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Farmers' willingness to pay for agricultural extension services in Limpopo province, South Africa

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Abstract

The provision of agricultural extension services in South Africa has transitioned from state-funded systems to privatised models, raising questions about smallholder farmers' willingness to pay for such services. This study employs a binary probit model on a sample of 319 smallholder farmers in Thulamela and Collins Chabane municipalities to examine their willingness to pay for agricultural extension services. The results show that marital status, farm size, perceived improvements in production output, privatisation of extension services and proximity to extension officers significantly influence farmers' willingness to pay for extension services. Notably, although annual income was anticipated to influence the likelihood of payment, it exhibited minimal effect. The findings emphasise the importance of enhancing the quality of public extension services and adopting pluralistic approaches to effectively address farmers' diverse requirements. Future research is needed to explore more robust theoretical frameworks for likely-to-pay analyses of smallholder farmers in developing countries.

Key words: willingness to pay, extension services, smallholder farmers, South Africa

1. Introduction

The Ministry of Agriculture in South Africa provides extension advisory services based on principles, rules and criteria in the country (Maake & Antwi, 2022). In the past, extension services were primarily

funded by state organisations following the diffusion of the innovation paradigm. The training and visit (T&V) strategy was used to impart knowledge to rural farmers, who were expected to share it with the surrounding populations (Ateka *et al*. 2019; Mbeche *et al*. 2022). However, the public sector-led extension has been criticised for being centralised, dogmatic, and intolerant of the two-way flow of ideas and decision-making. Governments face financial burdens due to T&V delivery, and the methods are not adaptable and provide less tailored advice to resource-poor farmers (Musa *et al*. 2013; Mbeche *et al*. 2022).

The low adoption of technology among farmers in South Africa has led to a lack of influence from qualified extension professionals, which has resulted in the formation of private consulting firms (Mbeche *et al*. 2022). This led to a pluralistic extension system that provides services to various farmers. However, these services are not widely accepted or utilised in the poorest areas due to limited coverage, a lack of popularity, and the fact that they operate on incentives, only offering assistance to farmers who can afford to pay for services (Loki *et al*. 2019; Agbugba *et al*. 2020).

Farming is primarily subsistence-based in many emerging nations, particularly in Africa, where the human population is high and land is scarce. Most of these farmers rely predominantly on agriculture as a source of livelihood. However, they face challenges, including pests and diseases, limited access to modern technology and credit, climate change impacts, and restricted access to water for irrigation. All of these aspects threaten farmers' livelihoods and socioeconomic standing (Ogunmodede *et al*. 2020). Farmers need prompt access to extension and advisory services for improved crop and animal production to reduce food insecurity. Agricultural extension services have long provided farmers access to a wide range of knowledge and innovations to boost farmers' yields, raise income, and allow a higher standard of living (Ogunmodede *et al*. 2020). However, public and conventional extension systems frequently fail to meet the diverse requirements of resource-poor farmers in many developing countries (Danielsen & Matsiko 2016). For instance, farmers need more information and understanding about managing new invasive pests. Still, public extension systems might not be able to give them this support because of inefficiencies, resource limitations, and the fact that some extension officials lack adequate knowledge, which results from inadequate training in the recent challenging subjects facing farmers.

As an emerging nation, South Africa faces dual pressures: the need to enhance agricultural productivity through effective extension services, and the necessity of adapting to privatisation and pluralistic service models to meet farmers' diverse needs (Smith 2012). Understanding smallholder farmers' willingness to invest in agricultural extension services, as explored in this study, becomes vital in shaping sustainable agricultural policies and practices suitable for an emerging economy such as South Africa.

The optimal farmer-to-extension agent ratio is between 1:500 and 1:800 (Ajala *et al*. 2013; Ogunmodede *et al*. 2020). The expected extension agent-to-farmer ratios in Ghana, Nigeria and Zambia are 1:1 500, 1:2 500 and 1:1 200-3 000, respectively (Ajala *et al*. 2013; Ogunmodede *et al*. 2020). Owing to the shortcomings of public extension systems, calls have been made for the private sector to assist in providing farmers with effective extension services (Ogunmodede *et al*. 2020). According to Rivera and Sulaiman (2009), the marketing of private extension services is only feasible if farmers are ready to pay for them, especially when the services have previously been offered for free.

The Thulamela and Collins Chabane municipalities in Limpopo Province are characterised by high agricultural potential, yet many smallholder farmers face significant challenges, including limited access to high-quality extension services (Kom *et al*. 2022). Understanding the factors influencing farmers' likelihood to pay for extension services is crucial for designing effective delivery models

that balance cost recovery with inclusivity (Afful & Lategan 2014; Agbugba *et al*. 2020). While many studies in the field employ willingness-to-pay (WTP) frameworks rooted in random utility theory, this study focuses on analysing the likelihood of smallholder farmers paying for extension services, an essential step toward understanding their potential engagement with privatised systems. Unlike willingness-to-pay (WTP) studies, which are rooted in random utility theory, this research employs a binary probit model to examine the probability of payment based on farmers' socioeconomic and demographic characteristics. The results contribute to the growing literature exploring factors influencing farmers' decisions in agricultural extension contexts. The binary probit model is particularly well suited for analysing the dichotomous nature of the dependent variable (the decision to pay or not to pay for services), while accommodating the influence of multiple socioeconomic and demographic factors. By leveraging this model, the study aims to provide insights into the key drivers of payment likelihood, offering actionable recommendations for policy makers and stakeholders.

