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ASSESSING THE CONTRIBUTION AND IMPACT OF ACCESS TO EXTENSION SERVICES TOWARD SUSTAINABLE LIVELIHOODS AND SELF-RELIANCE IN EASTERN CAPE PROVINCE, SOUTH AFRICA

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ABSTRACT

Public Extension services remain the repository and main source of agricultural information for smallholder farmers in developing countries. Their role includes linking farmers to relevant institutes and disseminating research-based knowledge and technology to rural people with the aim of improving their livelihoods. Extension officers disseminate information about new innovative techniques to crop and livestock farmers and related production and management practices leading to the improved socio-economic status of the rural communities. Despite this and farmers having access to extension services, smallholder farming appears to be struggling to meet the rural population's daily food and employment needs. Moreover, empirical and detailed evidence of the contribution and effect of extension services toward sustainable farmer livelihoods remains scanty in the Eastern Cape province, South Africa. Therefore, the study sought to investigate the contribution and impact of extension services toward sustainable livelihoods and self-reliance in Eastern Cape Province in South Africa. The study used a multi-stage sampling procedure to collect data from 258 smallholder farmers using a semi-structured questionnaire. Binary Logistic regression and Propensity score matching was used for analysis. The study results showed that most respondents were females with an average age of 47 years and twelve years of farming experience. Moreover, the results show that farmers had ten years of schooling and operated on average farm sizes of 3 ha. The findings also indicated that farmers had access to extension services and were members of farm organizations contributing to their farming and building self-resilience. Farmers also indicated that financial support, distance to market outlets, and lack of transportation were among the challenges threatening their livelihood. Binary logistic regression showed that age, years spent in school, off-farm income, and farm size affected farmers' access to extension services. Propensity Score Matching results showed that farmers with access to extension services had better sustainable livelihoods and self-reliance than farmers without access. The study concludes that extension services have a positive effect on the sustainable livelihood of farmers. The study recommends that governments and NGOs invest more in agricultural extension officers for farmers to reach their farming potential and ensure sustained livelihoods and self-reliance.

Key words: Eastern Cape, Extension Services, Smallholder Farmers, Sustainable Livelihoods, Propensity Score Matching

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INTRODUCTION

Agricultural extension is defined as a system intended to enable farmers, their organizations/groups, and other market actors to access knowledge, information, and technologies to promote agricultural development [1]. Access to the extension has long been a key component that permits farmers to attain information, training, and technologies that can be used to advance their livelihoods and are an important factor in promoting agricultural development [2, 3]. The benefit for farmers in accessing extension services is the gaining of strategic partners in research, education, agribusiness, and other relevant institutions, supporting them to develop their technical, organizational, and managerial skills to enhance the agricultural sector. Huerta-Barrientos [4] posited that extension officers are enablers of farmers' entrepreneurial, social, and ecological capacities in rural areas to be effectively involved in production and livelihood activities that demand modest positioning and understanding of the environment. This reconstruction of farmer entrepreneurial capacity helps improve production and, subsequently, rural incomes and welfare and mitigates other rural problems, Adebayo and Worth [2]. Despite these accolades, extension services appear to be struggling to provide adequate services to farmers, leaving many agriculture-dependent rural dwellers unable to sustain their livelihoods [5].

The South African Government reiterated that Agriculture remains one of the most significant economic pillars, a source of energy and food security for all. The need for a vibrant agricultural sector in rural households is exacerbated because the majority of dwellers derive their livelihoods from practising farming [6, 7]. As a result, farming in Africa is dominated by smallholder farming given the fundamental role they play in the establishment of better livelihoods and food security in developing communities, in sub-Saharan Africa [7, 8]. Mdoda *et al*. [9] postulated that smallholder agriculture helps in sustaining livelihoods for farmers and communities through income generation and employment. Phakathi and Wale [10] support this argument that smallholder agriculture constitutes a key vehicle to lessen pervasive poverty. However, the performance of the smallholder sector is reported to be below potential because of a number of institutional, market-related, infrastructural, and technological challenges [11]. According to Raidimi and Kabiti [12], South Africa is facing high levels of food insecurity among households as a result of the decline in food production. Hence access to extension services is significant to build sustainable livelihoods and self-reliance among farmers and households in South Africa.

