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Farmer's perceptions of effectiveness of public agricultural extension services in South Africa: an exploratory analysis of associated factors

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Abstract

Background: Effective public extension and advisory services have the potential to improve agricultural productivity; net farm income; and food security amongst resource-poor farmers. However, studies conducted to measure the effectiveness of extension and advisory services, offered by the Government of South Africa, have focused on the methods used, instead of the guiding principles, such as demand-driven services; equity; prioritization of farmer's needs; and social and human capital development. The aim of this research paper was to determine farmers' perceptions regarding the effectiveness of public extension and advisory services and associated factors. Perceptions of the effectiveness were measured using sixteen variables. A group of 442 farmers, in the Gauteng province, receiving government agricultural extension and advisory services, were randomly selected to participate in the study. Using a semi-structured survey instrument, primary data was collected through physical interviews and then analysed using computer software.

Results: The study found that public extension and advisory services in Gauteng were perceived as ineffective. Three socio-demographic factors (education level, age and farm/plot size) significantly influenced farmer's perceptions towards public extension and advisory services. Moreover, the Principle Axis Factoring (PAF) results indicated that there were three underlying factors of the perceived effectiveness of public extension services, namely: relevance and good quality services; provision of information on improving agricultural production; and availability of the technologies required by farmers.

Conclusions: Large-scale farmers perceived public extension services to be less effective. The exploratory factor analysis extracted three underlying factors which accounted for 81.81% of the variance of the perceived effectiveness of public extension services. Farmers recommended that public extension and advisory services should be of good quality; relevant; and should improve agricultural production to be considered as effective by the farmers. Moreover, provision of extension and advisory services should be determined by farm/plot size.

Keywords: Effectiveness, Extension, Factor analysis

Background

Agricultural extension is a source of information for most farmers with low literacy levels and poor access to Information and Communication Technology (ICT) in developing countries. Through access to extension and advisory services, farmers receive diverse information

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about cultivation practices; fertilisation; plant protection (pests, weeds and disease control); marketing; livestock and crop management; climate change; and so forth. Because of the important role and benefits of agricultural extension, access to public extension and advisory services is imperative for most farmers, especially those who cannot afford private extension services. As a result, government is the main provider of extension services in most developing countries [1–3]. One of the reasons that the government is highly involved in rendering extension services, is to ensure that farmers receive the support which will enable them to produce adequate and quality produce, and thus enabling the country to be food secure. Therefore, effective public extension services play an important role in agricultural sustainability and food security of a country. Effectiveness of extension services have been widely investigated globally using various methods. Most scholars have measured the effectiveness of extension services using delivery methods, such as farmer trainings, farm/home visits, office calls, field demonstrations, field/farmers days, workshops/open discussions [4–7]. Facilitation of study groups and distribution of printed materials has also been used as a way to determine effectiveness of extension services [4]. The ability of extension personnel to manage orientation, expose farmers to mass media, provide scientific orientation and innovate farmers could be used to determine whether extension services are effective or not [8]. Extension system capable to utilizing Information and Communication Technologies such as televisions, radio, telephones, helpline and social media (Facebook, Twitter, etc.) are considered as effective [5]. Moreover, other scholars have measured the impact of extension services on farmers' income and agricultural production [9, 10]; innovation adoption rate, food safety and nutrition [7]; campaigns, lectures, exhibitions, literature and signboards [11]; and transferring crop production and management knowledge to farmers [12], as measures of the effectiveness of extension services. The above background indicates that different methods have been employed by scholars to measure effectiveness of extension services.

The results of the effectiveness of extension services vary from one place to the other; even though there are some commonalities in some instances. In Ekurhuleni Metropolitan and Sedibeng District Municipalities, Gauteng province of South Africa, the results of a focus group involving smallholder farmers showed that public extension services were not effective in sharing printed information, nor communicating and facilitating workshops, but were, however, effective in utilizing methods, such as trainings, demonstrations, farmers' days, individual farm visits and on-farm trials and research [4]. In an experimental research conducted amongst smallholder poultry farmers in Dakhalia governorate, Egypt, it was found that public extension services were most effective in demonstrations; meetings; and the distributions of pamphlets [13]. However, in Khyber Pakhtunkhwa province, Pakistan, the findings of a survey showed that majority of farmers perceived extension services as ineffective in the following methods farm/home visit, phone office calls, demonstration plots, field days, demonstration plots, farmer trainings, local agriculture fair and workshop/open discussion [6]. The T test results of a survey that sampled rice growers (farmers) receiving extension services from government and private sector in Pakistan indicated that public extension services were moderately effective in the dissemination of information through demonstrations and farm/home visits [5]. However, in the said study, it was found that public extension services were less effective in agricultural campaigns; Farmers' days; and signboards aimed at building farmers' capacity. Again, maize growers in Kilindi District of Tanzania held the opinion that agricultural extension agents were ineffective in transferring knowledge about selection of cultivars, choosing planting date, seed treatment, crop protection (weed, pest and disease control), fertilizer application, irrigation and harvesting practices, and demonstration methods [12]. The T test results of the experimental research that involved recipients and non-recipient of extension services in Jordan found that net income and agricultural production were not statistically significant ($p > 0.05$); thus, extension services were ineffective in improving farmers' net income an production [9]. On the contrary, survey results from Kaduna state, Nigeria showed that effective extension services enhanced productivity and farmers' income [10]. A survey that involved extension practitioners in the Eastern Cape province of South Africa found that public agricultural extension was ineffective in uplifting farmers from poverty and in providing necessary resources [14]. Literature presented above shows that information about effectiveness of extension services can be collected through a survey, experimental research and focus groups involving farmers and extension practitioners. Moreover, different methods were used to measure effectiveness of extension services.