2. A review of reflection on agricultural extension

Agricultural extension services are vital for disseminating knowledge, innovations and technologies to farmers, significantly influencing productivity and livelihoods. Historically, these services have transitioned from predominantly state-funded systems, such as the training and visit (T&V) approach, toward more privatised and pluralistic models (Rivera & Sulaiman 2009; Mbeche *et al*. 2022). Privatisation aims to improve efficiency and adaptability, but its success hinges on farmers' willingness to financially support these services. Numerous studies identify socio-economic characteristics that influence farmers' likelihood to pay for extension services. Variables such as age, gender, education level, marital status, and household size significantly affect farmers' decision-making processes (Yapa & Ariyawardana 2010; Ejeta *et al*. 2019). For instance, younger, educated and economically stable farmers tend to have a higher willingness to pay due to a better appreciation of the services' value (Boe *et al*. 2020; Sumo *et al*. 2023). Land size and type of agricultural activities also strongly predict farmers' payment likelihood. Farmers with larger farms or those engaged in high-value agricultural practices tend to perceive greater value in extension services and exhibit higher payment willingness (Danielsen & Matsiko 2016: Loki *et al*. 2019). Economic factors, including farmers' annual income and the perceived economic benefits of extension services, are decisive in shaping willingness to pay. Studies indicate a clear link between higher income levels and an increased probability of paying for privatised extension services, highlighting the need for targeted pricing strategies and subsidisation to ensure inclusivity for resource-poor farmers (Labarthe & Laurent 2013).

Globally, the privatisation of extension services is perceived positively for enhancing responsiveness and efficiency, although significant challenges remain in maintaining equity for and accessibility by marginalised groups (Rivera & Sulaiman 2009; Kasilingam & Krishna 2022). For instance, farmers in Sub-Saharan Africa generally express a positive willingness to pay, albeit with regional disparities influenced by local economic conditions and extension service quality (Abdu-Raheem & Worth 2016). The literature also highlights critical gaps in public extension systems, such as inadequate training of extension personnel, infrequent farmer visits and delayed feedback, significantly limiting their effectiveness (Musa *et al*. 2013). Addressing these gaps through improved training, enhanced infrastructure and ICT integration could substantially enhance the effectiveness and reach of extension services (Bjornlund *et al*. 2020). From a methodological perspective, traditional utility-based models dominate extension studies, yet alternative approaches such as binary probit regression provide nuanced insights into farmers' discrete decision-making processes (Moore 2013). These quantitative analyses are essential for developing targeted policies and strategic interventions in agricultural extension.

Adopting a pluralistic system in SSA has allowed farmers to benefit from various agricultural services, enhancing the quality and value of these services (Bjornlund *et al*. 2020). However, this

approach has also reduced government involvement in agricultural extension activities. Continued government support remains essential for addressing critical needs, such as disaster response, risk-sharing, system regulation, quality control of services and promotion of reforms, regardless of whether the services are provided by public, private or other sectors (Mutimba 2014; Abdu-Raheem & Worth 2016). This study, however, focuses on the likelihood of payment, providing a descriptive narrative of factors influencing smallholder farmers' payment behaviour. This approach complements existing research by offering insights into farmers' responses to extension services without relying on utility-based assumptions.

3. Materials and methods

3.1 Description of the study area

The study was conducted in Thulamela and Collins Chabane municipalities, Limpopo Province of South Africa (Figure 1). The agricultural system in the Thulamela and Collins Chabane municipalities is characterised by two types: large-scale commercial farming and smallholder farming, with sweet potatoes, beans, vegetables, maize, tomatoes and pumpkins the commonly grown vegetables (Kom *et al*. 2022). Due to budget constraints, this study focused only on the Collins Chabane Municipality and the Thulamela Municipality. Following the local elections held on 3 August 2016, the Collins Chabane Local Municipality (CCLM) was created under Section 12 of the Municipal Structures Act (No. 117 of 1998). In Vhembe District, the municipality is now the fourth local municipality (Category B). It shares boundaries with Musina in the north, Thulamela in the northeast, Mopani District in the south, and Makhado in the west. It is located in the northern region of Limpopo province. The region comprising the municipal area, which has a total area of 5 467.216 km^2, was formerly part of the Thulamela and Makhado Local Municipality (Kom *et al*. 2022).

