021). Others assessed the relationship between fiscal decentralisation and service autonomy (Lameck & Kinemo, 2021), the effect of the local government reform programme on enhancing farmers' demand for reformed extension service (Mapesa, 2020) and decentralisation by devolution and farmers' access to AES (Masanyiwa *et al.*, 2019). However, little attention has been paid to the accessibility of AES by gender and across different geographical locations, and factors that influence the extension accessibility.

Therefore, this paper focused on assessing the accessibility of AES under a decentralised system, using smallholder sunflower farmers in the Dodoma and Singida regions of Tanzania. Specifically, it addresses two objectives: (1) assessing the accessibility of AES by sex and across surveyed districts. (2) Determine factors (demographic characteristics, farm characteristics, and institutional) that influence accessibility of AES among smallholder sunflower farmers.

1.1 Research Hypothesis

H_{01}: There are no significant differences in AES accessibility between male and female smallholder sunflower farmers in Dodoma and Singida regions of Tanzania.

H_{02}: There are no significant differences in AES accessibility across the surveyed districts in Dodoma and Singida regions of Tanzania.

II. LITERATURE REVIEW

2.1 Theoretical Review

This study is guided by two theories: The Access Theory and the Decentralisation Theory to assess the accessibility of AES across districts and gender, and factors that determine their accessibility.

2.1.1 Access Theory

Access Theory, as proposed by Ribot and Peluso (2003) defines access as the ability to benefit from resources or services beyond formal ownership or entitlement. It assumes that access to a certain service is shaped by structural, relational, and institutional mechanisms, including socio-relations, economic status, geographical location, and governance structures. In the context of AES delivery, Access theory underpins the identification of factors influencing farmers' access to AES, operationalised through demographic and farm characteristics (age, sex, education, incomes, farming experience, farm size) and institutional factors (extension visits, proximity to service centres). These factors collectively shape farmers' ability to obtain, utilise and benefit from extension services (Masanja *et al.*, 2023). Similarly, in other fields such as natural resources and health systems, Access Theory has demonstrated its usability in identifying key determinants of service access (Coolsaet *et al.*, 2020; De Jong & Fernandez-Monge, 2020), thus affirming its versatility and suitability for investigating determinants of AES accessibility in this study.

2.1.2 Decentralisation Theory

Decentralisation Theory was incorporated to assess variations in extension service accessibility across districts and genders. The core idea of Decentralisation Theory is that devolving authority, resources and decision-making power from central governments to local governments enhances efficiency, responsiveness and equity in service delivery (Smoke, 2015; Rondinelli, 1981). In the context of AES, it posits that decentralisation can lead to more equitable access to AES across different socio-demographic and geographical locations. However, under Tanzania's D by D framework, differences in local government capacity, resource allocation, governance arrangements, and the extent to which local governments integrate gender perspectives in extension planning and implementation may create disparities in the accessibility of extension services among districts and across genders. Therefore, this theory guides the assessment of accessibility of AES across gender and districts.

2.2 Empirical Literature Review

In conducting the study of the accessibility of agricultural extension services among smallholder sunflower farmers in Tanzania's decentralisation system, several studies were reviewed. Empirical evidence indicates that accessibility of AES among smallholder farmers remains generally low despite reforms intended to improve service delivery. Masanja *et al.* (2023) in a district-level study in Kibondo, Tanzania found that only a small proportion (18%) of smallholder farmers had access to extension support, despite of the services being decentralised to LGAs. The authors argue that decentralisation by itself cannot ensure effective extension services while there are staffing constraints and logistical limitations at the district level. Similar findings are reported outside Tanzania. For example, Midamba and Ouko (2024) examined extension access among smallholder farmers in Western Uganda, found that only about 42.5% of farmers accessed extension services, indicating moderate but still insufficient coverage. Another evidence from Ghana further supports this observation. For example, a study by Mahama *et al.* (2024) on agricultural extension services and household welfare from the Ghana socioeconomic panel survey, found that only 11% of households reported receiving any form of extension support, indicating that access remained highly limited in practice, despite implementing decentralisation reforms.

Beyond overall access levels of AES, empirical literature further highlights that gender disparities in accessing AES are highly pronounced. Nchanji *et al.* (2025), while examining climate-smart agriculture in Southern Tanzania, noted a significant gender disparity in both access and utilisation of extension services. Female farmers were less likely to access extension support than male farmers, even when services are available within their localities. The authors attributed this disparity to differences in education, income, asset ownership and social network, as well as extension systems that implicitly favour male farmers. Beyond Tanzania, comparative evidence from other African contexts reinforces these findings. Midamba and Ouko (2024), using a cross-sectional survey in assessing gender disparities in agricultural extension among smallholders in Western Uganda, found that female farmers had a significantly lower extension access score than male farmers, even after controlling for household and farm characteristics. The study

highlights the role of social norms, mobility constraints and unequal access to information in shaping gendered outcomes within decentralised systems.