In addition, several studies that investigated the effectiveness of extension services have also explored factors influencing effectiveness or determinants [6, 8, 15–17]. Information about the determinant of the effectiveness of extension services has been analysed using methods, such as, principal component analysis (PCA); Regression models (Ordered Logistic, Binary Logit; Probit; Ordinary Least Squares; and Multiple logistic); descriptive statistics; T test; and qualitative analysis. The results of PCA extracted the following factors underlying factors

associated with the effectiveness of extension services, policy-making factors, which accounts for 17.2% of the variance; followed by socio-cultural factors (16.4%); and structural and economic factors which accounts for 14.1% and 13.3%, respectively [18]. In a study whose participants were extension personnel, the findings of Ordinary Least Squares (OLS) regression showed that the effectiveness of extension services is influenced by factors, such as age; marital status; work experience of extension personnel; acquisition of extension education; field of expertise; and number of villages served by extension personnel [15]. Studies that involved farmers and analysed data using various regression methods (Binary Logistic, Multiple regression and Ordered Logistic) found that perceived effectiveness of extension services was positively and significantly influenced by farmers' socio-demographic characteristics, such as age [17]; farming experience [8, 17]; gender [16, 17]; farm size [16] and educational status [8, 17]. Other significant factors influencing farmers' perceptions about the effectiveness of extension services are knowledgeable extension personnel [19]; farmer's attitudes towards extension services, and extension services received [17]. Moreover, training received; contact with extension agents; scientific orientation; information source utilisation; and innovativeness are positive and significant predictors of perceived effectiveness of extension services [8]. In a study that utilised the Delphi Technique and subjected data to descriptive statistical analysis, it was discovered that quality of training and lack of resources influenced the performance of most extension agents [20]. The performance of extension personnel influences access to extension services by farmers. Likewise, access to extension services is a significant predictor of farmers' perceptions about the effectiveness of extension services [17]. Based on the above-mentioned studies conducted on agricultural extension services, it is evident, that globally, scholars have employed various data analysis methods to identify important factors influencing perceived effectiveness of extension services.

In South Africa, the provision of extension services is guided by the principles, norms and standards for extension advisory services in agriculture, as developed by the Ministry of Agriculture. The guiding principles are demand-driven services; promotion of equity; flexibility to changing needs; monitoring and evaluation; participatory approaches; prioritization of farmers' needs; social and human capital development; strengthening structural partnerships; facilitating skills development and access to technology; improved planning and decision-making; sustainable income generation; and the conservation of natural resource [21]. Therefore, it is important to measure the effectiveness of public extension and advisory services against the guiding principles, because they are the key drivers of extension services in South Africa. The above background prompted the researchers to measure the effectiveness of extension and advisory services, using the South African guiding principles as developed by government. The objectives of the study were to determine the perceived effectiveness of public agricultural extension and advisory services and to ascertain the determinants (influencing factors). The theoretical framework of the study is presented in Fig. 1.

Materials and methods

Study area

The study was carried out in the Gauteng province of the Republic of South Africa. Gauteng province covers an estimated 18,179 km^2 [22] of the country and is the smallest of the nine provinces in South Africa. However, it is the most populous province, with an estimated population of 15.4 million [23]. The province is subdivided into three metropolitan municipalities and two district municipalities, namely: the City of Johannesburg Metropolitan Municipality; the City of Tshwane Metropolitan Municipality; the City of Ekurhuleni Metropolitan Municipality; the Sedibeng District Municipality; and the West Rand District Municipality. Gauteng is the economic hub of South Africa, and contributes 35% of the gross domestic product (GDP) in the country, as well as 11% on the African continent [24]. As a result, the province is highly urbanized due to an influx of labour migrants from other provinces of South Africa, as well as the Southern African region. About 25.5% of the 57.7 million people in South Africa, resides in Gauteng [25]. The key economic drivers in the province are government services, manufacturing, trade, mining, transport, finance, electricity, construction, personal services and agriculture. Although agriculture is one of the economic sectors in Gauteng, it contributes only 1% of the GDP in the province [24]. Agriculture in the province mainly consists of livestock and crop production; as well as fishery at both small- and large-scale farming. There are 2291 commercial farming units in Gauteng, which creates about 16,420 skilled and unskilled employment opportunities [26].

Conceptual framework

Conceptual framework refers to the structure developed by the researcher to explain the development of the phenomenon to be studied [27]. Moreover, framework indicate the logic that will be followed to undertake the research [28]. The research approach used in the study was quantitative. Quantitative research approach was adopted, because it enables collection, capturing and analysing of numerical data [29]. In addition, a

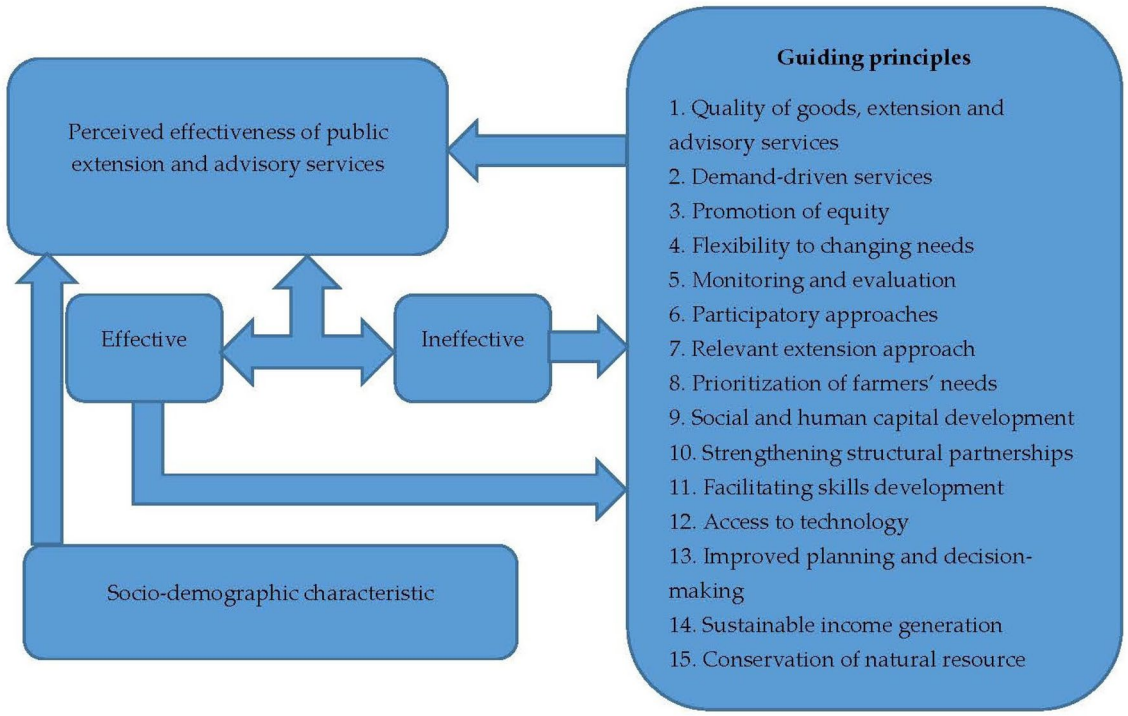

Fig. 1 Theoretical framework of the study

descriptive survey design was employed to undertake the research. A survey was chosen, because it describes how the perceptions of the respondents are associated with their characteristics [30]. The focus of the study was to assess farmers' perceived effectiveness of public extension and advisory services through descriptive assessment. The conceptual framework employed in the study is presented in Fig. 2.