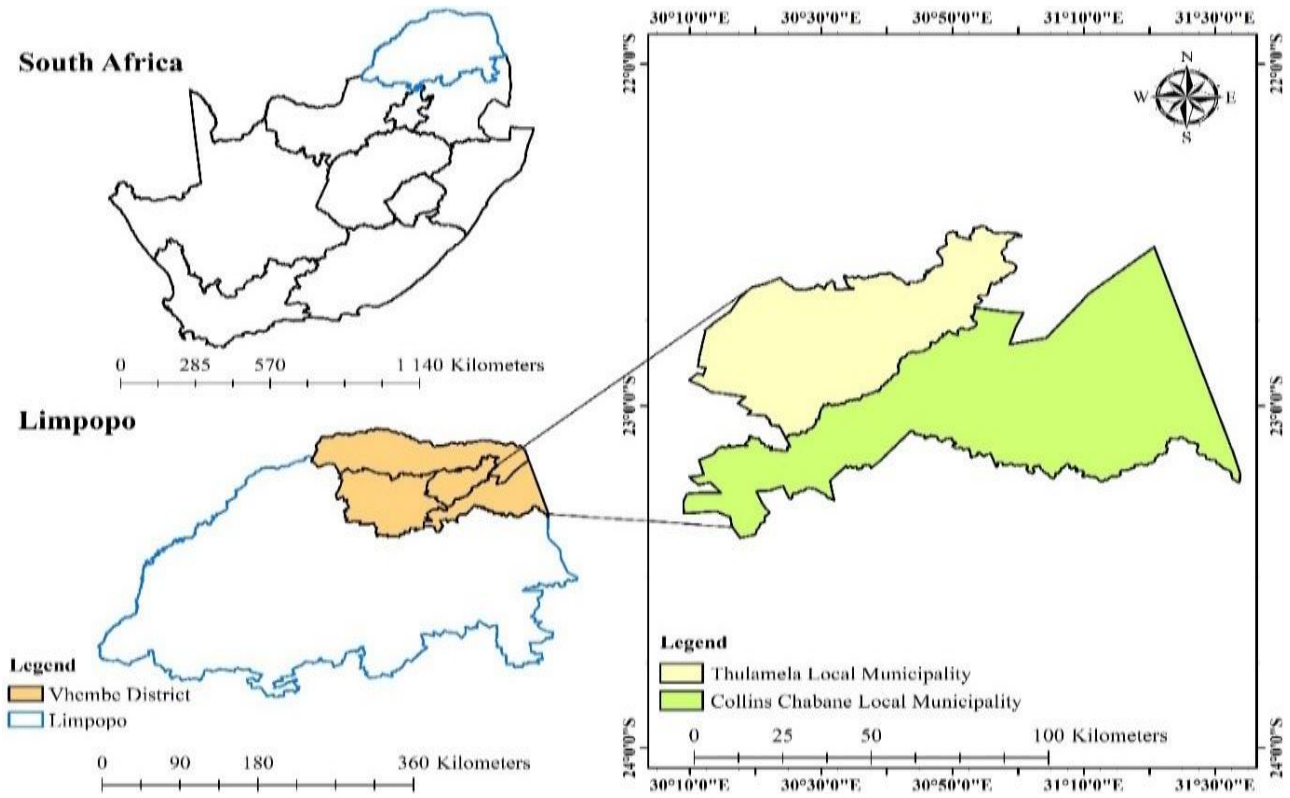

Figure 1: Study site, Vhembe District, Limpopo Province
Source: Author's compilation

3.2 Data collection

Data were collected from 319 farmers from a population of 580 smallholder farmers using a probability sampling method involving a stratified and simple random sampling technique. A pretested questionnaire was used as the primary data collection tool for this study. The questionnaire was administered by well-trained enumerators through face-to-face interviews with the respondents. A total of 191 women and 128 men participated in the questionnaire-based survey. A total of 19 female and male smallholder farmers participated in the four focus group discussions (FGDs). The FGDs were randomly compiled from participants who did not participate in the questionnaire interviews. The four FGDs were divided into two groups: eight female smallholder farmers and two groups of six male smallholder farmers, to ensure full participation by female smallholder farmers in the absence of male smallholder farmers.

Before collecting data in the study area, a probability sampling method involving a stratified random technique was used to select farmers. Farmers in the Thulamela and Collins Chabane municipalities were divided into two sub-group municipalities (176 from Collins Chabane and 404 from Thulamela). The sample size for the study was computed based on the following formula:

$$n = \frac{N}{Ne^2}, \quad (1)$$

where n is the desired sample size, N is the total target population, and *e* is the degree of accuracy required, normally set at 0.05 (5% of acceptable sampling error) (Kothari 2004; Asfaw *et al*. 2017). Therefore, in each subgroup, a simple random sampling technique was used to select a total of 319 smallholder farmers (121 from Collins Chabane municipality and 198 from Thulamela municipality). In this study, the respondents were asked if they were likely to pay for extension services: (No [0], yes [1]); they were asked to rank the level of frequency of farm visits by extension personnel (weekly [0], monthly [1], quarterly [2], annually [3], never [4]), and they were asked about the extension feedback (extension feedback takes too long [0], extension feedback does not take too long [1]).