Loki [13] posited that agricultural extension services are the cornerstone of rural development, the motive force for yield enhancements and sustainable livelihoods. Establishing household food security is extensively recognized as an important breakthrough in evolving the living standard of the rural poor and meeting Sustainable Development Goals (SDGs), objective 1 (no poverty), and objective 2 (zero hunger). Access to extension is the only way that can be used to educate and equip farmers to meet these SDG goals through the dissemination of relevant information and technologies to farmers. A study by Danso-Abbeam [14] indicated that agricultural extension is contributing positively to smallholder farming through capacity building in good agricultural practices, forming linkages among the value chain actors (input dealers, farmers, wholesalers, and retailers, which enhances their production and output) and other value-addition techniques. Biswas *et al.* [15] noted that the impact of agricultural extension services is positively and significantly associated with agricultural productivity and farm returns in developing countries. However, little is known of the contribution and impact of extension access toward sustainable livelihoods and self-reliance. Many studies have been conducted focusing on factors and the impact of agricultural extension services carried out by non-governmental organizations [2, 13, 16-18]. Hence, this study was conducted to establish new facts that will assist policymakers and farmers in accessing extension services. Access to the extension will assist farmers and households in achieving sustainable livelihoods. Therefore, this study investigated the contribution and impact of access to extension services toward sustainable livelihoods and self-reliance in Eastern Cape Province, South Africa.

Theoretical framework

A theory is an assortment of interconnected definitions, thoughts, and proposals that clarifies proceedings by specifying the correlation between the variables. For this study, it was imperative to assemble guiding theories connecting the variables used to clarify sustainable livelihoods and self-reliance among smallholder farmers. The study adopted two theories, the Theory of Planned Behaviour (TPB) and the Norms Activation Theory (NAT), to explain the correlation between the variables. Both theories relate closely to how a farmer perceives an extension official and the service they provide. This then determines the farmers' attitude and whether they will adopt (behaviour) any agricultural innovation (service) the extension officer provides [19]. As alluded to earlier, there is evidence that extension services contribute significantly to the livelihood outcomes of smallholder farmers (income, food security, well-being, and sustained natural resources) and assets (base and vulnerability). On the other hand, self-reliance involves interventions to build capacity among smallholder farmers in six key areas: involvement in decision-making, comprehensive participation, drawing on own resources, being adapted to

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self-management, perseverance, and taking responsibility for one's actions and the primary role of extension services is to make sure they capacitate farmers with these skill sets [20].

The theory of planned behaviour (TPB) developed by Ajzen was adopted for this study because it reflects the relationships between the individuals (farmers) and the social and environmental aspects to explain consumer behaviour. Ahmmadi *et al.* [21], Abadi *et al.* [22] and Bozorgparvar [23] detailed that attitudes, perceived behavioural control, and subject norms affect intention indirectly while they directly influence the decision-making behaviour of farmers. The TPB aims to predict and explain human behaviour through personal and social factors. In this theoretical model, the main factor in forecasting an individual's behaviour is their intention to develop sustainable livelihoods and smallholder farmers' self-reliance. Based on the Theory of Planned Behaviour, smallholder farmers' use and access to extension services are influenced by various factors, including socioeconomic factors, policy, research, and institutional factors. Thus, it is necessary to understand these factors as access to extension services is vital in fast-tracking Sustainable Development Goals (SDGs), especially the first and second objectives to eradicate all forms of poverty and malnutrition. The purpose includes the motivational component needed to create the behaviour and directs how willing a farmer is to make efforts to produce sustainable livelihoods and self-reliance. The attitude toward a particular behaviour is measured as the first component determining the farmer's intention. This variable denotes the positive or negative valuation of behaviour in a specific situation. Farmers with a positive attitude toward a particular behaviour (access to extension services) are likely to perform better than those with negative attitudes. Attitudes are composed of two separate but highly interrelated mechanisms, including emotional and cognitive mechanisms. This study examines the correlation between framers' attitudes and intentions toward using and accessing extension services.

MATERIALS AND METHODS

Study area

The study was conducted in Eastern Cape Province, South Africa. Eastern Cape province is a province within South Africa and is the second biggest province (estimated at 168 966 square kilometers) in South Africa after Northern Cape province. The province is the third most populated province in the country with an estimated population of 6,562,053 million, which makes up 12.7%, following Gauteng and KwaZulu Natal provinces with an estimated population size of 12,272,263 (23.7%) and 10,267,300 (19.2%) million, respectively. This province

was formed in 1994 out of the Xhosa homelands or Bantustans of Transkei and Ciskei, together with the eastern portion of the Cape Province. The province is the traditional home of Xhosa people, although it has whites, coloured, and Indians but 80% of the population are Xhosa natives. According to Mdoda and Obi [24] and Sigigaba *et al.* [25], Eastern Cape is one of the poorest provinces in South Africa where the majority of people are living below the national average poverty level (ZAR 624 a month) and food insecurity is very high at 78%. This contributed highly to the high poverty rate in this province and abounded agriculture for employment in non-agricultural industries. Hence, it was very important to conduct this study to examine the contribution of agriculture and extension services toward building sustainable livelihoods to combat poverty and food insecurity in the province.