Another study by Midamba *et al.* (2022) using a systematic literature review method examined what impact gender differences have on agricultural extension. Their findings show that agricultural extension systems are not inherently gender neutral. Female smallholder farmers experience greater constraints related to time availability, household responsibilities and limited participation in decision-making, all of which systematically reduce their effective access to extension services. At the global level, FAO (2023) corroborate these findings by documenting persistent gender inequalities in agrifood systems, including unequal access to extension services, credit, and inputs. The report emphasises that extension systems often target male household heads and commercial producers, which systematically marginalises women smallholders.

In addition to gender differences, spatial disparities in extension access across geographical locations are widely reported. Decentralisation in many African countries, including Tanzania, was intended to improve equity and inclusiveness in service delivery across different geographical areas (URT, 1998). However, studies suggest that decentralisation has also introduced spatial disparities in service accessibility across districts. Nwafor *et al.* (2021) reviewed agricultural extension and advisory services in Sub-Saharan African countries and found that extension coverage varies significantly across countries and sub-national contexts, reflecting differences in institutional arrangements, financial structures and implementation capacity. The review documents that extension coverage is uneven across regions, districts and communities, particularly in countries that have adopted decentralisation or pluralistic extension systems. Another study by Agwu *et al.* (2023) reviewed agricultural extension and advisory services in Nigeria, Malawi, South Africa, Uganda and Kenya also found that a decentralised service environment produces significant variation in extension outreach, with farmers in remote or less resource-regions likely to receive inadequate advisory services. Similarly, evidence from Tanzania supports this view. For example, Wilson *et al.* (2025) examined farmer field and business schools in Iringa Rural district, found that participatory approaches improved access, but effectiveness varied considerably depending on district-level institutional support and resource allocation.

With respect to determinants of AES accessibility, empirical literature identifies a range of demographic, farm and institutional factors that shape farmers' access to AES. For example, Nagar *et al.* (2021) assessed determinants of farmers' access to extension services and adoption of technical inputs in India, where they found AES access to extension services was influenced by socioeconomic and technology variables such as caste, gender, religion and usage of ICT. Underlining investments in ICT to increase service accessibility. Another study by Mwangi *et al.* (2023) on determinants of smallholder farmers' access to agricultural extension channels and their effects on awareness and compliance with good agricultural practices in Kenya, also found that farmers' access to extension channels was shaped by farm size, incomes, higher asset scores, physical proximity and easy interaction with service provider, and communication channels used by farmers. The study suggests that farmers in resource-constrained areas and located farther from service points are structurally disadvantaged even under a decentralised extension system. Equally, in Tanzania, Masanyiwa *et al.* (2019) linked decentralised governance (D by D) to farmers' access to extension services, where they found that accessibility depends on number and distribution of extension offices at ward and village levels, financial capacity of local government authorities, distance between farmers and extension offices and logistical support (transport, allowances and training resources) the paper conclude that even under decentralisation many farmers remained unreached because local government lacked resource to operationalise extension mandates.

Overall, from the reviewed literature, three key empirical gaps emerge. First, although numerous of studies document a low level of agricultural extension accessibility under decentralised reform, few examine accessibility within specific crop value chains, particularly sunflower, which has distinct production, marketing and advisory needs. Second, while gender disparities and spatial inequalities are well documented, existing studies tend to analyse these dimensions in isolation, without jointly examining how gender and district-level decentralisation interact to shape extension accessibility. Third, most studies focus on general smallholder populations and rarely integrate district-level institutional capacity, gender and household-level determinants within a single analytical framework. Consequently, there remains limited empirical evidence on how agricultural extension accessibility varies simultaneously across gender and districts among smallholder farmers in Tanzania's decentralised governance system.

III. METHODOLOGY

The study was conducted in the Dodoma and Singida regions of Tanzania's semi-arid central zone. Both regions experience low, erratic rainfall of 500-800 mm annually, making agriculture predominantly rainfall-dependent and susceptible to climate variability. The major economic activity in these regions is farming, whereas sunflower is the leading cash crop, contributing significantly to household income (Tibamanya *et al.*, 2022). These regions were purposively selected because they represent Tanzania's central agricultural corridor, where the government has emphasised the provision of AES to strengthen sunflower value chain development (URT, 2020). Thus, providing an

appropriate setting to assess how farmers access extension services and the factors influencing accessibility under decentralised governance.

A cross-sectional research design was employed to capture AES accessibility and its determinants at a single point in time (Wang & Cheng, 2020). This design aligns with similar assessment studies (Masanja *et al.*, 2023; Masanyiwa *et al.*, 2019), justifying its applicability in the current study. The study population was smallholder farmers involved in sunflower farming, and the unit of analysis was the heads of farming households. To ensure a representative sample, a multi-stage sampling technique was employed. The process began with the purposive selection of four districts, namely Kondoa and Chemba in the Dodoma region and Ikungi and Manyoni in the Singida region. These districts were selected because they lead in production, accounting for 55% of the total regional sunflower production (NBS, 2021). Next, eight wards were randomly selected: two from each district. Following this, two villages were selected at random from each ward (see Appendix I). In the final stage, households were identified from the village register, focusing specifically on heads of households involved in sunflower farming. The sample size was 385 households, computed using Krejcie and Morgan's (1970) sample size formula for a finite population. The total number of agricultural households (N) in all surveyed districts was 263,313. The Morgan's formula was expressed as:

$$n = \frac{\mathrm{X}^2 * \mathrm{N} * \mathrm{P}(1-\mathrm{P})}{\mathrm{d}^2 * (N-1) + X^2 * P(1-P)}$$