3.3 Ethics statement

The study was performed according to the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments and was approved by the Humanities and Social Sciences Research Ethics Committee (HSSREC) of the University of KwaZulu-Natal (protocol reference number: HSSREC 00003210/2021). Accordingly, the Department of Agriculture in the Thulamela and Collins Chabane Municipalities of Limpopo Province granted permission to conduct the study in the Thulamela Municipality and Collins Chabane Municipality in 2022.

3.4 Methods of analysis

The Statistical Package for Social Scientists (SPSS) version 26 and StataSE 17 software were used to analyse the data. Data on smallholder farmers were summarised using frequencies and percentages. The Shapiro-Wilk test was used to determine whether the explanatory factors were normal before the variables were analysed. According to the test, the data were regarded as normal if the Shapiro-Wilk test p-value was higher than 0.05. A t-test was used to analyse the descriptive statistics for continuous variables using the SPSS software. The *p*-values for the t-test were calculated using SPSS. The chi-squared test was used to analyse the descriptive statistics of categorical variables using SPSS. SPSS was also used to generate the *p*-values throughout the study. The significance levels for the

coefficients in the study were categorised into three thresholds of significance: 1%, 5% and 10%. STATA was employed for econometric modelling.

3.5 Estimating determinants of smallholder farmers' willingness to pay for extension services: Binary probit regression model

A binary probit model was employed to determine the willingness of smallholder farmers to pay for extension services. Probit regression is used to model a binary response variable. The assumptions under this model are as follows: (1) there is sufficient data with more than 30 observations; (2) the data are assumed to follow a standard normal distribution, and the error term also follows standard normality; and (3) categorical predictors are assumed to have a linear effect on the response variable (Moore 2013). This model was suitable for the study's objective, as it examines a dependent variable with two categorical outcomes: likelihood to pay for extension services (coded as 1) or not to pay (coded as 0).

The model was econometrically stated as:

$$P_i=F\ (Z_i) = \frac{1}{1+ e-(\alpha+\sum\beta iX_i)}\ , \quad (2)$$

where P_i is the probability that a respondent is willing to pay for extension services; and X_i represents the i[th] explanatory variables. α and β_i are the regression parameters to be estimated, and e is the base of the natural logarithm.

For ease of interpretation of the coefficients, a probit model can be written in terms of the odds and log of the odds. The odds ratio of smallholder farmers willing to pay for extension services (P_i) to the probability that smallholder farmers will not pay for extension services (1-P_i) is:

$$\left(\frac{P}{1-P}\right) = e^{Z_i} \quad (3)$$

Taking the natural logarithm of Equation (3) yields:

$$In\left(\frac{P}{1-P}\right) = e^{Z_i}= Z\ i= \alpha+ \beta 1\ X_1 + \beta 2\ X_2 + \ldots\ldots + \beta m X_m \quad (4)$$

If the disturbance term Ui is considered, the probit model becomes:

$$Zi = \alpha + \sum_{i=1}^{m} \beta i\ X_i + Ui\ , \quad (5)$$

where X_i denotes the i[th] predictor variable. The parameters α and β of the model can be estimated using the maximum likelihood method (Moore 2013).

The dependent variable used in this study was farmers' willingness to pay for extension services, categorised as a binary response (Table 1).

Table 1: Description of the dependent variable used in the model

The binary probit regression model	
y = 1	likelihood to pay for extension services
y = 0	likelihood not to pay for extension services

Source: Results of research survey

The explanatory variables influencing the willingness to pay are described and categorised with their expected signs in Table 2.

Table 2: Description of independent variables used in the model

Independent variables	Description and unit of measurement	Expected sign
Age	Categorical, level of household head age in years	+
Gender	Binary, 1 if the head is male and 0 if female	+/-
Marital status	Categorical, marital status of household head	+
Education level	Categorical, educational level of household head	+
Household size	Categorical, level of family size in numbers	-
Land size	Categorical, level of land size in hectares	+
Type of agricultural land farming	Categorical, type of household head production	+
Production purpose	Categorical, production purpose of household head	+
Extension access	Binary, 1 access to extension service and 0 otherwise	-
Frequency extension visit	Categorical, level of extension personnel visits	-
Farming experience	Categorical, level of farming experience of the head in years	+
Extension feedback length	Binary, 1 not too long and 0 otherwise	-
Difference in output	Binary, 1 yes and 0 otherwise	+
Annual income	Total income earned by the household head (R)	+
Privatisation of extension	Binary, 1 yes and 0 otherwise	+
Distance to extension officer	Categorical, distance to extension personnel in km	-
Technology adoption	Categorical, distance to extension personnel in km	+

Notes: + indicates that the variable was expected to have a positive effect on the dependent variable; - indicates that the variable is expected to have a negative effect on the dependent variable.
Source: Results of research survey

4. Results

4.1 Descriptive statistics

Table 3 shows the socioeconomic and demographic information of the smallholder farmers who participated in this study. The independent variables used in the study were checked for normality and were deemed normal.