The study area's climatic condition lies between the sub-tropical in KwaZulu-Natal and the Mediterranean climate of Western Cape Province. The province parades a bimodal precipitation pattern, with a winter precipitation zone to the west and a summer rain zone to the east. Due to unpredictable rainfall seasons, growing times differ throughout the province. The province's climatic conditions are suitable for agricultural production, especially livestock, crop, vegetable, and citrus. The province is dominated by smallholder farmers who practice farming as their source of livelihood and derive their small incomes from farming. The majority of these smallholder farmers strictly practice farming for home consumption and surplus for the market, as farming is their only strategy to alleviate poverty and reduce food insecurity at the household level. Figure 1 displays the study area. The study made use of a cross-sectional research design to collect data because of its accuracy, time efficiency, and precision.

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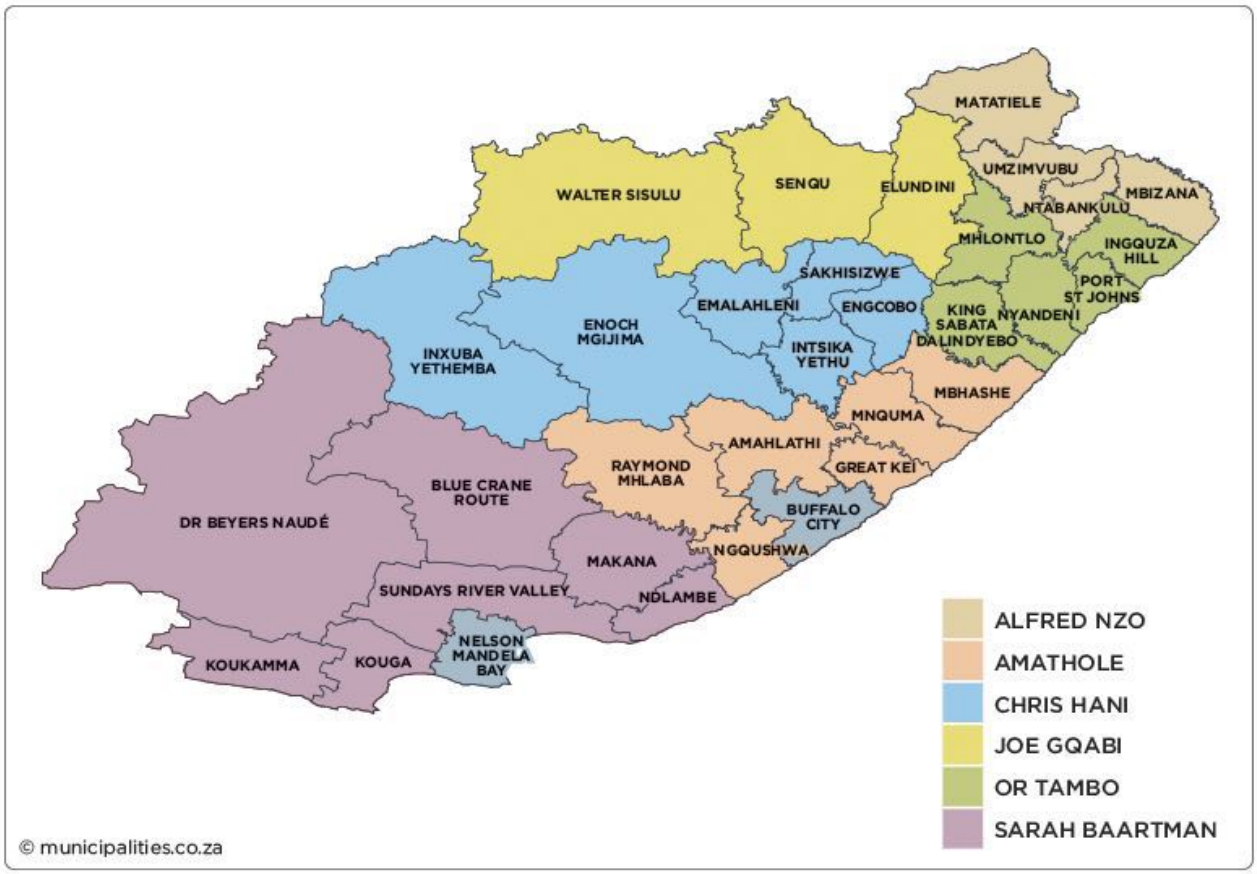

Figure 1: Map showing the study area
Source: [25]

Sampling Procedure, Frame and Sample Size

The study was quantitative and used a survey to gather data from respondents. The target population for this study was smallholder farmers in the Eastern Cape. The smallholder farmers practising these types (crop, vegetable and livestock) of farming formed part of the sampling frame, and the sampling unit was the farmer's head.

