Research article

Understanding farmers' perceptions on advisory services in Tanzania: Comparative insights from principal component analysis and Q-methodology

Annette Goodluck [*], David Jakinda Otieno, Willis Oluoch-Kosura

Department of Agricultural Economics, University of Nairobi, Nairobi, P.O. Box 29053-00625, Kenya

A B S T R A C T

Agricultural advisory services help farmers to access farming skills, technologies and agricultural markets. The services are offered by different actors, who all together form the pluralistic advisory service providers. In recent years, pluralistic advisory service providers have emerged in various developing countries including Tanzania. Pluralistic providers have different institutional arrangements and varying levels of effectiveness, which lead farmers to have diverse perceptions towards them. However, the perceptions of farmers on pluralistic advisory services have not been fully documented, making it difficult to gauge the level of acceptance of the diverse services offered. This paper employs principal component analysis (PCA) and Q-methodology to elicit farmers' perceptions on the pluralistic services using samples of 627 and 23 farmers, respectively. Results from both methods showed that pluralistic providers offered diverse services ranging from production to market information. Further, the two approaches provided concurring findings that advisory services offered did not meet farmers' advisory demands. Furthermore, each method served to fill the shortcomings of the other. Therefore, we recommend a complementary application of both approaches rather than treating them as mutually exclusive in the analysis of perceptions.

1. Introduction

Agricultural advisory services are activities that facilitate farmers to increase production and link them to markets. Through agricultural advisory services, farmers receive information, build skills and are exposed to different technologies [1]. As noted by [2] agricultural advisors are uniquely positioned to support and signpost farmers on a variety of issues including food and nutrition, health and safety. Such services are offered by different players including public extension agents, private organizations, farmers' organizations and other community-based organizations such as non-governmental organizations (NGOs). These together form the pluralistic advisory service providers.

In Tanzania, 65 % of the national population of nearly 62 million people are employed in agriculture [3]. Majority of them are small-scale farmers with a mean farm size of 1.2 ha [4]. There are about 15,000 villages in the country and 9139 field extension officers [5]. This implies that some farmers cannot access even a single advisory agent in their villages. Meanwhile, the national agriculture policy of 2013 promotes pluralistic advisory services by encouraging participation of private organizations and civil society

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organizations such as NGOs and farmer-based organizations in offering advisory services to farmers [6]. This led to emergence of pluralistic advisory services in some parts of the country. The pluralistic service providers relieve portion of the government's fiscal burden by sourcing funds from other development agencies [1,7]. In addition, pluralistic providers solve the problem of inadequate public extension services in remote areas. However, pluralistic providers such as private organizations and NGOs have different institutional arrangements from the widely used public providers [8–10]. This leads to variations in behavior of providers in areas such as promoting good relationships with farmers, methods of delivery, effectiveness of services offered and feedback system from the farmers [11,12]. Consequently, farmers develop diverse perceptions towards the pluralistic advisory services and this may negatively affect the level of acceptance and use of such services.

A study by Ref. [13] focused on the perspectives of farmers on a single service provider and called for further studies on other providers who promote pluralistic advisory services. In addition [14], showed a need for future studies to explore the perceptions of farmers on accessed information from different service providers. However, measuring intangible indicators such as perceptions, attitude and perspectives might lead to biased results when interviews or focus group discussions are used. Likewise [15], pointed out that surveys are not suitable for comparison of perceptions and viewpoints of participants on a subject matter. Consequently [16,17], suggested future studies to focus on the methods and approaches that could improve aspects of perceptions and hence, increase farm productivity.

This study addressed the above knowledge gaps by answering the following research questions: a) how do farmers perceive pluralistic advisory services? b) what factors influence farmers' perceptions on pluralistic advisory services? c) which method between principal component analysis and Q-methodology measures perceptions well? Understanding the perceptions of farmers towards pluralistic advisory services is of paramount importance as perceptions have a considerable effect on farmers' participation in the uptake of such services [18]. Further, identifying the perceptions of farmers can assist pluralistic providers in developing targeted advisory sessions and messages [19].