Sampling

There are about 9000 farmers in the Gauteng province of South Africa [31]. A sample (*n*) of 368 would have had to be drawn from a population (*N*) of 9000 to achieve a margin error of 5% [32]. Because of the above description, a sample of 368 farmers receiving agricultural extension and advisory services from the Provincial Department of Agriculture, were targeted for participation in the study. However, more farmers showed interest to participate in the study. As a result, a sample (*n*) of 442 was randomly selected to participate in the study. Participants were selected after the study had received permission from the Gauteng Department of Agriculture and Rural Development (GDARD) as well as ethical approval from the CAES Research Ethics Review Committee at the University of South Africa. The ethics reference number for the project is 2016/CAES/073. The study participants were black African, coloured and white farmers aged 18 years and above.

Data collection

Collection of primary data was carried out using a semi-structured questionnaire (interview guide), which was validated and pilot tested to ensure its reliability. The researcher completed the questionnaire during face-to-face interviews with the participants. The aim of the study, the objectives, the ethical implications, as well as the rights of the participants were explained to the participants before the interviews commenced. Furthermore, each participant was required to give consent for the interview by signing the informed consent form. The questions focused on the effectiveness of the extension services which emanated from the guiding principles for extension support and advisory services as developed by the National Department of Agriculture in the Republic of South Africa. The questions were presented as five-point Likert scale questions: 1 = Very ineffective; 2 = Ineffective; 3 = Average; 4 = Effective; and 5 = Very effective. The measurements of the effectiveness of public extension and advisory services were quality of extension services; relevance of extension approaches used; and rendering of demand-driven, good quality services and goods (Batho Pele); promotion of equity; flexibility

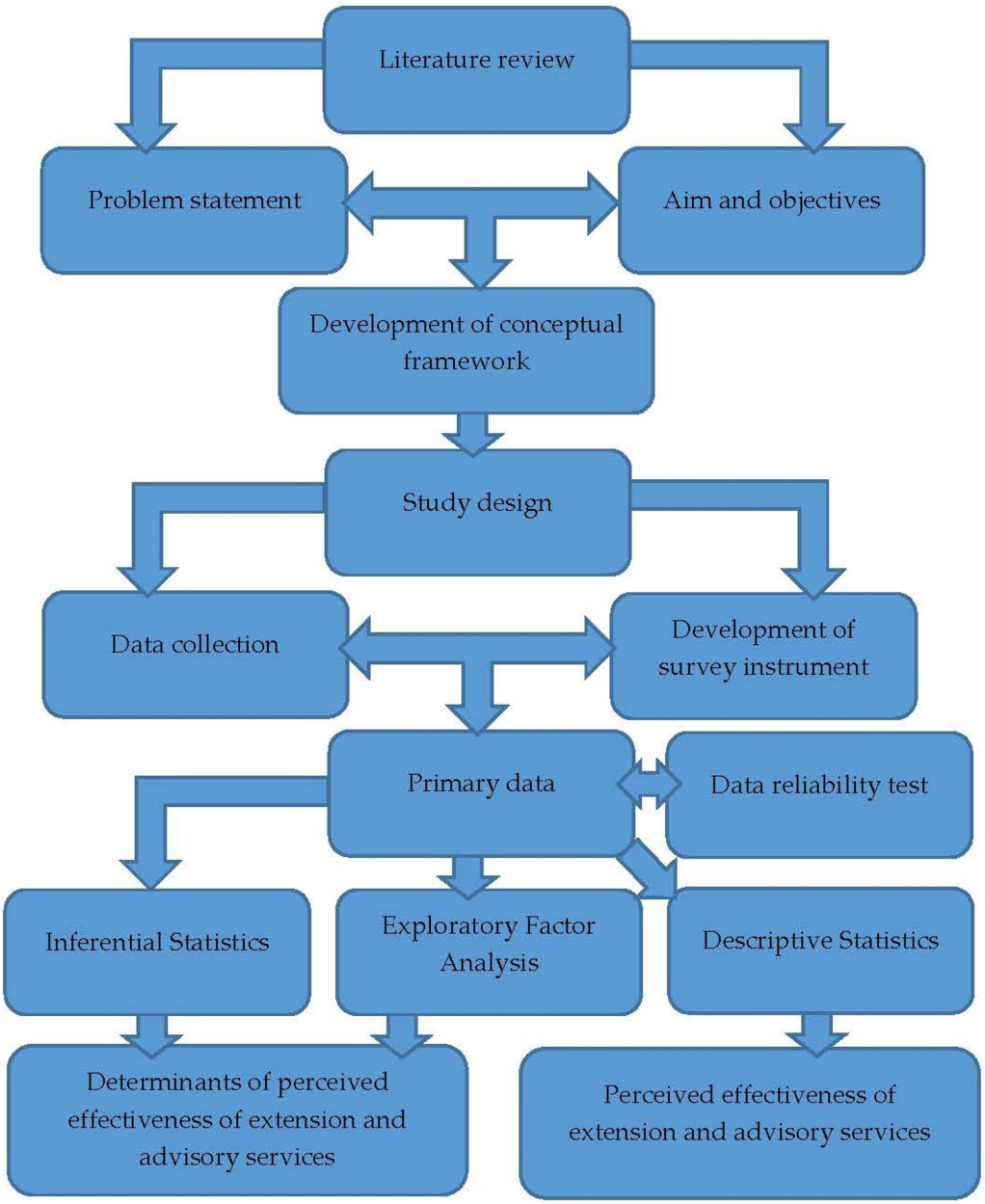

Fig. 2 Conceptual framework of the study

in responding to farmers' changing needs; effectiveness in monitoring and evaluation tools; prioritising the needs of the beneficiaries; focusing on human and social capital development; use of participatory approaches; facilitating access to technology and services which sustains income generation; improving planning and decision-making; sustainability of agricultural production; agricultural skills development; and strengthening of institutional arrangements.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 27, was used to analyse the data. Because a Likert-scale survey instrument was used to collect the data, the data was treated as interval data. The first analysis, performed in SPSS, measured the reliability and internal consistency of the survey scale used to collect the data. To achieve this, Cronbach's alpha's coefficient was determined. All 16 variables which measured perceived effectiveness of extension and advisory services in the survey

instrument (questionnaire), were loaded for analysis in the reliability test. The Cronbach's alpha coefficient value obtained in the analysis, was 0.97. Because of that, the internal consistency was satisfactory; and thus, the questionnaire was reliable. Cronbach's alpha coefficient values between 0.58 and 0.97 are considered satisfactory [33]. Furthermore, the mean scores for all the variables ranged between 3.12 and 3.45. As a result, all the questions in the survey instrument were retained for principal Exploratory Factor Analysis (EFA) and descriptive statistical analysis. After it was found that the survey instrument was reliable, the descriptive and inferential statistical analyses were performed. The descriptive statistical analysis included mean, median, frequencies, percentages and interquartile range (IQR). The proportions of very ineffective and ineffective, were grouped together and categorised as ineffective, whereas average was considered as moderately effective. Furthermore, the proportions of effective and very effective, were grouped together and defined as effective.