The results in Table 3 show that the sample of 319 smallholder farmers in the study area was dominated by female smallholder farmers (59.9%), with 40.1% being male smallholder farmers. Most smallholder farmers were between the ages of 45 and 55 (at 27.6%). Approximately 24.5% of the smallholder farmers were 66 years old and older, and some were younger than 25 years of age (3.8%). Approximately 46.7% of the smallholder farmers in the study area were married, 28.2% of the farmers were single, 20.4% were widowed, and 4.7% of the smallholder farmers were divorced. About 45.8% of the smallholder farmers had attended secondary school, while 23.8% had attended primary school. A total of 19.4% had attended some form of tertiary education, and 11% of the smallholder farmers had never attended school. Table 3 shows that approximately 56.5% of the smallholder farmers had a household size between one and five members, while 41.8% of the smallholder farmers had six to 10 family members and 1.7% of the farmers had a household size ranging from 11 to 15.

Table 3: Socio-economic demographic profiles of smallholder farmers

Household characteristics		Study (*n* = 198)	Area (*n* = 121)	Total (N = 319)	Percentage (%)
		Collins Chabane Municipality	Thulamela Municipality		
Gender	Male	64	64	128	40.1
	Female	134	57	191	59.9
Age	< 25	8	4	12	3.8
	26–35	20	15	35	11
	36–45	36	18	54	16.9
	46–55	51	37	88	27.6
	56–65	40	12	52	16.3
	> 66	43	35	78	24.5
Marital status	Single	60	30	90	28.2
	Married	88	61	149	46.7
	Divorced	8	7	15	4.7
	Widowed	42	23	65	20.4
Educational level	Never attended	21	14	35	11
	Primary school	40	36	76	23.8
	Secondary school	100	46	146	45.8
	Tertiary	37	25	62	19.4
Household size	1–5	115	65	180	56.5
	6–10	81	52	133	41.8
	11–15	2	4	6	1.7

Source: Results of research survey

4.2 Smallholder farmers' willingness to pay for extension services

Figure 2 shows that 97% of smallholder farmers in the study area were willing to pay for information and communication technology, and 3% of the smallholder farmers were not likely to pay for information and communication technology. In the study, 36% of the respondents agreed to pay for personal visits and training by extension personnel. In comparison, 64% of the respondents did not agree to pay for personal visits and training by extension personnel. In the study, 77% of the respondents agreed to pay for crop and livestock inputs, while 33% of the respondents did not agree to pay for crop and livestock inputs. The study shows that 80% of the smallholder farmers were likely to pay for marketing skills, while 20% of the smallholder farmers were not likely to pay for marketing skills.

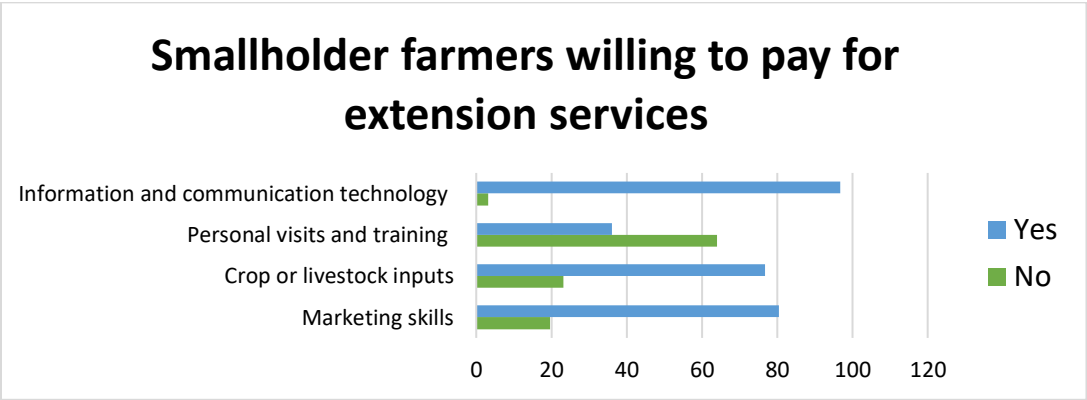

Figure 2: Smallholder farmers likelihood to pay for extension services
Source: Authors' compilation from results of research survey

Table 4 presents the t-test results for the continuous variables. These was a statistically significant relationship between smallholder farmers' likelihood to pay for extension services and their annual income ($p < 0.01$). The t-test indicates that smallholder farmers likely to pay for extension services had a total mean average income of R20 801.23, and smallholder farmers who were not likely to pay for extension services had a total mean average income of R16 810.37.