2. Materials and methods

2.1. Theoretical background

According to the theory of planned behavior; attitude, subjective norms and perceived behavior control influence the behavior of an individual [20]. The opinions of farmers on performance of providers and individual beliefs on whether most people like or dislike to work with providers influenced the perceptions of farmers towards providers. In addition, the perceptions on how easy or difficult it is to access and work with pluralistic providers influence farmers' behavior. This means perceptions are subjective in nature while the scales measuring perceptions such as Likert scale, Guttman scale and Thurstone scale are objective in nature [21,22]. Several studies have made use of these scales to measure perceptions [23–26]. This means that the subjective nature of perceptions is left out as these scales are used. Various studies have empirically established the differences and similarities of principal component analysis (PCA) approach which uses the Likert scale and the Q-methodology which incorporates subjectivity of respondents on different societal issues
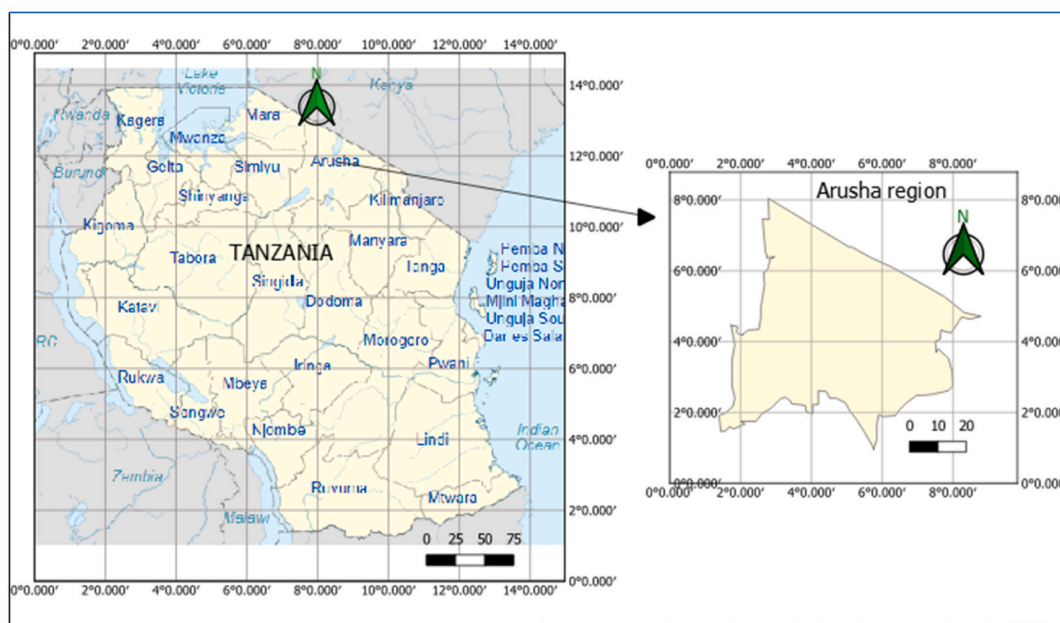

Fig. 1. Study sites in Tanzania.
Source: Authors' compilation

(see for example 27–33). However, no study has comparatively applied both methods to assess farmers' perceptions on multiple agricultural advisory services. Nevertheless, literature suggests combining Q-methodology with other methods such as surveys to make it more fruitful [34]. Therefore, the current study will fill this knowledge gap and contribute to the body of knowledge by applying Q-methodology and PCA method to study the perceptions of farmers on advisory services.

2.2. Study area

This study was based on primary data collected from farmers in Arusha region in Tanzania (Fig. 1). The region is divided into seven districts: Arusha City, Arusha District Council, Karatu, Longido, Meru, Monduli and Ngorongoro. Karatu and Meru districts were purposively selected because they had high concentration of farming. In Karatu, about 61 % of the population are employed in crop farming while such agricultural activities in Meru district occupy 64 % of the land [35,36]. Other districts are inhabited by pastoralists while in Arusha city about 66 % of the population is employed in office work and business operations [37].

2.3. Study design, sampling and data collection

2.3.1. Q-methodology

The Q-methodology is a mixed-methods approach that uses qualitative approaches to capture the subjectivity of perceptions and opinions, and subsequently quantitative techniques to analyze data [38]. The method entails six elaborate steps: construction of a concourse, Q-sampling, developing a P-set, Q-sorting, correlation and factor extraction and factor interpretation.