In addition, the following inferential statistical analyses were performed: Ordered Logistic Regression (OLR); and PAF analysis and correlation. OLR was used to analyse data of the socio-demographic factors influencing farmers' perceptions about the effectiveness of public agricultural extension and advisory services. The average mean score was used as a dependent variable in the OLR model. In OLR, a polychotomous-ranked dependant variable is predicted as a function of explanatory factors, describing individual or unit characteristics [34]. The basic principle of estimating OLR descried by [35], is as follow:

$$\Pr(Y_{\mathrm{i}} \leq j) = \Pr\left(\beta_1 X_{1\mathrm{i}} + \beta_2 X_{2\mathrm{i}} + \ldots + \beta_{\mathrm{k}} X_{\mathrm{ki}} + u_{\mathrm{i}} \leq \alpha_j\right).$$

In the aforementioned equation, the probability is that Y_{i} (dependant variable) is within category j and below. Therefore, Y_{i} is in category 1, 2, …, or j, whereas u_{i} is the error term. In the current study, the empirical model estimated, using OLR is as follows:

$$\Pr\left(\mathrm{PEPEAS} \leq 5\right) = \Pr\left(\beta_1 \mathrm{EL} + \beta_2 \mathrm{G} + \beta_3 \mathrm{AG} + \beta_4 \mathrm{FS} + u_{\mathrm{i}} \leq \alpha_5\right).$$

whereby PEPEAS = perceived effectiveness of public extension and advisory services; E = education level; G = gender; AG = age group; FS = farm/plot size; U = error term.

The perceived effectiveness of public extension and advisory services was categorised as 1 = Very ineffective; 2 = Ineffective; 3 = Average; 4 = Effective and 5 = Very effective.

Exploratory Factor Analysis (EPA) was performed to reduce the number of variables and to assess multicollinearity that exists between the correlated factors [19]. The type of EPA employed in the study was PAF. PAF is used to determine the underlying factors related to a set of items [36]. The purpose of the PAF analysis in the study was to determine underlying dimensions of the perceived effectiveness of public extension services. The first step was to determine the adequacy of the sample size for PAF analysis using the Kaiser–Meyer–Olkin (KMO) measure. Bartlett's test of sphericity, was also performed as part of the analysis of variance. Bartlett's test of sphericity is used to test whether the data is suitable for factor analysis [37]. Again, Bartlett's test measures the correlation matrix. The value of the KMO measure obtained was 0.97, which indicates that the sample size was adequate for PAF analysis. A value of ≥ 0.90 is considered excellent for factor analysis [38]. The results of the Bartlett's test were as follows: the Chi-square value obtained was 7262.68 with 120 degrees of freedom (df), and the significant value was 0.00. This means that the Bartlett's test of sphericity was statistically significant at 120 degrees of freedom. Because Bartlett's test of sphericity was statistically significant ($p < 0.01$), the data was suitable for factor analysis.

Thereafter, all 16 variables which measured perceived effectiveness of extension and advisory services in the survey questionnaire, were loaded for PAF analysis. PAF with oblique promax rotation was employed. Oblique rotations (direct oblimin, quartimin and promax) gives more accurate results in social science research compared to orthogonal rotations (Varimax, quartimax and equamax) which may lose valuable information [39]. Moreover, oblique promax rotation was selected, because it gives better results than oblimin [40]. Different criteria was used to retain the factors for further analysis. A scree plot was used to select the total percentage variance accounted for (PVAF) in the transformed variables. In the scree plots, factors located, where the size of the eigenvalues started to make an elbow, or break, were retained [39, 41]. Factor loadings above 0.50 were also retained [41, 42]. After retaining the factors which met the above-mentioned criteria, a correlation analysis of the factors was performed.

Results

Socio-demographic characteristics of the respondents

The socio-demographic information of the respondents collected in the study was racial affiliation, gender, age, educational background and farm/plot size. The results of socio-demographic characteristics of the respondents are presented in Table 1. The results showed that largest proportion of the respondents were black Africans. Thus, the recipients of public extension and advisory services in the study area were black African farmers of which majority (51.8%) were females. The findings of educational level

Table 1 Socio-demographic characteristics of the participants ($n = 442$)

Variable name	Frequency	Percent (%)
Race		
Black African	429	97.0
Whites	11	2.5
Coloured	2	0.5
Gender		
Male	213	48.2
Female	229	51.8
Age		
< 35	86	19.5
35–45	86	19.5
46–55	105	23.8
56–65	94	21.2
> 65	71	16.0
Level of education		
No formal education	61	13.8
Primary education	72	16.3
Secondary education	219	49.5
Abet education	31	7.0
Diploma	16	3.6
Bachelors degree	19	4.3
Honour degree/BTech	10	2.3
Masters	12	2.7
Doctorate	2	0.5
Variable name	**(Min–Max)**	**Mean**
Farm/plot size (ha)	0.001–72	4.6

indicated that more than two-thirds (72.8%) of the participants had basic education (primary, secondary education and ABET), less than one-fifth (13.8%) had no formal education and 13.4% had acquired tertiary qualifications (diploma, bachelor's degree, honours degree/BTech, master's and doctoral degrees). It implied that most farmers could read and write, because they had formal education (tertiary and basic education). The results of farm/plot size showed that on average, the respondents occupied farming land of 4.6 ha with a minimum of less than one hectare (< 1 ha) and maximum of more than seventy hectares (> 70 ha). Therefore, the recipients of government extension and advisory services in Gauteng province were both large and small-scale farmers.