Where: n is the sample size required, X^2 is the table value of chi-square (3.841) for 1 degree of freedom at the desired confidence level of 95%, N is the total population size, P is the population proportion (assumed to be 0.5 for maximum sample size, and d is the degree of accuracy expressed as a proportion (0.05). Therefore, substituting N (263 313) into the formula resulted in a sample size of 384.54

$$(n) = \frac{3.841 * 263\ 313 * 0.5(1-0.5)}{0.05^2 * (263\ 313-1) + 3.841 * 0.5(1-0.5)} = 384.54$$

Besides, since the number of households varied across districts and wards, a proportional stratified sampling technique was applied to generate a representative sample size from each district and ward surveyed (see Appendix 2). Within each stratum, a simple random sampling technique was used to select households from the list of agricultural households obtained from the village registers.

The method of data collection was a survey questionnaire because it allows the systematic collection of data on a wide range of variables (Taherdoost, 2022). A questionnaire was used to gather data on the socio-demographic and economic characteristics of smallholder farmers, institutional, and farm characteristics that influence access to extension services. This facilitated statistical analysis to identify relationships and predictors of accessibility.

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26. The analysis involved both descriptive and inferential statistics. Descriptive statistics, including mean, median, and mode, were used to summarise farmers' socio-economic characteristics related to AES accessibility. These were the age, sex, year of schooling, annual income, farming experiences, farm size, distance to extension service, and frequency of extension visits. Equally, cross-tabulation was employed to determine AES accessibility by sex.

Inferential statistics, including Chi-square tests, One-Way Analysis of Variance (ANOVA), and Ordinal Logistic Regression (OLR), were also employed to assess the relationship between variables. Chi-square test of independence was used to assess associations between the sex of respondents and accessibility of AES (H_{01}). ANOVA with Tukey's Honestly Significant Difference (Tukey HSD) post hoc test was used to assess whether there are statistically significant differences in AES accessibility across districts (H_{02}). Before employing ANOVA, Levene's Test of Homogeneity of Variances was tested to verify that group variances are equal (Odoi, 2020); thereafter, One-Way ANOVA, with the Tukey HSD post-hoc test, was used to assess whether there are statistically significant differences in mean AES accessibility scores between districts. Tukey HSD post-hoc test was employed to provide precise pairwise comparisons of AES accessibility between districts. Tukey's HSD was preferred for its ability to control the familywise error rate and its suitability for unequal sample sizes across groups (Nanda *et al.*, 2021). It also offers a conservative and robust method for making all possible pairwise comparisons among group means while maintaining the overall Type I error rate (Midway *et al.*, 2020).

In determining predictors of AES accessibility (objective two), the OLR model was used. Before fitting the model, Accessibility was measured through an index derived from ten items using Exploratory Factor Analysis (EFA) and Principal Component Analysis (CPA). These items were the access to guidance on proper farm preparation, advice on seed variety selection, soil testing, planting methods, pest and disease control, harvesting and post-harvest handling, value addition, market information, linkage to agricultural credit services and application of mobile-based extension services. Before employing factor analysis, sampling adequacy and suitability of data for factorisation were tested using Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity, and reliability and internal consistency of the survey scale was tested using Cronbach's alpha. The KMO value was 0.931, indicating good sampling adequacy for EFA. According to Shrestha (2021), a KMO value of 0.90 or higher is considered excellent for factor analysis. Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 2894.374$, df = 45, $p < 0.05$), further suggesting that the data were suitable for factor analysis.

Following confirmation of data suitability for factorisation, a Principal Component Analysis (PCA) with varimax rotation was conducted to construct a composite accessibility index for AES. This approach was used to reduce the ten observed indicators into a single latent variable representing the overall accessibility of AES among smallholder sunflower farmers. Varimax rotation was preferred because it produces uncorrelated factors with distinct, high-loading variables, enhancing easy interpretations (Mabel & Olayemi, 2020). The ten items measuring AES accessibility were loaded for PCA analysis, and a scree plot determined the number of components to retain, revealing a clear break after the first component (see Appendix 2). Only one factor was retained, with an eigenvalue of 6.5, accounting for 65.4% of the total variance, meaning all ten items loaded strongly on this single component with loadings ranging from 0.692 to 0.861, and communalities from 0.692 to 0.861 (see Appendices 3 and 4). The generated factor was treated as a unidimensional scale representing the overall accessibility of AES. Furthermore, the Cronbach Alpha coefficient value was 0.941, exceeding the recommended threshold of 0.70, indicating high internal consistency and reliability of the scale (Amirrudin *et al.*, 2021).