Table 4: T-test results for determinants of smallholder farmers' willingness to pay for extension services

Variable (mean)	Measure	Likelihood that smallholder farmers will pay for extension services	*p*-value
Annual income (ZAR)	No	20 801.23	***
	Yes	16 810.37	
Household size	No	5.44	ns
	Yes	5.33	

Notes: *** means the coefficient is statistically significant at the 1% level. ns = not statistically significant
Source: Results of research survey

Table 5 presents the results of the chi-squared test for the categorical variables. A statistically significant relationship was found between smallholder farmers' likelihood to pay for extension services and their age ($p < 0.1$). Table 5 shows that 33.3% of the smallholder farmers aged 25 or younger were not likely to pay for extension services, and 66.7% were likely to pay for extension services. In the category of smallholder farmers between the ages of 26 and 35, 14.3% of the farmers were not likely to pay for extension services, while 85.7% were likely to pay for these services. In the category of smallholder farmers between the ages of 36 and 45, 25.9% of the farmers were unlikely to pay and 74.1% were likely to pay for extension services. In the category of smallholder farmers were between the ages of 46 and 55, 20.5% of the smallholder farmers were unlikely to pay for extension services and 79.5% were likely to pay. A minority of smallholder farmers between the ages of 56 and 65 were not likely to pay for extension services, at 13.5%, while 86.5% were likely to pay. Finally, in the category of smallholder farmers who were between the ages of 66 and older, 32.1% were not likely to pay and 67.9% were likely to pay for extension services.

There was a statistically significant relationship between smallholder farmers' likelihood to pay for extension services and their farm size ($p < 0.05$). The results indicated that 36.8% of the smallholder farmers with less than one hectare were unlikely to pay for extension services, while 63.2% were likely to pay. In the category of one hectare, 14.4% of the smallholder farmers were unlikely to pay for extension services and 85.6% were likely to pay for these services. In the category of one to five hectares, 28.4% of the smallholder farmers were not likely to pay for extension services and 71.6% were likely to pay. The results further indicate that 14.3% of smallholder farmers with a farm size greater than five hectares were unlikely to pay for extension services, while 85.7% were likely to pay.

A statistically significant relationship was found between smallholder farmers' likelihood to pay for extension services and their agricultural production purpose ($p < 0.01$). The results indicated that 4.7% of livestock smallholder farmers were not likely to pay for extension services, while 95.3% were likely to do so. Furthermore, 33.1% of the smallholder crop farmers were not likely to pay for extension services and 66.9% were likely to pay. Furthermore, among smallholder farmers involved in mixed farming, 20.4% were not likely to pay for extension services and 79.6% were likely to pay.

There was a statistically significant relationship between smallholder farmers' likelihood to pay for extension services and the duration of their farming experience ($p < 0.05$). Among smallholder farmers who had been farming for less than 10 years, 31.8% were unlikely to pay for extension services and 68.2% were likely to pay. In the category of 11 to 20 years of farming experience, 13.1% of the smallholder farmers were not likely to pay for extension services and 86.9% were likely to pay.

Of the farmers with 21 to 30 years of experience in farming, 19.7% were not likely to pay for extension services and 80.3% were likely to pay. Among smallholder farmers with farming experience of longer than 31 years, 29% were unlikely to pay for extension services and 71% were likely to pay.

As shown in Table 5, a statistically significant relationship exists between smallholder farmers' likelihood to pay for extension services and their difference in production output ($p < 0.01$). The results indicate that, of smallholder farmers with no difference in production output, 13.5% of the smallholder farmers were unlikely to pay, and 86.5% were likely to pay for extension services. Of smallholder farmers who identified a difference in production output, 40.2% of the smallholder farmers were not likely to pay for extension services, and 59.8% were likely to pay for such services.

A statistically significant relationship was found between smallholder farmers' likelihood to pay for extension services and technology adoption ($p < 0.01$). The results indicate that, for smallholder farmers who had a low level of technology adoption, 18.5% of the smallholder farmers were unlikely to pay for extension services and 81.5% were likely to pay for these services. Of the smallholder farmers who had low technology adoption, 23.5% were unlikely to pay, while 76.5% were likely to pay for extension services. Among the smallholder farmers who had high technology adoption, 43.6% were not likely to pay for extension services and 56.4% were likely to pay.

Table 5: Association between willingness to pay for extension services and socioeconomic parameters

Variable	Measure	Unlikely to pay for extension services [*n* = 73 (%)]	Likely to pay for extension services [*n* = 246 (%)]	X^2 sig. level
Age	< 25	4 (34.3)	8 (66.7)	
	26–35	5 (14.3)	30 (85.7)	
	36–45	14 (25.9)	40 (74.1)	*
	46–55	18 (20.5)	70 (79.5)	
	56–65	7 (13.5)	45 (86.5)	
	> 66	25 (32.1)	53 (67.9)	
Gender	Male	31 (24.2)	97 (75.8)	ns
	Female	42 (22.0)	149 (78.0)	
Marital status	Single	19 (21.1)	71 (78.9)	
	Married	32 (21.5)	117 (78.5)	
	Divorced	4 (26.7)	11 (73.3)	ns
	Widowed	18 (27.7)	47 (72.3)	
Educational level	Never attended	8 (22.9)	27 (77.1)	
	Primary school	14 (18.4)	62 (81.6)	ns
	Secondary school	39 (26.7)	107 (73.3)	
	Tertiary	12 (19.4)	50 (80.6)	
Farm size	< 1 hectare	21 (36.8)	36 (63.2)	
	1 hectare	21 (14.4)	125 (85.6)	**
	1–5 hectare	29 (28.4)	73 (71.6)	
	> 5 hectare	2 (14.3)	12 (85.7)	
Type of agricultural land	Dryland agriculture	24 (19.8)	97 (80.2)	ns
	Irrigated agriculture	49 (24.7)	149 (60.6)	
Production purpose	Livestock	3 (4.7)	61 (95.3)	
	Crop	47 (33.1)	95 (66.9)	***
	Mixed farming	23 (20.4)	90 (79.6)	
Extension access	No	6 (8.7)	63 (91.3)	
	Yes	67 (26.8)	183 (73.2)	
Frequency of extension visits	Weekly	4 (28.6)	10 (71.4)	
	Monthly	33 (39.8)	50 (60.2)	