Effectiveness of public extension and advisory services

The perceived effectiveness of public extension and advisory services were determined using different variables derived from the South African norms and standards for extension and advisory services in agriculture. The results of the farmers' perceived effectiveness of public extension and advisory services in the study area are presented in Table 2. The results showed that, of the 16 variables measured in the study, public extension and advisory services were perceived as effective in five variables. This is shown by more than half (> 50%) of the respondents who agreed that public extension services were effective and very effective. A median of five (5) also support the notion that public extension services were perceived to be effective in all five variables. Moreover, all five variables had IQR between 3.2 and 3.6 for 95% CI lower bound and upper bound, respectively. Most importantly, public extension and advisory services were perceived by 55.0% as effective in complying with the principles of Batho Pele (rendering good quality services and goods) when dealing with people and planning activities; followed by promoting equity through subsistence small-scale farmers, women farmers, disabled farmers and commercial farmers with 54% of the respondents. About 53% of the respondents perceived public extension services as being effective in providing and facilitating advice on skills development in agriculture. Furthermore, 52% and 51% of them held the opinion that public extension services were effective in providing and facilitating

Table 2 Perceived effectiveness of public extension and advisory services in the Gauteng province ($n = 442$)

Variable (Item)	Proportion of the participants (%)					Median (IQR)
	Very ineffective	Ineffective	Average	Effective	Very effective	
Renders high quality extension and advisory services	8.8	9.3	31.4	38.9	11.5	4 (3.3–3.5)
Uses extension approaches that are relevant to the beneficiaries	9.0	8.8	31.2	38.5	12.4	4 (3.3–3.5)
Is demand driven	8.6	13.1	29.6	36.9	11.8	3 (3.2–3.4)
Is compliant with the principles of Batho Pele when dealing with people and planning activities	8.8	7.0	29.2	39.8	15.2	4 (3.3–3.6)
Promotes equity through subsistence small-scale farmers, women farmers, disabled farmers and commercial farmers	10.0	10.9	25.6	37.3	16.3	4 (3.3–3.5)
Is flexible in responding to farmers' ever-changing needs	11.1	13.6	28.7	35.7	10.9	3 (3.1–3.3)
Has effective monitoring and evaluation tools	10.6	11.1	31.7	36.0	10.6	3 (3.1–3.4)
Prioritises the needs of the beneficiaries	10.4	13.6	30.1	36.9	9.0	3 (3.1–3.3)
Focuses on human and social capital development	10.0	12.9	29.4	35.1	12.7	3 (3.2–3.4)
Uses participatory approaches in planning, implementation and evaluation of their projects/programmes	12.2	8.4	29.4	36.0	14.0	3.5 (3.2–3.4)
Facilitates access to extension and advisory services that lead to sustainable income generation by clients	10.2	13.1	30.8	34.8	11.1	3 (3.1–3.3)
Provides and facilitates access to agricultural information for improved planning and decision-making	8.8	10.2	29.4	41.2	10.4	4 (3.2–3.4)
Facilitates access to technology and where possible, provides such technologies	11.8	14.7	32.1	32.1	9.3	3 (3.0–3.2)
Provides and facilitates access to advice on sustainable agricultural production (including conservation of natural resources)	10.2	9.0	30.8	36.2	13.8	3.5 (3.2–3.5)
Provides and facilitates advice on skills development in agriculture	11.1	7.2	28.3	37.8	15.6	4 (3.3–3.5)
Strengthens institutional arrangements (partnerships, restructuring, corporatisation, funding, establishment of new entity/ties) for the effective delivery of services	12.9	13.1	25.1	35.5	13.3	3 (3.1–3.4)
Average	10.3	11.0	29.6	36.8	12.4	–

IQR interquartile range

access to agricultural information for improved planning and decision-making, and using extension approaches that are relevant to the beneficiaries, respectively. Finally, 50.4% of them were of the opinion that the government was effective in rendering high quality extension and advisory services. In general, public extension and advisory services in the Gauteng province, were perceived as ineffective, because 49% of the respondents indicated that the services rendered were average. The median score of 3.3 is also in support of the above explanation. In support, extension services were perceived to be ineffective in most of the variables, with a median of ≤ 3.5 and $< 50\%$ of the respondents who perceived the services as effective.

Factors influencing effectiveness of public extension and advisory services

The overall effectiveness of public extension services was measured using the average score of all 16 variables which measured the perceived effectiveness of public extension and advisory services. The descriptive statistic results showed that, in general, about 43.7%, 33.5%, 10.2%, 7.2% and 5.4% of the respondents perceived public extension services as effective, average, ineffective, very ineffective and effective, respectively. It implied that a minority (49.1%) of the respondents' perceived public extension services as effective, as shown by the proportions of very effective and effective combined. A median value of 3 and IQR (3.2–3.4) indicates and supports the notion that public extension services were perceived as ineffective. Moreover, 33.5% of the respondents held the opinion that public extension and advisory services were moderately effective, while 17.4% indicated that the services were ineffective. The results of the OLR model fitting, achieved a chi-square value of 37.994 with a degrees of freedom (df) of four (4). Moreover, the model was statistically significant at 1% interval level ($p < 0.01$). It implied that the model could significantly predict the threshold [$p < 0.00$; $\chi^2(4) = 37.99$]; therefore, the model is suitable for the data. Again, the chi-square outputs of Pearson and Deviance achieved for goodness-of-fit were 1489.20

Table 3 Parameter estimates of the OLR results of the factors influencing perceptions towards the effectiveness of public extension and advisory services ($n = 442$)

Variables	Estimate (β)	Std. Error	*P* value
Threshold			
1 = very ineffective	− 1.48	0.37	0.00
2 = ineffective	− 0.43	0.34	0.21
3 = Average	1.26	0.34	0.00
4 = Effective	4.21	0.42	0.00
Location			
Education level	0.35	0.06	0.00
Gender	− 0.26	0.18	0.15
Age	0.16	0.07	0.02
Farm/plot size	− 0.04	0.01	0.00

[a] Dependent variable: perceived effectiveness of public extension and advisory services

and 925.44, respectively. The degrees of freedom (df) for both chi-square outputs (Pearson & Deviance) was 1252. However, Pearson chi-square was statistically significant ($p = 0.00$), while Deviance was insignificant ($p = 1.00$). According to [43], non-significant results of Pearson and Deviance chi-square implied that the data fit the model well. However, they do not always have to be similar. Therefore, the model fit the data, because Pearson chi-square was not statistically significant. The values of Pseudo *R*-Square were 0.082, 0.089 and 0.033 for Cox and Snell, Nagelkerke, and McFadden, respectively. Unlike in Multiple Regression Models, the Pseudo *R*-Squares measures have limitations in evaluating the overall model fit [44]. As a result, the values are accepted as they are, without further interpretation.