A multi-stage sampling procedure was adopted and used to select farmers in the study. The first stage of the sampling was selecting 4 District Municipalities within the Eastern Cape Province which have potential in crop production and contribute immensely to farmers' well-being. These District municipalities were OR Tambo, Chris Hani, Amatole and Joe Gqabi. In the second stage, 3 local municipalities and 6 wards were selected due to their involvement in crop farming. Also, stratification sampling was used to stratify smallholder farmers into crop, vegetable, and livestock farming. The basis for using stratified sampling was concentrating only on

crop farming for this study. The third stage and final stage was randomly selecting smallholder farmers to form part of the study. The study sample size was 258 smallholder crop farmers in the Eastern Cape Province of South Africa.

Data Collection

This study employed a quantitative research approach that involved collecting data through a survey. The study made use of primary and secondary data. Primary data was collected through semi-structured questionnaires between January and September 2018. The study used closed-ended and open-ended questionnaires administered by well-trained enumerators using face-to-face interviews. The questionnaires were pre-tested, and the area was not included in the study. The pre-testing was done to check reliability, accuracy, and time taken to answer the questionnaires and train enumerators. The collected data was on farmer profile, land ownership, access to extension services and contribution, challenges faced, and impact of extension services towards sustainable livelihoods. The secondary data were collected from published peer-reviewed journals, books, Department of Agriculture reports, and farmers weekly.

Data Analysis

The collected data were coded and entered into Excel then transported to STATA 15 and Statistical Package for Social Sciences (SPSS) version 25 for the purpose of analysis. Descriptive statistics were employed to estimate farmers' profiles and contributions to extension services using means, frequencies, percentages, pie charts, and tables. The binary Logit model was used to estimate determinants of accessing extension services by smallholder farmers. Propensity score matching (PSM) was used to estimate the effect of extension services on farmers' sustainable livelihoods.

Binary Logistic regression

The study adopted binary logistic regression to estimate determinants of access to extension services by smallholder farmers in the study area. The Binary Logistic models have been used to recognize the correlation in the error terms of access and adoption equations and estimate a set of variables used. This model is widely used because it denotes a regression whereby a statistical tool is used to determine two choices [26]. This method was chosen because it is a standard analysis method when the outcome variable is dichotomously measured with a value of 1 or 0, where 1 = access to extension and 0 = no access to extension services. Sigigaba *et al.* [25] specified that binary logit regression has more advantages than the Probit model because it estimates the dichotomous outcome variables, which are more straightforward and flexible to make results more

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meaningful for interpretation. X_i represents the set of parameters that influence farmers accessing extension services.

Access to extension services as a farmer was a dependent variable regressed against explanatory variables such as socioeconomic and farm characteristics. The Binary Logistic model was employed because it accommodates two categories in the dependent variable. It can resolve the heteroscedasticity problem and address the assumption of cumulative normal probability distribution. Hence, the binary logistic model was selected for this study. Let π_i be the probability of success. Additionally, consider X = (X_1, X_2, ... X_n) as a set of explanatory variables which can be discrete, continuous, or a combination of both discrete and continuous. Then, the binary logistic function for π_i is given by:

$$\text{logit}\,\pi_i = \log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots \ldots + \beta_n x_{i,n;} \ldots\ldots 1$$

Where

$$\pi_i = \frac{\exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots + \beta_n X_{i,n;}\right)}{1 + \exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots + \beta_n X_{i,n;}\right)} = \frac{\exp\left(x'_i \beta\right)}{1 + \exp\left(x'_i \beta\right)} = \Lambda\left(x'_i \beta\right) \ldots . 2$$

Where

π_i denotes the probability that a sample is in a given category of the dichotomous response variable, commonly called the success probability and, clearly, $0 \leq \pi_i \leq 1$. $\Lambda(.)$ is the logistic cumulative distribution function (CDF), with $\lambda(z) = e^z/(1 + e^{-z}) = 1/(1 + e^{-z})$ and β s represents a vector of parameters to be estimated [26]. The expression $\left(\frac{\pi_i}{1-\pi_i}\right)$ is called the odds ratio or relative risk.