Construction of a concourse refers to the collection of all statements that people say about the topic at hand [39]. The concourse needs to be diverse and comprehensive to capture different perceptions of farmers. The concourse for the perceptions of farmers on pluralistic advisory services was developed through two main ways. First, was the websites of service providers and literature review of studies that addressed perceptions of farmers on service providers. From the websites, information displayed and success stories from the farmers were used to draw concourse statements. Through the websites and literature review, statements related to timing of advisory services, availability of providers, productivity levels and food security were obtained. Secondly, face-to-face interviews were conducted with six main service providers in the study area: public extension officers, Research Community and Organizational Development Associates (RECODA), farmer-to-farmer extension (F2FE), Farm Radio International (FRI) and MVIWAARUSHA (A network of farmers and pastoralists groups in Arusha region). The main topics covered in the interviews were: capacity such as number of employees and their education levels and number of clients served by each provider. Moreover, the interviews sought to find out service delivery methods used by each provider such as the use of short messages, phone calls and face-to-face visits. The main types of services offered such as production, post-harvest handling, agricultural credit and food and nutrition security as well as the frequency of meeting the farmers and availability of feedback systems were also discussed. From the websites of providers, literature review and face-to-face interview with service providers, a concourse of 100 statements was developed to evaluate the perceptions of farmers on pluralistic advisory services.

The Q-sampling step entails use of a concourse matrix to select statements from the concourse to form a Q-statement set or a Q-Sample [40]. The concourse matrix filters statements in a manner that minimizes researchers' bias [41]. The selection process involves breaking down the concourse into a series of themes on the basis of theory, research or observations [30]. Following [8], we adopted six themes described in the best-fit framework: effectiveness, relevance, satisfaction, accessibility, timeliness and feedback. Effectiveness is the success made by service providers in producing a desired output such as a food secure farmer. Relevance is the usefulness of the advisory services and its importance to the farmers. Satisfaction is the utility farmers derive from using the advisory services. Accessibility refers to the ease of farmers to reach service providers and afford the services offered. Timeliness is the ability of service providers to offer services in a prompt manner. Feedback is the positive or negative information that passes from the receiver of service (farmer) to another person. All statements in the concourse were grouped under one of the themes in an *ad hoc* manner [42]. The other dimension of the concourse matrix consisted of the origin of the statements: websites/literature review and interviews. According to Ref. [43] a Q-sample is obtained by selecting 30 to 50 potential statements from the identified themes. In this study, a total of 43 statements were selected to form the Q-sample as shown in Table 1. The statements were translated to the local *Swahili* language. The statements were printed on small cards that were randomly numbered at the back.

In Q-methodology, a P-set or heterogeneous group of resource persons - representing the breadth and diversity of views and opinions is the guiding principle in selecting the respondents [44]. In this study that had 43 Q-statements, a total of 23 resourceful farmers were purposively selected as shown on Table 2; giving a ratio of 43:23. The P-set chosen in this study was representative of the age categories of active farmers in Tanzania, sex of farmers, number of crops grown and leadership roles in farmer groups. Previous studies had ratios of 36:25 [41], 44:36 [44], 30:22 [45], 16:35 [46] and 37:64 [47].

Farmers performed *Q-sorting*, which is the process of rank-ordering the Q-samples on a continuum from most agree on one hand to

Table 1
Distribution of statements under various themes.

	Relevance	Effectiveness	Timeliness	Accessibility	Feedback	Satisfaction	Total
Websites/literature review	11	2	3	6	1	2	25
Interviews	5	7	0	2	2	2	18
Total	16	9	3	8	3	4	43

Table 2
Diversity of farmers involved in Q-methodology.

	Categories	RECODA	RECODA, MVIWA	RECODA, MVIWA, FRI	RECODA, F2FE	Public extension service	F2FE	MVIWA	None	Total
Age	30–40	–	–	–	–	2	1	–	1	4
	41–50	1	1	1	–	3	2	1	1	10
	51–60	–	–	1	1	3	1	–	–	6
	61–70	1	–	–	–	–	–	1	–	2
	≥71	–	–	–	–	1	–	–	–	1
Sex	Male	1	1	1	1	6	2	2	–	14
	Female	1	–	1	–	3	2	–	2	9
Number of crops Grown	1	–	–	–	1	3	–	–	–	4
	2	1	–	–	–	3	–	–	–	4
	3	1	–	–	–	2	3	1	2	9
	4	–	1	2	–	1	1	1	–	6
Leadership	Village	–	–	–	–	–	–	1	–	1
	Farmer group	1	1	–	1	–	3	1	–	7
	Lead farmer	–	–	1	–	–	–	–	–	1
	VICOBAs	–	–	–	–	2	–	–	–	2
	None	1	–	1	–	7	1	–	2	12

Table 3
Characteristics of farmers involved in PCA.