The results of the parameter estimates of the Ordered Logistic Regression (OLR) model of the factors influencing perceptions towards the effectiveness of public extension and advisory services are presented in Table 3. The results showed that only two of the four independent variables (education level and age), fitted in the regression model, were positive, while the others were negative (gender and farm/plot size). Both positive variables (education level and age group) were statistically significant at 1% and 5% levels of significance (99% and 95% confidence interval), respectively. Education level had a positive ($\beta = 0.35$) and significant relationship ($p < 0.02$) with perceived effectiveness of public extension and advisory services, with all other factors being constant. Furthermore, there was a positive ($\beta = 0.35$) and significant correlation ($p < 0.00$) between age and perceived effectiveness of public extension services. Therefore, when farmers' age increased, they perceived extension services as more effective.

Nevertheless, the relationship between farm/plot size and farmers' perceptions toward public extension and advisory services, was negative ($\beta = -0.04$) and statistically significant ($p < 0.00$). It means that when farm/plot size increases, farmers perceive public extension services as less effective, with all things being equal.

Exploratory factor analysis

This section presents the results of the exploratory factor analysis which was performed using PAF. The purpose was to identify underlying factors regarding the perceived effectiveness of public extension and advisory services in the study area (Gauteng province). First, the results of the adequacy of the sample size for PAF analysis and the test of sphericity are presented, followed by the scree plot; the cumulative column explaining total variance; the exploratory factor analysis; and the factor correlation matrix. After the first analysis, three factors were extracted from the exploratory factor analysis. Furthermore, 12 variables were retained for further analysis after dropping those with loadings less than 0.50. The KMO score obtained was 0.96, which implied that the sample size was still adequate for factor analysis. Furthermore, Bartlett's test of sphericity was statistically significant ($p < 0.01$), meaning the data was also appropriate for factor analysis. The Chi-square value obtained, was 5113.89 with 66 degrees of freedom (df).

Figure 3, presents the scree plot that indicates how eigenvalues were plotted against factors. The results in the scree plot showed that the elbow started to decrease at Factor 4 with an eigenvalue of 0.35. Therefore, the first three factors on the slope, before the graph started decreasing to form an elbow, were retained. A detailed explanation regarding the names of the factors that were retained is provided in Table 4.

The results of the cumulative column explaining total variance is presented in Table 4. The results depict that the three extracted factors contributed 81.81% of the variance. Individually, factors 1, 2 and 3 contributed 70.72%, 6.10% and 5.00% to the total variance, respectively. Factor 1 demonstrated the highest eigenvalue with 8.49, followed by Factor 2 with 0.73 and 0.60 for Factor 3. Descriptions of all the factors, loading values and their communalities are presented in Table 5.

Table 5 presents the results of the exploratory factor analysis of the effectiveness of public extension and advisory services. The results show that the analysis extracted three factors for the effectiveness of public extension and advisory services, in the study area. Factor 1 consisted of six variables, followed by Factor 2 and Factor 3 with four and two variables, respectively. The three extracted

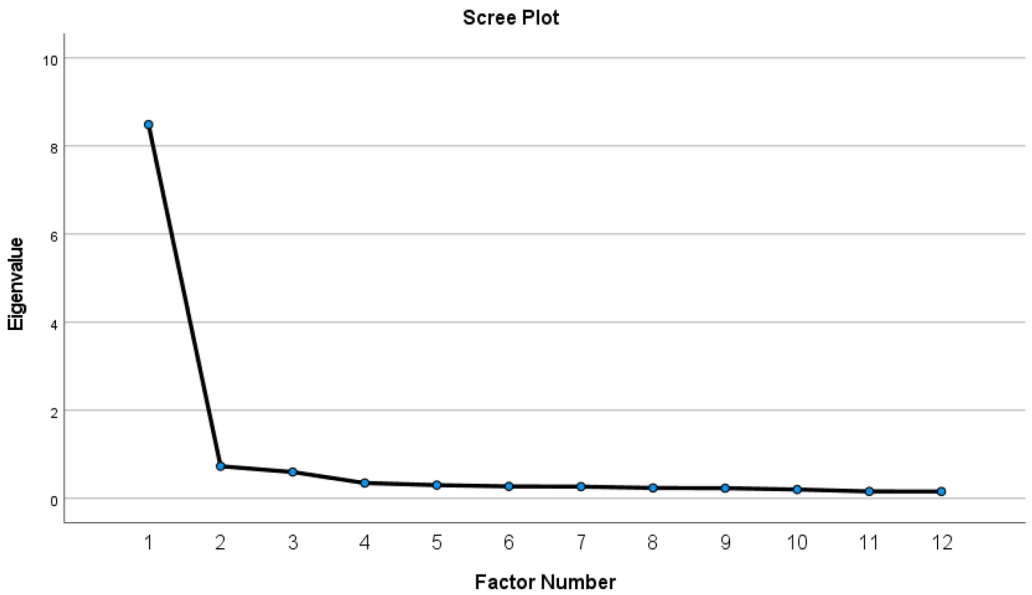

Fig. 3 Scree plot for factor analysis

Table 4 Cumulative column explaining total variance

Total variance explained							
Factor	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total
1	8.49	70.72	70.72	8.24	68.69	68.69	7.35
2	0.73	6.10	76.81	0.48	4.03	72.72	6.57
3	0.60	5.00	81.81	0.31	2.61	75.33	6.47
4	0.35	2.91	84.72				
5	0.30	2.52	87.24				
6	0.27	2.28	89.52				
7	0.27	2.23	91.75				
8	0.24	1.98	93.73				
9	0.23	1.94	95.67				
10	0.20	1.69	97.36				
11	0.16	1.32	98.69				
12	0.16	1.31	100.00				

factors are labelled as follows: Factor 1 is relevant and good quality extension and advisory services (Promoting equity when rendering relevant and good quality extension services; and using appropriate approaches that are flexible and effective in monitoring and evaluation). Factor 2 is the provision of information which improves agricultural production (Facilitating and providing access to information which improves agricultural skills; planning and decision-making; and which sustains agricultural production and strengthens institutional relationships). Factor 3 is providing technologies required by farmers (Facilitating and providing access to technology that prioritises farmers' needs). Factor loading for a large proportion of the participants was more than 0.60; therefore, the correlation between the extracted factors and the items associated with them was high. In addition, most variation was extracted, because the communalities of all the items were between 0.63 and 0.79. The results of the communalities showed that 63–79% of the variability in the perceived effectiveness of public extension and advisory services, is explained by the three factors (1–3).