Estimation and Likelihood Ratio Test

Maximum likelihood is the preferred method to estimate β since it has better statistical properties, although the test can use the least-squares approach. Consider, the logistic model with the single predictor variable X given by the logistic function of:

$$\pi\,(X) = \frac{\exp\left(x'_i \beta\right)}{1 + \exp\left(x'_i \beta\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

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The model predicts to find the estimates such that plugging βˆ into the model for π (X) gives a number close to 1 for all subjects that have access to extension services and 0 otherwise. Econometrically, the likelihood function is given by:

$$L(\beta_0, \beta_1) = \prod_{i:Y_{i=1}} \pi(x_i) \prod_{i\prime:Y_{i\prime=0}} (1 - \pi(x_{i\prime})) \quad \ldots\ldots 4$$

The estimates βˆ are chosen to maximise this likelihood function. The logarithm is taken on both sides to calculate and use the log-likelihood function for the estimation purpose. Researchers made use of the likelihood ratio to test if any subset of estimates β is zero. Suppose that p and r represent the number of β in the full model and the reduced model, respectively. The likelihood ratio test statistic is given by:

$$\Lambda* = 2\,[l(\beta^{(0)}) - l(\beta)] \quad \ldots\ldots 5$$

where l(βˆ) and l(βˆ(0)) are the log-likelihoods of the full model and the reduced model, respectively, evaluated at the maximum likelihood estimation (MLE) of that reduced and $\Lambda* \sim \chi$ 2 n−r ; n and r being the number of parameters in full and the reduced model, respectively.

Propensity Score Matching (PSM)

The study adopted propensity score matching to estimate impact of extension services on sustainable livelihoods of smallholder farmers in the study area. Propensity Score Matching (PSM) is a widely used tool for impact evaluation, and it is used to create a statistical contrast group based on model probability to evaluate the treatment effect on endogenous and exogenous factors [27]. Propensity Score Matching (PSM) is used to estimate impact analysis in the agricultural sector to understand the effect group compared to the control group. Several studies have used this model, such as, to compare the control and effect groups in agricultural studies. The PSM method requires a treatment variable to be binary; therefore, the group of farmers with access to extension services was treated as a binary and farmers with no access to extension services as a control group.

Propensity Score Matching (PSM) denotes the combination of treatment and control units with similar propensity score values, possibly other covariates, and the discarding of all unmatched units. According to Oyetunde-Usman *et al.* [28], PSM assumes the unconfoundedness assumption, also known as the conditional independence assumption, which implies that once Z is controlled for, access to the extension group is random and uncorrelated with the outcome variables. According to this assumption, the treatment needs to be exogenous, implying that any systematic difference in outcomes between the treatment and comparison groups with the same values for characteristics X can be attributed to the treatment. The second assumption, called common support or overlap, guarantees

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that individuals/groups with the same values for characteristics X have a positive probability of farmers with access to extension and those who do not / treatment. As a result, these are the main reasons why propensity score matching is a good fit to estimate the impact of extension services on farmers' livelihood using farm income and indicators.

Farmers with access to extension services were taken as the treatment group, and those who did not have access to extension services were taken as a control or comparison group. Therefore, after matching the difference between their farm incomes, the average effect of contract accessing extension services on the farm income of farmers was calculated. The conditional probability of receiving a treatment, given pre-treatment characteristics is as follows:

$$P(X) = P_r\{D = {}^{1}/_{X}\} = E\{{}^{D}/_{X}\} \quad \text{.....6}$$

Where D = {0,1} determines treatment exposure and X is represented as pre-treatment characteristics. The treatment effect reflects the variation welfare of farmers who had access to extension services and those who did not. Hence, farmers with Access to extension T = 1, and who do not have access T = 0.

$$\mathbf{T} = Y_i(1) - Y_i(0) \quad \text{.....7}$$

Let Y_i^T the farm income status by treatment group (farmers with access), and Y_i^C The farm income by controlled group, then the difference in farm income status between treated and controlled group will see as:

$$\Delta_i = Y_i^T - Y_i^C \quad \text{.....8}$$

WhereΔ_i, the change in farm income as a result of access to extension services. Equation 4 represents the Average treatment effect for the population (ATE):

$$\Delta_{ATE} = E(\Delta_i) = E({}^{Y_i^T}/_{D} = 1) - E({}^{Y_i^C}/_{D} = 0) \quad \text{.....9}$$

ATE shows the effect of farm income on farmers.

Where

$E({}^{Y_i^T}/_{D} = 1)$: Farm income for individuals who have access (Di = 1) or with treatment.

$E({}^{Y_i^C}/_{D} = 0)$: farm income of farmers without access or without treatment. Then the average effect of treatment on the treated (ATT) will be

$$\mathbf{ATT} = E(E({}^{Y_i^T - Y_i^C}/_{D} = 1) = E({}^{Y_i^T}/_{D} = 1) - E({}^{Y_i^C}/_{D} = 1) \quad \text{....10}$$

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There must be the assumption of conditional independence and common support to fulfil in executing propensity score matching. Conditional independence infers that treatment assignment (access to extension services) merely should be influenced by observable characteristics and variables, while a common support assumption ensures that farmers with the same covariates' values have direct relations of accessing extension service or otherwise. The first step in the propensity score matching technique is estimating propensity scores. It is a single index number summarised from covariates affecting an individual. However, an econometric model has to be chosen before evaluating propensity scores.