The generated composite index (overall accessibility of AES) was treated as a continuous variable in the ANOVA model to test mean differences across surveyed districts, because the index was constructed from multiple items that, together, provide a score with sufficient variability. This approach preserves the full variability of respondents' responses, allowing direct comparison of mean accessibility scores groups than when collapsed into categories like low, moderate, and high, which could lead to a loss of information (Langenberg *et al.*, 2022). For Ordinal Logistic Regression, however, the index was transformed into ordered categories (very low, low, moderate, high, and very high) to align with the model's assumption of an ordinal dependent variable. The categorisation was guided by the distribution of standardised scores, ensuring grouping captured the natural variability observed within the sample (Tutz, 2022). Standardised scores were preferred over other approaches, such as equal-quantile or fixed-interval, which risk imposing arbitrary cut-offs that may suppress true variability within the data (Graetz, 2022). The specific cut-off values for each accessibility level are provided in Appendix 5. The five ordinal levels functioned as the dependent variable in ordinal logistic regression to identify factors influencing AES accessibility. Predictor variables were categorised into three groups: farmers' demographics (age, sex, education, income), structural factors (number of extension workers, extension visits, proximity to AES centres), and farm-specific factors (farm size). Equation 1 represents the regression model formula employed.

$$\log\left(\frac{p(Y \leq j)}{P(Y > j)}\right) = \gamma j + \sum_{m=1}^{M} \beta m \mathrm{Xm} \ldots\ldots\ldots (\text{Equation 1})$$

Y is the ordinal dependent variable (overall accessibility of AES) computed from ten items using EFA; J denotes the cut point threshold (for j =1234); P (Y≤ j) = Cumulative probability that farmer's accessibility falls in category j or below; P(Y> j) = Probability that accessibility falls in a category above j; γj = Threshold (intercept) for category j; X_m = Predictor variables (Age, education, sex, extension visits, incomes, number of extension workers, proximity to extension service centres, farm size, farming experience); βm = Coefficient of predictor Xm, assumed constant across all thresholds (proportional odds assumption) and; M = Total number of predictors in the model

IV. FINDINGS & DISCUSSION

4.1 Characteristics of Respondents

The paper sought to establish socio-economic and farm characteristics of smallholder farmers that may influence the accessibility of AES. Table 1 provides summary statistics on the general profile of respondents in terms of their age, education, sex, annual income, farming experience, number of extension visits, distance to the nearest extension service centre, and farm size.

Table 1

Socio-Economic Characteristics of Farmers

Variable	Mean	Median	Mode	Minimum	Maximum
Age	43.14	42	28	18	80
Years of schooling of respondents	7.65	7	7	0	17
Farming Experience in years	17.01	18	3	2	58
Annual income	2,931,948	2,700,000	3,000, 000	900,000	11,000, 000
Distance to extension centre	5.11	5	5	1	20
Number of extension visits	1.02	1	0	0	5
Farm size	2.91	2	2	1	30
Sex of Respondent	**Frequency**		**Percentage (%)**		
Male	244		63.4		
Female	141		36.6		

The findings in Table 1 show that the average age of farmers was 43 years, implying that the majority of farmers were middle-aged adults, a group generally considered to become economically active and more likely to participate in farming activities and agricultural decision-making. The findings further indicate that the median number of years spent in school was seven, equivalent to completion of primary education. This indicates that primary education completion is common among the surveyed farmers, although some had no formal education, while others had up to 17 years of schooling. The median level of education achieved by farmers implies that a significant percentage of farmers achieved a minimum level of literacy acquisition that can help facilitate the ability of these farmers to comprehend extension messages, innovation use, and utilisation of agricultural support services. Moreover, considering experiences in farming activities, the findings showed an average experience in farming activities of 17 years, showing a vast stock of knowledge in carrying out agricultural activities. The longer experience in farming activities is associated with greater familiarity with AES and their potential value addition to farming activities.

The findings further showed a great imbalance in farmers' annual income levels, with a median annual income of TZS 2 700 000. This indicates that many smallholder farmers operate with limited financial resources. According to the National Bureau of Statistics (NBS, 2022), the national basic needs poverty line was TZS 49,320 per adult equivalent per month, equivalent to about TZS 2,959,200 per household per year for an average of five five-member households. This reflects the low-income status typical of smallholder farmers in rural Tanzania, whose production and income sources are highly vulnerable to climate and market shocks. In terms of access to extension services, the median distance was about 5 km to the nearest extension centre, with a range that varied between 1 and 20km. This implied that a greater distance from the nearest extension service centre may be associated with lower accessibility to extension services, especially for farmers living farther from the points where extension services were being delivered.

The extent of extension visits was low, with a median of a single visit per cropping season, while some farmers did not receive any extension visits at all. According to FAO (2021) guidance, extension agents should visit farmers at every key stage, such as during farm preparation, planting, weeding, and application of inputs, harvest, and post-harvest handling, to provide technical advice and monitor progress. The scarce contact with the extension services implies probable gaps in the delivery of extension services that can interfere with knowledge and innovation transfer for farmers. The median farm size was 2 acres, which is typical for the smallholder farmers' profile that dominates Tanzanian agriculture (Abdulwahid *et al.*, 2024). In gender composition, male respondents were 63.4% compared to female respondents being 36.6%. This representation that favours males reflects likely more widespread enterprise on male-dominated land holding as well as decision making in agriculture. However, the fact that female farmers constitute a considerable proportion gives an intuition for gender consideration in the delivery of extension services in a bid to make such services more equitable.