Table 5 Results of the exploratory factor analysis of the effectiveness of public extension and advisory services ($n=442$)

Variables	Factor			Communalities
	Factor 1	Factor 2	Factor 3	
Promotes equity through subsistence small-scale farmers, women farmers, disabled farmers and commercial farmers	0.80			0.77
Is compliant with the principles of Batho Pele when dealing with people and planning activities	0.80			0.79
Offers high quality extension and advisory services	0.67			0.79
Uses extension approaches that are relevant to the beneficiaries	0.65			0.77
Has effective monitoring and evaluation tools	0.65			0.78
Is flexible in responding to farmers' ever-changing needs	0.52			0.74
Provides and facilitates advice on skills development in agriculture		0.74		0.74
Provides and facilitates access to agricultural information for improved planning and decision-making		0.68		0.75
Provides and facilitates access to advice on sustainable agricultural production (including conservation of natural resources)		0.68		0.76
Strengthens institutional arrangements (partnerships, restructuring, corporatisation, funding, establishment of new entity/ties) for the effective delivery of services		0.60		0.63
Facilitates access to technology and where possible, provides such technologies			0.69	0.74
Prioritises the needs of the beneficiaries			0.65	0.78
Eigenvalue	8.49	0.73	0.60	9.82
Cumulative variance explained (%)	70.72	6.10	5.00	81.81

Therefore, the factor analysis explains the variation in eleven of the twelve (11 out of 12) variables very well.

After extracting all the factors and their individual variables, the factor correlation matrix was generated. The results indicated that relevant and good quality extension and advisory services (Factor 1) was positively correlated with provision of information that improves agricultural production (Factor 2), $r=0.74$. This implied that participants, who were of the opinion that public extension and advisory services were effective in rendering relevant and good quality extension services, perceived the provision of relevant information that improves agricultural production as an important measure of effective extension services. Factors 1 (rendering relevant and good quality extension and advisory services) and 3 (Providing technologies required by farmers) were correlated ($r=0.74$). This means that farmers who perceived relevant and good quality extension and advisory services as a measure of effectiveness, held the opinion that extension services should provide technologies required by farmers to be considered effective. Finally, factors 2 (providing information that improves agricultural production) and 3 (Providing technologies required by farmers) were positively correlated ($r=0.71$). Therefore, farmers who perceived public extension and advisory services as effective in providing information that improves agricultural production, held the opinion that extension services that provide technologies to the farmers are effective.

Discussion

The aim of the study was to determine farmers' perceived effectiveness of public extension and advisory services in the Gauteng province and the underlying factors. The study found that in general, farmers perceived public extension and advisory services in the province as ineffective. However, extension services were perceived to be effective in six out of sixteen variables (6/16) measured in the study (see Table 2). Therefore, government extension officers did not meet all the expectations in the the norms and standards for extension and advisory services in agriculture developed by the Ministry of Agriculture in South Africa. The implications of the perceived ineffective extension and advisory services, in some of the variables measured, may negatively affect agricultural activities of farmers. For example, ineffectiveness in rendering demand driven services, inflexibility, and poor prioritisation of farmers' needs, may result in rendering extension services that are irrelevant to farmers. A demand-led and flexible system will enable government to render services that are responsive to farmers' needs. In addition, the perceived ineffectiveness of public extension in facilitating and providing access to technology and advice that sustains agricultural production, is a major concern. In support, it has been reported that in Kilindi District of Tanzania, public extension services were not effective in transferring information that improved maize production of the farmers [12]. Parallel to that, access to extension services had insignificant impact on

agricultural production of farmers in Jordan [9]. In contrast, farmers in Kaduna State, Nigeria indicated that effective extension services enhanced their agricultural productivity [10]. Extension services that do not promote adoption of innovations that sustain agricultural production may negatively affect farmers' productivity. Research has shown that the adoption of agricultural innovations and farm production, have a positive and significant correlation [45]. Meaning, farmers who adopt innovations are more likely to achieve higher agricultural outputs. Furthermore, adoption of new technologies has a positive and significant relationship with farm income [46]. Thus, in the current study, extension services were unlikely to help farmers achieve higher agricultural productivity through adoption of new technologies.

On the other hand, public extension services were effective in addressing some of the farmers' needs. This is an indication that public extension officers effectively rendered some of the expected services to the farmers in the study area. For example, effective in compliance with the principles of Batho Pele (good quality services and goods) when dealing with people and planning activities; as well as rendering high quality extension and advisory services, is positive. The findings by [12, 47] were in disagreement, because they found that in Tanzania and Pakistan, most farmers held the opinion that government was not effective in rendering extension services of good quality. In addition, studies conducted in South Africa (West Coast and Amathole District Municipalities) showed that public extension services were not satisfactory to most farmer [48, 49]. Thus, farmers perceived the quality of public extension services to be poor. Moreover, the study findings in Table 2 showed that farmers perceived public extension services to be effective in providing and facilitating access to agricultural information for improved planning and decision-making, and using relevant extension approaches. Similarly, studies conducted in South Africa [48, 49]; Ghana and Zambia [7]; Egypt [13] found that most farmers perceived public extension services as effective in the dissemination of information. On the contrary, farmers in South Africa and Pakistan indicated that public extension services were not effective in the dissemination of information through print material [9]; agricultural campaigns, farmer's days, and signboards [5]. Moreover, in Pakistan it was also discovered that agricultural extension services provided insufficient information to most farmers [47]. Information access enables farmers to make decisions that improve their farming and solve problems [50]; moreover, information is essential in improving agricultural outputs, marketing and distribution strategies [51]. Thus, through public extension and advisory services, farmers in the study area held the opinion that they were able to make informed decisions when planning their agricultural activities. In addition, the majority of the farmers held the opinion that government extension officers were not discriminating when rendering extension services. This is evident, because public extension services were perceived to be effective in promoting equity through subsistence small-scale farmers, women farmers, disabled farmers and commercial farmers. This is in contrast to the study that discovered that female farmers were less likely to receive extension services of good quality [52]. Thus, the respondents in the current study were of the opinion that public extension services did not exclude farmers because of scale of operation, gender and physical abilities. It showed that the respondents have full confidence about the approaches used by government extension officers to promote equality through extension and advisory services.