Variable	Categories	Percentages (%) of farmers (n = 627)
Sex	Male	51.8
	Female	48.2
Number of crops grown	1	12.8
	2	40.4
	3	26.6
	4	13.7
	≥5	6.5
Age	21–30	5.3
	31–40	15.2
	41–50	30.6
	51–60	24.9
	61–70	17.2
	≥71	6.9
Working with service provider	Yes	72.4
	No	27.6

Table 4
Eigenvalues and percentages of explained variance.

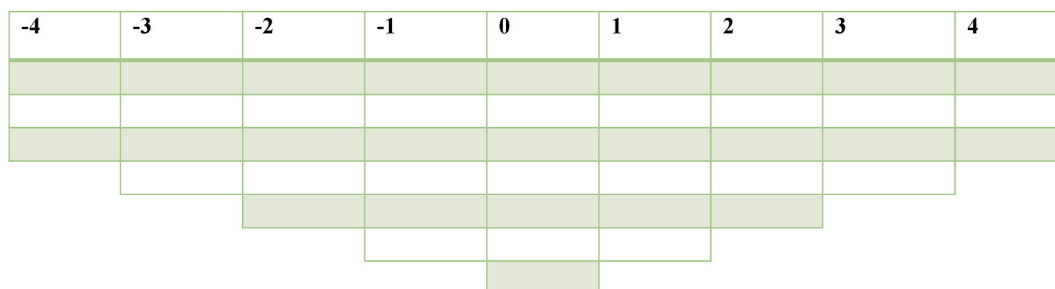|	Factor 1/PC1	Factor 2/PC2	Factor 3/PC3	Factor 4/PC4	PC5	PC6	Total explained variance
Eigenvalues for Q-method	4.97	3.25	2.76	1.96	–	–	–
Eigenvalues for PCA	11.90	3.42	2.54	1.55	1.28	1.18	–
Explained variance Q-methodology (%)	21.63	14.11	12.01	8.54	–	–	56.29
Explained variance PCA (%)	27.68	7.94	5.91	3.60	2.99	2.75	50.88

Fig. 2. A *Q*-sort matrix.

most disagree on the other [42]. The 43 statements were ranked in relation to each other on a scale ranging from −4 (strongly disagree) to 0 (neutral) to +4 (strongly agree) as shown by the *Q*-sort matrix (Fig. 2). A total of 23 Q-sorts were obtained. The Q-sorting process was followed by an interview whereby farmers were invited to give details on their sorting. The post-sorting interview allows qualitative interpretation of the Q-sorts [30].

The next step involved correlation and factor extraction. The Q-sort of each participant was correlated with all other Q-sorts using a *PQMethod* (version 2.35) with a *PQROT* of 2.0. The PCA and centroid factor analysis are two alternative ways for factor extraction in the Q-methodology. The PCA method solely use mathematics to determine the number of factors to extract while the centroid factor analysis is more theoretical. Therefore, in this study PCA was used for factor extraction. The Kaiser-Guttmann criteria was used to determine the number of factors to retain [30]. This criterion, requires factors to have Eigenvalues of at least 1. In addition to that factors were considered significant if they had at least two factor loadings. Consequently, four factors were selected. A total of 20 out of 23 Q-sorts loaded significantly in one of the factors. The three Q-sorts that did not load significantly on a factor were not used for further analysis. Pearson correlation test was done on the extracted factors. Since factors had different number of factor loadings, statement factors were normalized using a standardized z-score [44]. Finally, the factors were interpreted based on the placement of each statement in relation to others. Thus, statements ranked highest implied that farmers strongly agreed with them. Statements ranked as higher or equal to indicated that the scores were higher or equal to the same statement in other factors. Further, statements ranked as lower or equal to implied that the scores were lower than or equal to the score of the same statement in other factors. Lastly, statements ranked lowest had lowest score (strongly disagree). The factor loadings and rankings are presented in Tables 5–8. The z-scores were used to identify consensus and distinguishing statements.

2.3.2. Principal component analysis method

The PCA is a technique for reducing a large number of correlated dimensions to few uncorrelated ones with maximum explained cumulative variance. In the PCA method, a five-point Likert scale was used to rank the 43 statements developed from Q-methodology into 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) and 5 (strongly agree).