Therefore, these findings on socio-economic characteristics of respondents noted in this study in alignment with previous findings on smallholder farmers in Sub-Saharan Africa. Middle-aged dominance reflects evidence by Maina *et al.* (2020), who found that farmers in their productive ages participate more in farm activities as much as they are receptive to new technologies. Likewise, findings on levels of schooling agree with Nkonki-Mandleni *et al.* (2022), who noted that the primary level of schooling was prevalent among smallholders, with implications for the interpretation of extension messages by farmers as they adopt. And visitation by extension personnel runs in parallel with Masanja *et al.* (2023) in Tanzania and Midamba *et al.* (2022) in Uganda, where limited extension contact by farmers with extension personnel came out as a crucial determinant against effective service delivery.

4.1.2 Agricultural Extension Service Accessibility by Sex

The paper further attempted to determine how AES accessibility differs across the sex of respondents. This aspect was chosen because it features prominently in the literature of extension as a significant predictor of accessibility to agricultural services (Azzarri & Nico, 2022; Kelil & Girma, 2021). Cross-tabulations were conducted across sex to determine the differences in AES accessibility across this variable. Similarly, the Chi-square test of independence was employed to test whether there are significant differences in AES accessibility between male and female farmers (H_{01}) as presented in Table 2.

Table 2

Accessibility of AES by Sex (n=385)

AES Accessibility	Sex of Respondent		Total (n=385)
	Female (n=141)	Male (n=244)	
Very low	44 (31.2%)	67 (27.5%)	111 (28.8%)
Low	34 (24.1%)	50 (20.5%)	84 (21.8)
Moderate	18 (12.8%)	32 (13.1%)	50 (13.0%)
High	23 (16.3%)	34 (13.9%)	57 (14.8%)
Very high	22 (15.6%)	61 (25.0%)	83 (21.6)
Total	**141 (100%)**	**244 (100%)**	**385 (100%)**

Note: Pearson's Chi-square test results - sex*AES accessibility (χ^2 (df 4, N=385) = 4.982, p = 0.289

The findings in Table 2 present the accessibility of extension services across sex, revealing that female farmers were over-represented in the very low accessibility group (31%) compared to men (27.5%). In spite of these disparities, the Chi-square test of independence revealed that the sex and AES accessibility relationship was not statistically significant ($\chi^2 = 4.982$, $p = 0.289$). Therefore, we failed to reject the null hypothesis that there are no significant differences in AES accessibility between male and female farmers in the study area. Accordingly, this implies that sex had no significant influence on AES access in the study area. This finding contrasts with much of the literature (Osabuohien *et al.*, 2023; Midamba *et al.*, 2022), which often highlights persistent gender gaps in accessing services. To this effect, however, the non-statistical relationship reinforces the hypothesis that sex distinctions could be context-specific. In Tanzania's decentralised context, this outcome may reflect deliberate gender-mainstreaming efforts at lower local government levels where agricultural extension workers are mandated to ensure inclusivity while attending to farmers. Equally, the introduction of mobile platforms such as M-Kilimo (M-Agriculture) has likely contributed to making gender gaps less visible in quantitative analysis. Through these platforms, traditional barriers faced by women, such as mobility constraints, time conflict and limited voice during extension meetings, are reduced since M-Kilimo allows two-way communication between farmer and extension officer. However, in spite of this thinking, researchers firmly suggest that women often tend to experience structural as well as institutional constraints, such as restricted movement, resource access, and gendered expectations, that may not always appear in tests statistically (Okello *et al.*, 2023; Witinok-Huber *et al.*, 2021).

4.2 Agricultural Extension Service Accessibility by Districts

A one-way ANOVA was conducted to test the null hypothesis ($\mathbf{H_{02}}$) that there are no significant differences in AES accessibility across the surveyed district in central Tanzania. A standardised composite index (standardised overall accessibility of AES) was used as the dependent variable. Similarly, the Tukey HSD post hoc test was conducted to determine where exactly the differences in accessibility of AES occur across the districts. Findings from ANOVA and Tukey HSD test are presented in Table 3.

Table 3

Accessibility of AES across districts

Factor	**One-Way ANOVA**	**Sum of Squares**	**df**	**Mean square**	**F**	**P-value**
District	Between Groups	31.304	3	10.435	11.272	0.000
	Within Groups	352.696	381	0.926		
	Total	**384.000**	**384**			
Tukey HSD Post Hoc I-J Test of Mean Difference across Districts						
District	**(J) District**	**Mean Difference (I-J**		**Std. Error**		**Sig.**
Chemba	Kondoa	-.629*		.143		.000
	Ikungi	-.275		.130		.150
	Manyoni	.177		.137		.571
Kondoa	Chemba	.629*		.143		.000
	Ikungi	.354		.143		.066
	Manyoni	.806*		.150		.000
Ikungi	Chemba	**.**275		.130		.150
	Kondoa	-.354		.143		.066
	Manyoni	**.**452*		.137		.006
Manyoni	Chemba	-.177		.137		.571
	Kondoa	-.806*		.150		.000
	Ikungi	-.452*		.137		.006