	Quarterly	12 (21.8)	43 (78.2)	
	Annually	11 (14.5)	65 (85.5)	
	Never	13 (14.3)	78 (85.7)	
Farming experience	< 10 years	27 (31.8)	58 (68.2)	
	11–20 years	13 (13.1)	86 (86.9)	**
	21–30 years	13 (19.7)	53 (80.3)	
	> 31 years	20 (29.0)	49 (71.0)	
Extension feedback length	Too long	31 (16.3)	159 (83.7)	ns
	Not too long	42 (32.6)	87 (67.4)	
Differences in production output	No	28 (13.5)	179 (86.5)	***
	Yes	45 (40.2)	67 (59.8)	
Privatisation of extension	No	27(79.4)	7 (20.6)	ns
	Yes	46 (16.1)	239 (83.9)	
Distance to extension officer	1–5 km	40 (32.3)	84 (67.7)	
	6–10 km	12 (46.2)	14 (53.8)	ns
	11–15	9 (10.2)	79 (89.8)	
	> 16 km	12 (14.8)	69 (85.2)	
Technology adoption	Low	36 (18.5)	159 (81.5)	
	Average	20 (23.5)	65 (76.5)	***
	High	17 (43.6)	22 (56.4)	

Notes: The figures in parentheses are the percentages. ***, ** and * mean the coefficient is statistically significant at the 1%, 5% and 10% levels respectively; n = not statistically significant; *n* = sample size; X^2 = chi-square.
Source: Results of research survey

The determinants of smallholder farmers' likelihood to pay for extension services in the study area were estimated using a binary probit model (Table 6). The findings show that all the calculated coefficients were statistically significant because of the statistical significance of the likelihood ratio (LR) X^2 statistic ($p < 0.01$). The coefficients of the binary probit model do not depict the size of the impact of the explanatory variables. Instead, the marginal effects are discussed. Marginal effects measure how a change in the average value of the independent variables, expressed as a unit, affects the likelihood that a respondent in the study will pay for extension services.

Table 6: Binary probit estimates of smallholder farmers' willingness to pay for extension services

Independent variables	Coefficients	Robust std. error	Marginal effects
Age	-0.007	0.096	-0.002
Gender	0.086	0.201	0.023
Marital status	-0.159	0.100	-0.043*
Education level	-0.107	0.125	-0.028
Household size	-0.039	.003	-0.010
Land size	0.315	0.122	0.085***
Type of agricultural land farming	0.207	0.337	0.056
Production purpose	-0.206	0.197	-0.055
Extension access	-0.408	0.356	-0.110
Frequency of extension visits	0.008	0.105	0.002
Farming experience	0.022	0.113	0.006
Extension feedback	-0.092	0.271	-0.024
Difference in output	0.628	0.264	0.169**
Annual income	-5.46×10^{-6}	6.17×10^{-6}	-1.48×10^{-6}
Privatisation of extension	1.508	0.333	0.408***
Distance to extension officer	0.234	0.134	0.063**
Technology adoption	0.023	0.134	-0.006
Constant	0.226	0.852	
Number of observations = 319; LR X^2 = 88.41; Pseudo R^2 = 0.75			

Notes: ***, ** and * means the coefficient is statistically significant at the 1%, 5% and 10% levels, respectively. LR = likelihood ratio.
Source: Results of research survey

5. Discussion

The privatisation of agricultural extension services in South Africa and other African countries is gaining attention as a potential solution to improve service delivery and enhance smallholder farmers; productivity (Raidimi & Kabiti 2019; Loki 2022). Studies indicate that a significant proportion of farmers are willing to pay for privatised extension services, particularly those who are younger, have larger land sizes, and have access to existing services (Loki *et al*. 2019; Gebreegziabher & Mezgebo 2020). Factors influencing farmers' perceptions of privatisation include land tenure rights, frequency of extension officer visits, and satisfaction with current services (Loki 2022). However, challenges remain in implementing privatised services, including the need for public-private partnerships and to address the diverse needs of smallholder farmers (Raidimi & Kabiti 2017; Nwafor & Nwafor 2020). The transformation of extension services also requires consideration of the historical context, institutional arrangements and policy frameworks (Zantsi 2019; Ngomane *et al*. 2002).