RESULTS AND DISCUSSION

This section is divided into two sections, where the first one involves descriptive results and the second part addresses empirical results.

Demographic characteristics of smallholder farmers

Table 1 presents the socio-economic features of smallholder farmers. The study results showed that smallholder farming was dominated by female farmers (70%) with an average age of 47 years. These results were in line with Mdoda and Obi [24] that having middle-aged farmers dominate farming will attract younger people to farming and increase the adoption of innovative technologies to increase agricultural productivity and take farming as agribusiness. This showed that the superior participation of middle-aged farmers in farm production displays that farming in the province is rising. The household size was used as a proxy for farm labour, and farmers used their family members to work in the field, which played a crucial role in enhancing production. The average household size was six (6) people per household, which played a considerable part in availing the family labour, especially if household members fall within the working-age group. Smallholder farmers spent ten (10) years in school, making them literate to adopt innovative technologies and access information, then interpret the information received from extension officers. The result was supported by Oyetunde-Usman *et al.* [28] that educational attainment is crucial for adopting improved farming techniques by farmers and communicating efficiently with Departmental representatives. Farmers had an average farm size of 3ha, which they used for farming purposes and had an average of 12 years of farming experience. This recommends that most smallholder farmers in the study have significant experience that is important for farm decisions and improving agricultural productivity. The study results reveal that about 78% of farmers had access to extension services, while 60% of farmers were members of farm organizations.

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These results reveal that farmers' knowledge was enhanced, and agricultural information was available for them as they had access to extension services and were members of farm organizations. The study results reveal that the average household income was ZAR 5 860.00, and these households had access to extension services.

Contribution of extension services provided to smallholder farmers

The contribution of extension services was based on the assistance extension officers provide to the farmers to enhance their livelihoods. Table 2 shows various contributions of extension services towards building sustainable livelihoods and self-reliance by farmers in the study area. Smallholder farmers shared that extension officers contributed to their farming by disseminating relevant and reliable agricultural information. This played an important role in keeping farmers up to date with agricultural information, especially pricing and new technology use aimed at increasing yields and farm returns. Transfer of innovative technology (19%) was the second contribution that built farmers' knowledge about technology to use (such as pest management, mixed farming, irrigation use, use of organic manure, and improved crop varieties), which farmers have adopted for betterment and sustainability of the farm. These results were in line with Danso-Abbeam *et al.* [14] that agricultural extension delivers information and training on innovative technologies for farming societies that advance production, incomes and standards of living when accepted. Extension officers are good at providing agricultural and financial training (18%) to farmers, contributing to sustainable livelihoods and attracting young farmers to be involved even with no background in agriculture.

The farming landscape has changed in the study areas as extension officers provide farmers with agronomic techniques and market information (16%). This is a challenge in developing countries as farmers are remotely allocated, and there are communication barriers. Agricultural extension officers in the study make some sacrifices and means to make sure that they disseminate agronomic techniques and market information as early as the ploughing season so that farmers know everything before the ploughing season commences. Most farmers were literate as they spent ten (10) years in school, equivalent to secondary education, and some were not educated. Extension officers took it upon themselves to provide rural adult learning (knowledge transfer) to smallholder farmers. This played a crucial role as farmers could apply for government funding and training as they could write and sign, which most had problems with. Lastly, extension services from extension officers provided farmers in the study with post-harvest handling (reducing waste). This is the challenge influencing the sustainability of farming, especially for

smallholder farmers in developing countries. But extension officers provided such information to reduce wastage and enhance farmers' production.

Challenges faced by smallholder farmers in accessing extension services

The study estimated challenges faced by smallholder farmers using descriptive results. As descriptive results showed, about 104 smallholder farmers needed access to extension services, which was a huge challenge for farmers. Table 3 below displays challenges faced by smallholder farmers in the study area. Smallholder farmers stated that the major constraint they encountered was the need for more knowledge about extension services. This is a major problem in developing countries, especially in remote areas where most emerging and smallholder farmers need assistance with knowledge about agricultural services offered or available to them. This challenge has contributed immensely to the low sustainability of livelihoods generated by smallholder farmers as they rely on farmer-to-farmer for knowledge about agricultural techniques used and information. This gave rise to the use of obsolete technology for farming which led to a reduction in their production and farm returns. The lack of finances is the second challenge faced by the farmers in the study. The majority of farmers relied on social grants, and the little they generated from farm operations; as a result, they mostly only travelled within their villages to enquire about agricultural services as they had to travel long distances, which requires finances due to high transaction costs. This is common in Africa as finances are a challenge for smallholder farming. Since they produce for subsistence and only surplus for selling, they are often left with nothing to use for other farm operations such as attending training outside the farm, accessing extension officers or even travelling to farmers' days. Distance to market centres and the Department of Agriculture was challenging for farmers. This was challenging as most of the farmers were situated in an area where roads were not accessible and far from towns where markets and the Department of Agriculture were located; this constrained farmers. Another challenge was access to services and ability to sell their products as transaction costs were very high, forcing farmers to sell at the farm gate. Lastly, the lack of transportation challenged farmers and extension agents. Unfortunately, farmers and extension officers did not have their transports or cars to travel to the towns where officers were located or where farmers were located. These results agree with Antwi-Agyei and Stringer [29] that transportation is a challenge for both farmers and extension agents as most farmers are located in remote areas where it is not easy to access the roads. The distance is far, given that transportation costs are high for farmers and shortage of cars for extension agents to reach all farmers.