In order to avoid potential sampling bias, farmers with and without access to advisory services were included in the study because both sets of farmers are expected to have different perceptions that influence their non-use or use of those services. Previous studies such as [48–50] also took a similar approach. Farmers with access to advisory services worked with public extension officers, RECODA, F2FE, FRI and MVIWAARUSHA. Farmers without access to advisory services were drawn from two villages which had no any advisory service provider. This was to minimize the chance of spillover effects of advisory services among the farmers. The identification of these villages was possible with the help of ward extension officers. In addition, the villages were 30 km away from the tarmac road implying that it was not easy for farmers to travel to search for advisory services. Therefore, the study considered these farmers as those without access to advisory services.

The sample size of the farmers was determined following the formula by Ref. [51]:

$$n = \frac{Z^2 pq}{e^2} \tag{1}$$

whereby *n* is the sample size of farmers, *Z* is the desired confidence level, which is 95 %, *p* is the proportion of an attribute that is present in the population, *q* is 1-*p* and *e* is the desired level of precision which is 5 %. The study adopted a *p*-value of .07 which is drawn from the National Sample Census of Agriculture report which showed that 7 % of 7,677,291 farmers received advisory services during 2019/20 agricultural year [52]. The formula gives a sample size of 100 farmers to be drawn from each of the five advisory service providers. This made a total of 500 farmers with access to advisory services. A total of 100 farmers without access to advisory services were selected from each village using a simple random sampling technique. However, to account for potential non-response, the study

Table 5
Crib sheet for factor 1 under Q-method.

Statement number	Q-statements	Factor array
Highest		
6	Advisory service sessions are waste of time	4
36	Service providers give information on transport cost	4
40	Advisory services are provided at the inappropriate time	4
Higher or equal to		
19	It is costly to consult a service provider when a need arises	3
27	Service providers delay to offer agricultural advice	3
41	Advisory service providers offer a secured market for farmers' products	3
8	Farmers directly receive credits from the advisory service providers	3
Lower or equal to		
1	Farmers who work with advisory services have high yield	−3
4	Farmers who receive advisory services do not face the problem of food insecurity	−3
9	Advisory service providers offer technical support which increase access to credit	−3
Lowest		
16	The use of phone via short message services enables easy access of advisory service providers	−4
32	I would like to continue working with the same service provider in the next production season	−4
38	Service providers facilitate farmers to join farmer groups	−4

Table 6

Crib sheet for factor 2 under Q-method.

Statement number	Q-statements	Factor array
Highest		
6	Advisory service sessions are waste of time	4
36	Service providers give information on transport cost	4
39	Advisory service providers always require feedback regarding the service farmers receive	4
Higher or equal to		
41	Advisory service providers offer a secured market for farmers' products	3
14	Advisory service providers make inputs physically available to farmers	3
12	Advisory service providers offer training on food and nutritional security	3
Lower or equal to		
1	Farmers who work with advisory services have high yield	−3
3	I intend to work with advisory service providers in the next production season	−3
7	Farmers easily understand the information given by advisory services	−3
Lowest		
17	The advice received from advisory service providers is always correct	−4
18	Advisory service providers are the main source of agricultural information	−4
27	Service providers delay to offer agricultural advice	−4

Table 7

Crib sheet for factor 3 under Q-method.

Statement number	Q-statements	Factor arrays
Highest		
7	Farmers easily understand the information given by advisory services	4
24	Farmers have phone contacts of advisory service providers	4
Higher or equal to		
43	Advisory service providers offer conflicting advice	3
27	Service providers delay to offer agricultural advice	3
14	Advisory service providers make inputs physically available to farmers	3
23	It is difficult to physically access the advisory service providers	3
Lower or equal to		
28	Advisory service providers offer post-harvest handling information	−3
20	Advisory services are available during production season	−3
34	Advisory service providers link farmers with the input market	−3
41	Advisory service providers offer a secured market for farmers' products	−3
Lowest		
10	Skills on the right quantity of inputs to use are gained from the advisory service providers	−4
17	The advice received from advisory service providers is always correct	−4
32	I would like to continue working with the same service provider in the next production season	−4

Table 8

Crib sheet for factor 4 under Q-method.

Statement number	Q-statements	Factor 4
Highest		
4	Farmers who receive advisory services do not face the problem of food insecurity	**4**
15	Advisory services are available throughout the year	**4**
20	Advisory services are available during production season	**4**
Higher or equal to		
8	Farmers directly receive credits from the advisory service providers	**3**
31	Advisory service providers take short time to come to attend to farmers' problem	**3**
43	Advisory service providers offer conflicting advice	**3**
Lower or equal to		
3	I intend to work with advisory service providers in the next production season	**−3**
6	Advisory service sessions are waste of time	**−3**
11	The importance of consuming different food groups is learned from the advisory service providers	**−3**
13	Advisory service providers expose farmers to different agricultural technologies	**−3**
Lowest		
35	Delivery methods used by advisory service providers are easy to understand	**−4**
30	Farmers enjoy the services of the advisory service providers	**−4**
28	Advisory service providers offer post-harvest handling information	**−4**

increased the sample size by 10 %. Therefore, the total sample size was 770 farmers with and without access to advisory services. Due to incomplete questionnaires and non-responses, the eventual valid sample used in the PCA was 627 farmers.