Dependent variable: Overall accessibility of agricultural extension services

*****The mean difference is significant at the 0.05 level. Levene's test of homogeneity of variance for gender was significant at p = 0.289

The ANOVA results in Table 3 show that the variance in accessibility of AES by the four districts was statistically significant (F=11.272, $p < 0.05$). Therefore, we reject the null hypothesis, concluding that AES accessibility varies significantly across districts. Post hoc comparisons showed that the mean AES accessibility scores differed significantly between Kondoa and Chemba (mean difference = 0.629, $p < 0.05$) and between Kondoa and Manyoni, (mean difference = 0.806, $p < 0.05$). Similarly, Ikungi differed significantly from Manyoni (mean difference = 0.452, $p < 0.05$). However, no significant differences were observed between Chemba and Ikungi, Chemba and Manyoni or Kondoa and Ikungi ($p > 0.05$).

These results indicate that Kondoa district had the highest accessibility level, while the lowest being Manyoni. Kondoa's best performance could be attributed to better institutional strength, more extension workers, or persistent

digital extension efforts. In contrast, Manyoni's lower access can be attributed to inadequate infrastructure and limited ICT penetration- a common challenge cited in rural Tanzanian districts (Kurniasari & Herlina, 2022).

4.3 Determinants of accessibility of agricultural extension services in Tanzania

To further understand the factors influencing smallholder farmers' access to AES, an ordinal logistic regression analysis was fitted using a categorised overall accessibility index as the dependent variable. The regression model included a range of predictors, including socio-demographic factors (age, gender, education, income), farm characteristics (farming experience, farm size), and institutional factors (frequency of extension visit, proximity to extension service centres) as presented in Table 4. *Model fit Summary:* Null model, -2LL= 1208.467; Final Model, -2LL = 966.987 (Chi-square= 241.480, df=8, p <0.001). Mode goodness-of fit: Pearson Chi-square (1519.341, p = 0.558); Deviance = 966.987, (p =1.000); Pseudo R-Square: Cox and Sell =0.466, Nagelkerke= 0.487; McFadden=0.200.

Table 4

Predictors of Accessibility of Extension Services in the Study Area

Predictors	Estimate (β)	Odds Ratio (Exp (β))	Std. Error	Wald	df	Sig.
Age	.028	1.03	.016	2.881	1	.090
Sex	-.002	0.998	.206	.000	1	.992
Education (year of schooling)	.165	1.18	.049	11.448	1	**.001**
Farming Experience (years)	.051	1.05	.018	7.701	1	**.006**
Annual Income (TZS)	1.941E-8	1.00	7.980E-8	.059	1	.808
Proximity to the extension service centre	-.097	0.91	.043	5.172	1	**.023**
Number of extension visits	1.071	2.92	.122	76.784	1	**.000**
Farm size	-.003	0.997	.038	.005	1	.942

Based on the assumptions of the model (Table 4), the fitting statistics indicate that the final model significantly improved over the intercept-only model (Chi-square = 241.480, $p < 0.001$), meaning that the selected predictors significantly contributed to explaining variations in AES accessibility. Also, the goodness-of-fit statistics (Pearson Chi-square = 1519.341, $p > 0.05$, Deviance = 966.987, $p > 0.05$), justify the goodness-of-fit- fit of the model. The value of Pseudo R-square (Cox and Snell = 0.466, Nagelkerke = 0.487, McFadden = 0.200) also indicates the model explains a moderate proportion of the variability in AES accessibility.

After the establishment of the overall model fit, the analysis proceeded to identify important predictors of AES accessibility. As depicted in the regression findings (Table 4), the important predictors included the farming experience, level of education, location distance to extension centres, as well as the number of extension visits. Of all these predictors, the number of extension visits was the most significant ($p < 0.001$), highlighting the value of frequent and direct contact between extension agents and farmers in facilitating service uptake. In their own right, frequent visits not only ease the diffusion of knowledge as well as innovations but also build trust and familiarity required for long-term extension agent and farmer relationships. In the context of smallholder farmers, who often face limited access to agricultural information, regular extension visits serve as an entry point into gaining timely advice, adopting new technology, as well as increasing productivity. In effect, this finding is supported by evidence from Ethiopia, where it was established that the more extension agents visited farmers, the higher the likelihood of farmers' uptake of recommendations and higher trust in the extension system (Kibrom *et al.*, 2025).

Farmer's education level was also an important determinant ($p < 0.05$). Education enhances knowledge, sharpens the ability for critical thinking, and develops the ability for problem interpretation and solving. With regard to extension services, education gives the capacity for farmers to digest the technical content of agricultural information, interpret advice, and apply innovations. Educated farmers have higher chances of receiving instructions on the use of inputs compared to non-educated farmers. They are also more likely to communicate with extension agents than their non-educated counterparts. These results are similar to those of Mahama *et al.* (2024), who supported that educated farmers in Ghana have a higher likelihood of adopting agricultural innovation and conversing more with extension agents than non-educated farmers.