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Factors Influencing farmers' access to extension services

The study used a binary logistic regression to estimate factors influencing farmers accessing extension services. Farmers who did not have access to extension services were used as the untreated group, while those with access to the extension were used as the treatment group. The results are presented in Table 4. The study results demonstrate model fitness for the data with the p = 0.0000 of the hypotheses that all regression coefficients in each equation are jointly equal to zero is rejected. The values of R^2 of 0.658 show the model's capacity to reliably predict Factors Influencing farmers' access to extension services as explanatory variables, including an explanation of 66% of the variance.

The age of farming households had a negative coefficient and was statistically significant at a 1% level. This means a negative relationship between age and access to extension services. The estimated marginal effect of this variable shows that the probability of accessing services as an older farmer increases compared to their younger counterparts. These results align with Emmanuel *et al.* [30] and Danso-Abbeam *et al.* [14] found that the age of the farmers affects access to extension services. This implies that as farmers are getting old, access to extension services reduces as they rely on their farm experience than extension officers. These results suggest that as farmers age, their ability to seek agricultural services reduces compared to younger counterparts who can visit their offices. It may also be that older farmers may be unwilling to accept new information and improved technologies while younger ones are more flexible and eager for new information.

The years spent in school had a positive coefficient and were statistically significant at 5%. This implies that an additional year spent in school induces an increase in access to extension services by farmers. Extension officers are among the sources of innovation, and formal education is a crucial enabler of adoption because farmers with formal education are more motivated to adopt new farming techniques than those without formal education. This is because the more educated farmers are more likely to understand and interpret information better than uneducated farmers. The results show that the marginal effect of an additional year spent in school by farmers will induce an increased likelihood of accessing extension by 0.3. These results were in line with Baiyegunhi *et al.* [18] that an additional year of household head's education would increase the likelihood of participation in extension programs, enhancing agricultural yields and farm returns.

Farm size had a positive coefficient and was statistically significant at the 5% level. Farm size was associated with an increased probability of the extension program

participation. This implies that an additional hectare of land by the farmer will increase the adoption and use of extension services. The average marginal effect on the probability of y = 1 associated with farm size increases by 0.3%, ceteris paribus. The net benefits of farmers having access to extension programs and services increase with increasing farm size, possibly because bigger farms signify increased agricultural production potential. These results aligned with Danso-Abbeam *et al.* [14] that larger farms encourage farmers to participate and access extension services.

Off-farm income was found to be negative and statistically significant at 5%. This implies that an increase in the off-farm income by either 1% or more reduces the probability of farmers participating and access to extension services. This means that farmers have the financial power to help them sustain their household and farming expenditure. Off-farm income is indirectly related to access to extension services. These results concur with Mdoda and Obi [24].

Being a member of a farm organisation was found to be positive and statistically significant at a 5% level. This implies that an additional member of a farm organisation will increase the chances of accessing extension services. The average marginal effect on the probability of y = 1 associated with being a member of a farmer organisation increases by 0.3%. Extension officers in South Africa are orientated to work with farm groups, as evidenced by the cooperatives and other farmer groups that the government continues to advocate for. Extension officers provide services including new agricultural practices, market information of inputs and outputs, and training on innovative technologies to improve agricultural outcomes. Farmers who are members of farm organisations are likely to get sufficient awareness and knowledge of farm technologies and, hence, are sensitised to join extension programmes for more information on their farm business. These results agree with Bese *et al.* [31] that being a member of a farmer organisation increases the likelihood to access support services from various sources, including the private sector and NGOs.

Impact of Extension services on Smallholder Farm Income

The estimated treatment effects of accessing extension services on-farm income are presented in Table 5. Propensity Score Matching was used to assess the impact extension services have on farmers' livelihoods measured using farm income. The results show a statistically significant difference between the two groups after matching (farmers who had access to extension services were the treated group, while those who did not have access were non-treated). This indicates that in both groups of farmers, despite having similar characteristics,

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those with access to extension services were better off regarding farm returns than their counterparts. The study used nearest neighbour and kernel matching to estimate the average treatment effect on small-scale farmers.