A three-stage sampling technique was used to select the farmers. In the first stage two districts were purposively selected; Karatu

and Meru. This is because most farmers in these districts practiced crop farming. In the second stage, villages where various providers worked with farmers were purposively selected. In the third stage, simple random sampling was employed to select the farmers working with each provider. Data was collected in November and December 2021, and February 2022 through face-to-face interviews using structured questionnaires.

The principal component score was calculated as shown in equation (2).

$$PC_n = f(a_{ni}X_i \ldots \ldots a_{1k}X_k) \tag{2}$$

where *PC* is the component score, *n* is the total number of *PCs*, *a* is the component loading, *X* is the measured value of variable while *i* is the component number and *k* is the total number of variables. The Kaiser-Guttmann criterion was used to determine the number of principal components.

The use of PCA was validated by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy whereby a value of at least 0.6 is preferred [53]. Bartlett's sphericity test was used to check appropriateness of data and Cronbach's alpha reliability coefficient was used to test the internal consistency [54]. A binary logit model was applied to determine institutional and socio-economic factors that influence farmers' perceptions as shown in equation (3).

$$I_i^* = \beta_i \alpha + e_i \text{ with } I_i = \left\{ \begin{array}{l} 1 \text{ if } I_i^* > 0 \\ 0 \text{ otherwise} \end{array} \right\} \tag{3}$$

where I_i^* is a binary indicator variable that equals 1 if a farmer had good perceptions towards pluralistic advisory services and zero otherwise. Analysis and computations were performed in *R* software version 4.1.3 using FactoMineR and factoextra packages.

3. Results and discussion

3.1. Farmers' characteristics

Among the 23 and 627 farmers involved in Q-methodology and PCA method, about 87 % and 71 % aged between 30 and 60 years, respectively as shown in Tables 2 and 3. In both PCA and Q-methodology, there were more male farmers (52 % and 61 %). Most of the farmers (65 %) in the Q-methodology produced three to four different crops while majority of farmers (67 %) involved in PCA produced two to three crops. About 9 % and 28 % of farmers in Q-methodology and PCA method had no access to any service provider, respectively. In Q-methodology, leadership positions among the farmers were captured to ensure resourceful farmers were evaluated. About 48 % of the farmers were leaders in villages, farmers' groups or at the village and community banks (VICOBAs).

3.2. Validation of the PCA and Q-methodology

Four factors and six principal components were extracted under the Q-methodology and PCA, respectively. Both methods met the Kaiser-Guttman criteria and factors/principal components had Eigenvalues greater than one as shown in Table 4. Under the Q-methodology, each of the four factors had at least two factor loadings. Only three Q-sorts did not load on any of the factors and no Q-

Table 9
Coordinates for the PCA.