Proximity to extension service centres was a significant negative predictor ($\beta = -0.097$, $p = 0.02$). This means that those farmers living farther from the extension centre are less likely to access services. This is due to the fact that physical distance imposes practical barriers, for example, transport costs, time management, as well as limited infrastructure, especially in rural settings. Moreover, farming experience was an important positive predictor ($p < 0.05$), meaning that more experienced farmers tend to use extension services. This is because long-farming farmers, with time, have been faced with various agricultural challenges and have learned the value of professional guidance. Similarly, their built-in experience with time likely gives them reassurance in judging and utilising new agricultural information. However, other findings, for instance, Torres (2022), observed that start-up farmers desire certain value-added

technologies more in comparison to experienced farmers. This implies that while experience draws the farmer towards extension services utilisation, it may not necessarily mean openness to innovation, especially when new technologies challenge established practices.

Meanwhile, other predictors, including age, sex, annual farm income, and farm size, were not significant ($p > 0.05$). Although age had a positive coefficient, but was statistically insignificant in determining accessibility of AES ($p>0.05$). This suggests that, although older farmers tended to have slightly higher odds of accessing extension services compared to younger ones, the difference was not strong enough to be considered significant. The positive direction of the coefficient implies that as farmer grow older, their experiences and familiarity with agricultural networks may somewhat enhance their engagement with extension services. However, the lack of statistical significance indicates that age alone does not meaningfully explain variations in accessibility within the study area.

Moreover, sex could not substantially predict AES accessibility ($p > 0.05$), indicating no significant sex bias in AES delivery in the study area. It is probably because the decentralised extension system in Tanzania continues to value inclusivity of extension delivery at the field level, where both male and female sex participate in decision-making. Contrary to the above finding, Okello *et al.* (2023) as well as Witinok-Huber *et al.* (2021) reported women being constrained by factors of mobility limitation as well as exclusion from the decision-making forums, among others, impacting their access to AES.

Regarding the annual income of the farmer, it was also found not to be a significant predictor ($p > 0.05$). This is likely because AES in Tanzania is largely provided as a public good rather than priced services, so it might well be accessed by households with less income. In contrast, income plays a stronger role in access to advice and technologies when provided by private extensions. Additionally, farm size was not significant ($p = 0.94$). Although larger landholdings tend to go along with higher extension agent visibility, the absence of effect here implies the service might as well be distributed more evenly among the farmers, or targeted more by type of crop (e.g., sunflower) than by land size. It was similarly reported by (Loki *et al.*, 2021) that farm size does not necessarily influence the need for extension services among smallholder farmers.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study assessed the accessibility of AES under decentralised governance in Tanzania, focusing on gender and district-level disparities in accessing extension services, as well as factors influencing accessibility. Findings revealed that the accessibility of AES differs significantly across surveyed districts but not across genders. Factors such as education level, farming experiences, proximity to the extension centre, and the number of extension visits predicted accessibility. Age, sex, annual income of the farmer, and farm size were not significant predictors. These findings suggest that the district-level disparities call for targeted resource allocation, ensuring that districts with low accessibility receive additional support to balance service delivery. The absence of gender-based disparities indicates progress towards inclusivity; however, continued monitoring is essential to sustain equity across diverse farmer groups. Likewise, the study also concludes that extension programs should be tailored to farmers' knowledge levels, experience and capabilities. Also, outreach mechanisms such as the use of digital platforms and community-based extension agents should be strengthened to reduce the physical distance to extension service and increase the frequency of extension visits.

5.2 Recommendations

To address the district-level disparities in accessing AES, this study recommends that the Tanzanian government should allocate extension agents based on needs to ensure districts with lower accessibility scores, such as Manyoni, receive proportionately greater support. At the same time, complementary measures such as expanding the use of digital platforms and community-based outreach should be integrated in geographically disadvantaged areas, while, tailoring extension contents to farmers' education levels and farming experiences to strengthen farmers' ability to understand and act on extension advice.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDICES

Appendix I: Proportionate sample sizes

Formula for determination of proportionate sample size (Cochran`s, 1977):