Through the OLR model, education level and age were identified as the factors that positively and significantly influenced farmers' perceptions about the effectiveness of public extension services in the study area. It implied that farmers with higher education levels perceived public extension services as `effective compared to those who had lower education levels. The reason could be that highly educated people are well informed about the role of extension services; hence, they do not have high expectations from government extension officers. As a result, they were satisfied with the extension and advisory services rendered and considered public extension effective. On contrary, education had a negative and significant correlation with perceived effectiveness of extension services in promoting modern technologies [47]. Again, with all things being equal, older farmers perceived public extension services to be more effective than younger farmers did. This may be because older farmers are well experienced about farming, thus, they have less expectations from extension officers. Moreover, they may be unaware about the kind of services that should be rendered to them in accordance with the norms and standards for extension and advisory services prescribed by the Ministry of Agriculture. In support to the study findings, [17] also reported a positive and significant relationship between age and perceived effectiveness of extension services. However, in another study, age was found to be positive and insignificant on farmers' perceptions towards the effectiveness of extension services [15]. On the other hand, farm/plot size had a negative and significant correlation with perceived effectiveness of extension services. Thus, large-scale farmers perceived public extension services as less effective, with all things being equal. The motivation could be that large-scale farmers expected extension officers to visit them regularly, allocate more resources in accordance with their farm size and give them special preference. Therefore, when such

expectations were not met, such farmers perceived extension services to be less effective. In contrast to what was discovered in the study, farm size had a positive and significant influence on the perceived effectiveness of extension services [16].

The results of PAF analysis generated three important factors underlying the perceived effectiveness of public extension and advisory services (see Table 5). The findings showed that relevant and good quality extension and advisory services (factor 1) was the most important predictor of the perceived effectiveness of public extension services. It was followed by the provision of information which improves agricultural production (factor 2), and providing technologies required by farmers (factor 3). In contrast to the current findings, [18] found that the important factors influencing the effectiveness of extension services were structural, socio-cultural and economic factors, as well as factors relating to policy-making. In the current study, the most important predictor (factor 1) included providing appropriate, good quality and flexible extension and advisory services to all farmers using relevant extension approaches and effective monitoring and evaluation tools. It implied that extension services using flexible approaches that have clearly defined and effective monitoring and evaluation systems, were perceived to be the most effective. Therefore, farmers in the study area perceived a participatory extension approach as effective compared to a top-down approach, which is not flexible. This is not surprising, because globally, agricultural extension has been shifting from top-down towards participatory approaches. Participatory approaches enable farmers to play a critical role in the generation of knowledge and change of practice [53]. The approach involves farmers in the planning of activities and ensures that their needs are catered for, as opposed to the needs perceived by government [54]. Moreover, monitoring and evaluation of the extension services was an important variable that determined the perceived effectiveness of public extension services in factor 1. The reason could be that monitoring and evaluation enables farmers and extension agents to identify the shortfalls of the services, to revise the extension methods, and to improve the services rendered. Factor 2 shows that extension and advisory services which enabled farmers to acquire farming information and skills that improve and sustain their agricultural production and relationships with stakeholders, and were perceived as effective. This could be motivated by the fact that access to agricultural information has a positive correlation with agricultural production [10, 51]. Again, the respondents perceived their relationship with various stakeholders as an important variable that determines the effectiveness of extension services in factor 2. It implied that farmers expected extension officers to link them with various stakeholders that play an integral role in farming. Therefore, extension officers who linked farmers with corporate, financial institutions and other relevant stakeholders were perceived as effective. Measuring the effectiveness of extension services, by evaluating the relationship with various stakeholders, is an indication that farmers are in favour of a pluralistic extension delivery system. Globally, a pluralistic delivery system has gained popularity, because extension approaches have evolved from linear approaches to an agricultural innovation system that requires participation of various stakeholders. Agricultural innovation systems bring all potential public and private sectors in creation, diffusion, adoption and use of all types of agricultural knowledge relevant to production and marketing of produce [55]. Factor 3 is providing technologies required by farmers. Thus, farmers perceived extension services that facilitate and provide access to technology that prioritises farmers' needs, as effective. Transfer of technology through extension agents to the farmers, include critical information from research and development [56]. Hence, farmers in the study area valued the role that extension agents can play in the transfer of technology. Adoption of technology has the potential to improve agricultural production of the farmers [57]. However, not all technologies brought to the farmers, improve agricultural production, because some of them are irrelevant. As a result, farmers noted the importance of providing technologies that prioritizes their needs as an important measure to determine effectiveness of extension services.

Conclusions

The study found that, in general, public agricultural extension and advisory services in the Gauteng province were perceived as ineffective. However, extension services were effective in six principles in the norms and standards for extension advisory services in agriculture, as developed by the Ministry of Agriculture. Through the OLR model, the study identified three socio-demographic factors (education level, age and farm/plot size) that significantly influenced farmers' perceptions about the effectiveness of public agricultural extension and advisory services. The identified socio-demographic factors had positive (education level and age) and negative (farm/plot size) influences on farmers' perceptions. Large-scale farmers were of the opinion that public extension and advisory services were less effective; however, highly educated and older farmers perceived extension services to be more effective. Moreover, three underlying factors (dimensions) of the perceived effectiveness of public extension services were extracted through PAF analysis. The three underlying factors accounted for 81.81% of the

variance of the perceived effectiveness of public extension services. The three underlying factors may serve as a basis for informed policy decisions to improve agricultural extension and advisory services. The current study suggests that, for public extension and advisory services to be effective, extension agents should render relevant, good quality services and provide information that improves agricultural production and facilitates access to the technologies required by farmers. Again, farmers should receive extension and advisory services that are proportional to their scale of operation (farm/plot size). Moreover, other researchers could use the identified underlying factors to develop detailed survey instruments that measure the effectiveness of public extension and advisory services.

Abbreviations

CAES: College of Agriculture and Environmental Sciences; DoA: Department of Agriculture; DF: Degrees of Freedom; EFA: Exploratory factor analysis; GDARD: Gauteng Department of Agriculture and Rural Development; ICT: Information and Communication Technology; KMO: Kaiser–Meyer–Olkin; MS: Mean Score; PAF: Principal axis factoring; PCA: Principal component analysis; PPP: Public–private partnership; SPSS: Statistical Package for the Social Sciences; Unisa: University of South Africa.

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Author contributions

Both authors (MMSM and MAA) give consent for the manuscript to be published. Paper conceptualisation: MMSM, methodology: MMSM and MAA, data analysis: MMSM and MAA, writing: MMSM, editing and review: MA. Both authors read and approved the final manuscript.

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Availability of data and materials

The data used for the manuscript is attached in the documents submitted. The primary data is in Microsoft Excel. Furthermore, the statistical outputs from SPSS are attached. The names of the attached files for data and SPSS outputs are Primary data and SPSS Output_BMC.

Declarations

Ethics approval and consent to participate

The study received permission and ethics approval from GDARD and CAES Research Ethics Review Committee at the University of South Africa. The ethical clearance number for CAES Research Ethics Review Committee is 2016/CAES/073. All the selected participants were requirement to sign informed consent form before they were interviewed during data gathering.

Consent for publication

Not applicable.

Competing interests

All the authors declare that they do not have financial interests.

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