Perception statements	PC1	PC2	PC3	PC4	PC5	PC6
Providers offer technical support to increase access to credit	0.496	0.34	0.043	0.061	**−0.308**	0.076
Providers train farmers on different food groups	**0.763**	−0.027	−0.011	−0.022	**−0.308**	0.152
Providers train farmers on food and nutrition security	**0.763**	−0.032	0.018	−0.076	**−0.285**	0.144
Providers assist farmers to form farmers' groups	**0.734**	−0.079	0.107	−0.058	−0.12	−0.012
Providers require feedback from farmers	**0.728**	−0.039	−0.039	−0.015	−0.241	−0.088
Providers train on proper use of agric. inputs	**0.726**	0.0004	−0.083	0.03	−0.142	0.117
Providers are available during production seasons	0.643	−0.246	−0.07	**0.32**	0.07	−0.079
Farmers have phone contacts of providers	0.54	−0.005	−0.104	**0.369**	0.264	0.216
Providers link farmers with input markets	0.517	**0.499**	−0.011	−0.103	0.11	0.226
Providers link farmers with the output markets	0.477	**0.581**	0.017	−0.168	0.081	0.021
Service providers informed farmers on the price of the inputs	0.445	**0.556**	−0.01	−0.159	0.063	−0.04
I intend to work with service providers in the next production season	0.42	−0.143	**0.487**	−0.308	0.146	0.17
Service providers give information on where to get transport service	0.306	**0.696**	0.125	−0.058	0.194	−0.159
Farmers directly receive credits from the advisory service providers	0.251	0.443	0.109	0.19	**−0.306**	−0.086
Service providers give information on transport cost	0.246	**0.683**	0.141	0.092	0.157	−0.206
Service providers offer conflicting advice	0.014	0.058	**0.521**	0.293	−0.065	**−0.365**
Advisory service sessions are waste of time	−0.086	0.249	0.046	**0.481**	0.124	−0.237
Advisory services received were not suitable for farmers' needs	−0.159	−0.059	0.418	0.266	0.019	**0.323**
Providers delay to offer agricultural advice	−0.19	0.025	**0.49**	0.204	−0.035	**0.387**
It is difficult to physically access the service providers	−0.206	−0.045	**0.487**	0.054	**−0.325**	**−0.316**
It is costly to consult a service provider when a need arises	−0.229	0.036	**0.62**	0.066	−0.173	−0.105
Advisory services are provided at the inappropriate time	−0.249	0.131	0.444	**0.321**	−0.003	**0.322**

sort loaded on more than one factor. Under the PCA, the results showed that in all the 43 variables, the KMO was greater than 0.6 with the overall KMO of 0.93. Results from the Bartlett's test of sphericity suggested that there was sufficient correlation in the data for the PCA to be conducted with $p < .001$. The Cronbach's alpha was 0.725, indicating that the data had internal consistency and was suitable for PCA. In the PCA, the principal components cumulatively explained 51 % of the total variation while under Q-methodology the factors explained 56 %. This means more variance was explained under Q-methodology than PCA despite the fewer number of extracted factors under Q-methodology.

3.3. Perception categories

Factor 1 of the Q-methodology contributes 22 % of the total variation. It is composed of farmers working with NGOs, F2FE, private organization and ward extension officers (Table 5).

Factor 2 explains 14 % of the total variation. Farmers under this factor obtained advisory services from public service providers, private organization and F2FE (Table 6).

About 12 % of the total variation is explained by factor 3. Farmers under this factor worked with private organizations and NGOs (Table 7).

Factor 4 contributes 9 % of the total variation. Farmers under this category were served by public providers in wards and villages (Table 8).

In PCA, the perception categories represented as principal components (PC) 1, 2, 3, 4, 5 and 6 are shown in Table 9 and each PC contributes 28 %, 8 %, 6 %, 4 %, 3 % and 3 %, respectively of the total variation.

3.3.1. Perception 1: Market-oriented advisory services were provided but farmers regarded them to be ineffective

The results showed that factor 1 of the Q-method was similar to the PC2. In Q-method, farmers reported that advisory service providers gave information on transport services as shown by statement 36 with a factor score of 4, hereby denoted as (36, 4). Providers did not offer technical support to access credit rather, they provided agricultural credit directly to farmers (8, 3; 9, −3). In addition, advisory service providers offered secure markets for farmers' products (41, 3). Similarly, in PCA farmers were linked with the input and output markets. In addition, service providers were the main source of price information and transport cost information. Both PCA and Q-method agreed that advisory services focused on transport services and market access. The results are contrary to the study by Ref. [55] who showed that pluralistic providers in Malawi did not enable farmers to access input and output markets.

Factor 1 of the Q-method revealed that it was costly to consult providers when a need arises and access through phone was not common (19, 3; 16, −4). In addition, farmers claimed that providers delayed the agricultural advice (27, 3; 40, 4). Further, advisory services leading to formation of farmers' groups were not offered by the service providers (38, −4). Also, pluralistic advisory services did not enable farmers to have high yields nor become food secure (1, −3; 4, −3). This showed that the services were ineffective, notwithstanding the presence of pluralistic service providers. The results are similar to those of [50,56] who showed that extension system was not efficient despite massive investment and accessibility of farmers. Therefore, farmers regarded the pluralistic advisory services as wastage of time and were not ready to work with same providers in the next production season (6, 4; 32, −4).