$$n_i = \left(\frac{N_i}{N}\right) \times n$$

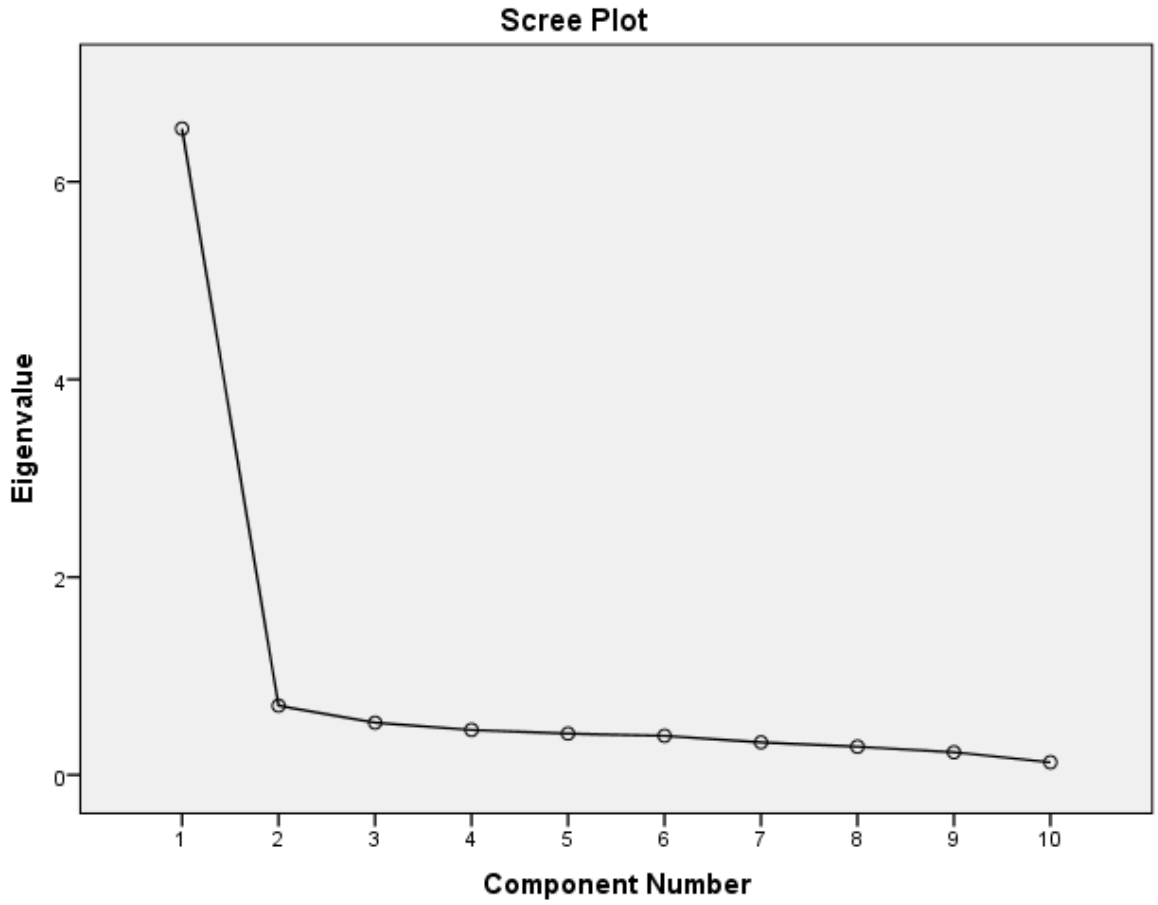
Where:
n_i is the sample size from council i
N_i is the number of agricultural households in council i
N is the total number of agricultural households in all selected councils
n is the desired overall sample size (n = 385)

Proportionate sample size

Council/ LGA	No. Households	Proportionate sample size per Council	Ward	No. Households	Proportionate sample size per Ward
Chemba	75 050	110	Gwandi	1 545	32
			Kidoka	3 693	78
Ikungi	74 527	109	Puma	2 686	56
			Dung'unyi	2 563	53
Manyoni	61 059	89	Chikola	3 294	54
			Heka	2 171	35
Kondoa	52 677	77	Pahi	3 382	42
			Mnenia	2 888	35
Total	**263 313**	**385**			**385**

Source: National Population and Housing Census (NBS, 2022)

Appendix II: Scree Plot of Principal Components for Accessibility Index



Appendix III

Cumulative column explaining the total Variance

Total Variance Explained						
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.537	65.373	65.373	6.537	65.373	65.373
2	.699	6.994	72.368			
3	.528	5.282	77.650			
4	.454	4.543	82.193			
5	.417	4.168	86.362			
6	.395	3.946	90.307			
7	.329	3.286	93.593			
8	.285	2.848	96.442			
9	.229	2.291	98.733			
10	.127	1.267	100.000			
Extraction Method: Principal Component Analysis						

Appendix IV

Results of the exploratory factor analysis of the accessibility of AES (n=385)

	Factor 1
	Communalities
Access to guidance on proper farm preparation	.861
Access to advice on seed variety selection	.841
Access to advice on soil test	.692
Access to advice on proper planting methods for sunflower seeds	.832
Access to advice for pests and diseases control	.834
Access to advice on sunflower harvesting and post-harvest handling	.796
Access to advice on sunflower value addition	.816
Access to information on market opportunities for sunflower products	.771
Advice and linkage with agricultural credit service facilities	.837
Access to mobile based extension services	.792
Extraction Method: Principal Component Analysis.	
1 factor extracted	

Appendix V

Categorisation of the overall accessibility of AES using Z-score

Category	**Z-Score Range *****	**Label**
Very low	≤ -0.70	Very low
Low	> -0.70 to -0.10	Low
Moderate	> -0.10 to 0.30	Moderate
High	> 0.30 to 0.80	High
Very high	> 0.80	Very high

Cut-off points were determined based on the **empirical distribution of standardised index scores**, aiming to ensure that category sizes meaningfully reflected observed variation in AES access among the sampled farmers.