The results in Table 5 show that all the matching estimators yield similar results and that having access to extension had a positive and statistically significant effect on net farm income. Additionally, the results are reliable across the different matching algorithms applied. The results indicate that net farm incomes would be about R6 525.45 less if farmers had no access to extension services. The differences among the values estimated using the two matching approaches show minimal differences in the outcomes from different algorithms, suggesting that the results are robust. These results were in line with Loki [32], Baiyegunhi *et al.* [18] and Hlatshwayo and Worth [20] that access to extension services enhances agricultural productivity and farm yield returns.

CONCLUSION

The paper aimed to provide empirical evidence on extension services' contribution to sustainable farmer livelihoods. Farm income was used as a measure of sustainable farmer livelihood. A total of 258 smallholder farmers were interviewed. The descriptive statistics show that female farmers are the majority in agricultural production. The binary regression model results showed that age, education and farm size significantly influenced farmers' access to extension services. Moreover, farmers with access to extension services were interested in larger family sizes that can help reduce labour costs and adopt improved variety, organic manure, mixed cropping practices, crop rotation, irrigation, and intercropping. Propensity Score Matching results showed that farmers with access to extension services had better farm income (propensity) compared to their counterparts who did not have access. The study, therefore, concludes that access to extension services significantly improves farm yields and farm income. The study recommends that policymakers, NGOs, the Private sector and Governments work jointly and support smallholder farmers' initiatives for better yield returns, sustained growth and commercial aspiration poverty reduction.

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CONFLICT OF INTEREST
All authors declare no conflict of interest.

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CONTRIBUTORS
Conceptualization: LO; Methodology: LO and LM; Project administration: LM; Formal analysis: LO and LM, Funding acquisition: LO and LM; Writing–original draft: LO and LM Reviewing and providing input to manuscript draft: LO and LM. All authors read and approved the final manuscript.

AVAILABILITY OF DATA AND MATERIALS
The datasets used during the current study is available from the corresponding author on reasonable request.

CONSENT TO PUBLICATION
Applicable

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Table 1: Demographic characteristics of farmers

Variables	Access to extension		No access to extension	
	N	%	N	%
Gender				
Male	48	31	31	29.78
Female	106	69	73	69.70
Marital status				
Single	32	20.45	21	19.90
Married	87	56.67	58	55.78
Widowed	36	23.15	25	23.89
Landowners				
Yes	85	55	56	54
No	69	45	46	44.20
Member of farmer organisation				
Yes	92	60	62	59.89
No	62	40	42	39.89
Total	154	100	104	100
Variables	Mean value		Mean value	
Age	48.20		46.30	
Household income	5 860		2 950	
Years spent in school	10.45		9.78	
Family size	6.36		6.20	
Farm size	2.89		3.26	
Farm experience	12.30		11.89	
Access to extension	78.10		58.23	

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Table 2: Contribution of extension services to smallholder farmers

Contribution of extension services provided	Frequency	Percentage (%)
Transfer innovative technology	29	19
Provide rural adult learning (knowledge transfer)	21	14
Provide agronomic techniques and market information	24	16
Provide agricultural and financial training	27	18
Post-harvest handling (reducing waste)	18	12
Relevant and reliable agricultural information.	35	23
Total	154	100

Table 3: Challenges faced by smallholder farmers

Challenges	Mean	T-Test
Distance to market centres and Department of Agriculture	0.281	0.005**
Lack of knowledge about extension services	0.303	0.040**
Lack of finances	0.305	0.013**
Lack of transportation	0.12	0.000**

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Table 4: Coefficient estimates of farmers with access to extension services

	Coefficient estimates		Marginal effect	
Variables	Coff.	Std. Err	Coeff.	Std. Err
Age	-2.430	0.005***	0.421	0.068
Years spent in school	0.870	0.023**	0.253	0.108
farm size	0.761	0.040**	0.310	0.230
Farm income	-0.576	0.034**	-0.205	0.078
Member of farm organisation	0.682	0.010**	0.351	0.152
Number of Observations 168	Pseudo R – Squared 0.658	–2 log-likelihood 103.868	Prob>chi2 = 0.000	LR Chi^2 (14) =55.66

Note: *** and ** mean 1% significant level and 5% significant level, respectively

Table 5: Effect of extension services on farm income

Output variable	Kernel Matching Method		
	ATT	Standard error	P-value
Farm income (ZAR)	6 525.45	362.17	0.033**
	Nearest Neighbours Matching Method		
	ATT	Standard error	P-value
Farm income (ZAR)	6 221.34	348.36	0.048**
Model Summary	Number of observations = 258	Matches requested	= 8
	Treatment model = Logit		

Significant effects are indicated with **: p ≤ 0.05; ***: p ≤0.01

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