This study provides critical insights into the determinants of farmers' willingness to pay (WTP) for agricultural extension services in Limpopo province, South Africa. As public sector-led extension services continue to face challenges related to underfunding, limited reach and low responsiveness, understanding farmers' readiness to financially support advisory services is essential for the sustainability and effectiveness of the delivery of agricultural extension. This is particularly relevant in Limpopo province, where smallholder farmers play a central role in food production and rural livelihoods, yet remain underserved by both public and private extension systems (Maake & Antwi 2022).

The findings from the binary probit model reveal that a combination of socioeconomic, farm-level and institutional factors influence farmers' likelihood to pay for extension services. Notably, land size emerged as a strong positive predictor of WTP. Farmers with larger landholdings are more inclined to pay, likely due to their greater investment capacity and higher expected returns from improved agricultural practices. This is consistent with the existing literature, which links resource availability with the greater uptake of fee-based agricultural services (Loki *et al*. 2019). Marital status was found to have a significantly negative effect on WTP, with unmarried farmers less likely to pay for services. This may reflect differences in household decision-making dynamics, or economic vulnerability among single-headed households. Ejeta et *al*. (2019) similarly found that marital status significantly influenced farmers' WTP, often linked to household stability and support systems.

A particularly noteworthy finding was the positive association between perceived improvements in production output and WTP. Farmers who recognised tangible benefits from previous extension engagements, such as increased yields or better farm management, were significantly more willing to pay. This underscores the importance of ensuring that extension services deliver visible and measurable outcomes. Danielsen and Matsiko (2016) emphasise that farmers are more likely to pay when extension services lead to observable improvements in productivity.

Another important dimension is the role of proximity to extension officers. Farmers located closer to extension personnel were more likely to pay for services, suggesting that access and logistical convenience influence perceived value and willingness to engage. Similar patterns were observed in studies by Shausi *et al*. (2019), who found that geographic proximity was associated with greater trust and participation in extension programmes. The study also finds strong support for privatisation as a positive determinant of WTP. Farmers exposed to private extension services were more willing to pay, indicating that demand-driven, responsive service models can foster stronger farmer engagement. However, this raises concerns about inclusivity and affordability, as not all farmers – especially those with limited resources – can bear the cost of private services. Rivera and Sulaiman

(2009) and Labarthe and Laurent (2013) both caution that privatisation must be balanced with equity considerations to avoid excluding marginalised farmers.

While annual income was not statistically significant in the final model, the descriptive statistics and t-test results suggest some association between higher income and greater willingness to pay. This nuanced finding may indicate that income interacts with other variables, such as land size or production goals, in shaping payment decisions. Sumo *et al*. (2023) similarly noted that, while income is a contributing factor, its impact on WTP is often mediated by other socioeconomic characteristics.

6. Conclusions and policy implications

The findings of this study underscore several important considerations for policy makers and practitioners in designing and implementing agricultural extension services in South Africa. First, extension service providers must prioritise the demonstration of tangible, measurable benefits that align with farmers' specific needs and priorities. When farmers see clear advantages, such as increased productivity or improved market access, they are more likely to engage with and invest in extension services. Building trust through transparent and outcome-focused programmes will be essential. Second, policies should strategically target farmers with more extensive landholdings, who are more likely to pay for services. At the same time, ensuring inclusivity by subsidising extension services for smaller-scale farmers who may not have the financial means to pay but stand to benefit significantly from the support is vital. Such an approach could enhance equity and broad-based agricultural development.

Third, logistical challenges must be addressed in remote areas to improve service accessibility. This can be achieved through investments in road infrastructure, the deployment of mobile extension units, or the integration of information and communication technologies (ICT) to bridge spatial gaps. Ensuring that extension services are within the reach of all farmers will enhance uptake and effectiveness. Lastly, while the privatisation of extension services has been shown to increase efficiency and responsiveness, it is crucial to balance this approach with inclusivity. Policy makers should consider hybrid models such as public-private partnerships and tiered pricing mechanisms to ensure that economically disadvantaged farmers are not excluded. These models can enable sustainable and equitable service delivery by combining the strengths of both sectors. Furthermore, future research should delve deeper into the behavioural and cultural dimensions of WTP, explore region-specific pricing models, and assess the long-term outcomes of different extension financing strategies in similar contexts.

7. Limitations and future research

While this study provides robust insights, it is not without limitations. The focus on payment likelihood does not account for broader behavioural factors, such as cultural attitudes or trust in extension agents. Future research could explore these dimensions using qualitative methods or hybrid analytical frameworks. Examining the impacts of tiered pricing models and alternative delivery mechanisms could provide further actionable insights. In conclusion, the study underscores the importance of understanding the nuanced determinants of payment likelihood among smallholder farmers. By addressing the identified barriers and leveraging the drivers of engagement, policy makers and service providers can enhance the accessibility, affordability and effectiveness of agricultural extension services in South Africa.

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