3.3.2. Perception 2: Pluralistic providers offered diversified advisory services

Factor 2 of Q-method was similar to PC1. The PC1 was built on the basis of training on proper use of agricultural inputs and training on food and nutrition security. Other statements that described this principal component were training on different food groups, assisting farmers to join farmers' groups and a strong feedback system. Similarly, in the Q-method, service providers informed farmers on the cost of transporting farm outputs to the markets (36, 4). The providers trained farmers on food and nutrition security (12, 3). Providers offered secure markets for farm outputs and ensured physical availability of farm inputs to farmers (41, 3; 14, 3). Providers also required feedback regarding the services they offered (39, 4). Each approach (PCA and Q-methodology) identified more than three different types of advisory services offered to farmers. This showed that multiple services were offered to farmers. Common advisory services identified by the two approaches include training on the use of farm inputs and food and nutrition security. The presence of a feedback system was also noted by the two approaches. These results are similar to those of [57] who found that in Europe the advantages of pluralistic providers include wide variety of advisory services.

The Q-method provided more description of the providers offering the multiple services. The results showed that advisory services were not always correct and farmers faced difficulties to comprehend the information and advice offered (17, 4; 7, −3). Consequently, farmers sought advisory services from various service providers (18, −4). This implied that farmers worked with multiple providers so as to understand and validate the advice received. The results are similar to those of [58] who showed that 28 % of farmers sourced advisory services from multiple providers. In addition, working with service providers did not result to better outcomes in terms of quantity of yields (1, −3). Hence, advisory sessions were perceived as wastage of time and farmers had no intention to work with service providers in the next production season (6, 4; 3, −3).

3.3.3. Perception 3: Difficulty in accessing private providers and vital advisory services not offered

Factor 3 of Q-method was correlated to PC3 and PC5. The PC3 was positively correlated with statements that farmers found it difficult and costly to access service providers. In addition, advisory services were delayed and farmers received conflicting advice. Likewise, factor 3 of the Q-methodology was built on the foundation of the statements that farmers found it difficult to physically access the private providers (23, 3). Service providers offered conflicting advice and the agricultural advice was not always correct (43, 3; 17, −4). Providers delayed to offer advisory services and providers were not available during the production season (27, 3; 20, −3).

The two approaches jointly agreed that farmers received conflicting advice, advisory services were delayed and providers were difficult to access. Farmers did not have access to private service providers because providers did not reside in their communities [17].

Furthermore, Q-method showed that farmers lacked advisory services which link them with the input and output markets (34, −3; 41, −3). In addition, farmers lacked advisory services on the right use of farm inputs and post-harvest handling techniques (10, −4; 28, −3). This factor therefore, show shortage of vital advisory services to farmers. This was similar to the PC5 which defined advisory services to lack training on food and nutrition security. Moreover, service providers were less concerned with agricultural credit. Therefore, factor 3 and PC 5 mutually described absence of necessary advisory services to farmers. These results are different from a study by Ref. [59] which showed that pluralistic advisory system deliver essential advisory services to farmers. The discrepancy is due to the fact that the previous study focused on advisory service models which train farmers on conservation agriculture while the current study involves perception of farmers on advisory services.

3.3.4. Perception 4: Easy to access public providers but advisory demands not met

Factor 4 of Q-methodology showed that farmers perceived that advisory services were available throughout the year, even during the production seasons (15, 4; 20, 4). The service providers took a shorter time to attend to farmers' problems (31, 3). This showed that farmers easily accessed the public service providers. Similarly, PC 6 expressed the same thing that it was easy for farmers to physically access the government service providers. This is contrary to studies by Refs. [60,61] which showed that public advisory services were less efficient in terms of access. The discrepancy is explained by the fact that in areas where pluralistic advisory services exist, they positively influence the operations of the public service providers and hence motivate their access to farmers.

The Q-method showed that farmers received credit from the service providers and farmers were food secure (8, 3; 4, 4). The agricultural credit might have emanated from Agricultural Marketing Cooperative Society (AMCOS) through the extension officers in wards and villages. However, Q-method went further and showed that providers lacked services such as post-harvest storage techniques, exposing farmers to different agricultural technologies and training on food groups (28, −4; 13, −3; 11, −3). This is similar to a study by Refs. [62,63] who showed that advisory services lacked relevant skills and their services did not focus on the specific needs of farmers. Delivery methods used were not easily understood by farmers and providers offered conflicting advice (35, −4; 43, 3). These made farmers perceive that they did not enjoy the services and had no intention to work with service providers in the next production season (30, −4; 3, −3). In addition, PC6 showed that advisory services were not suitable for farmers' needs. This is due to lack of necessary advisory services to farmers. These results go beyond those of [64] which showed that farmers in Africa lacked access to
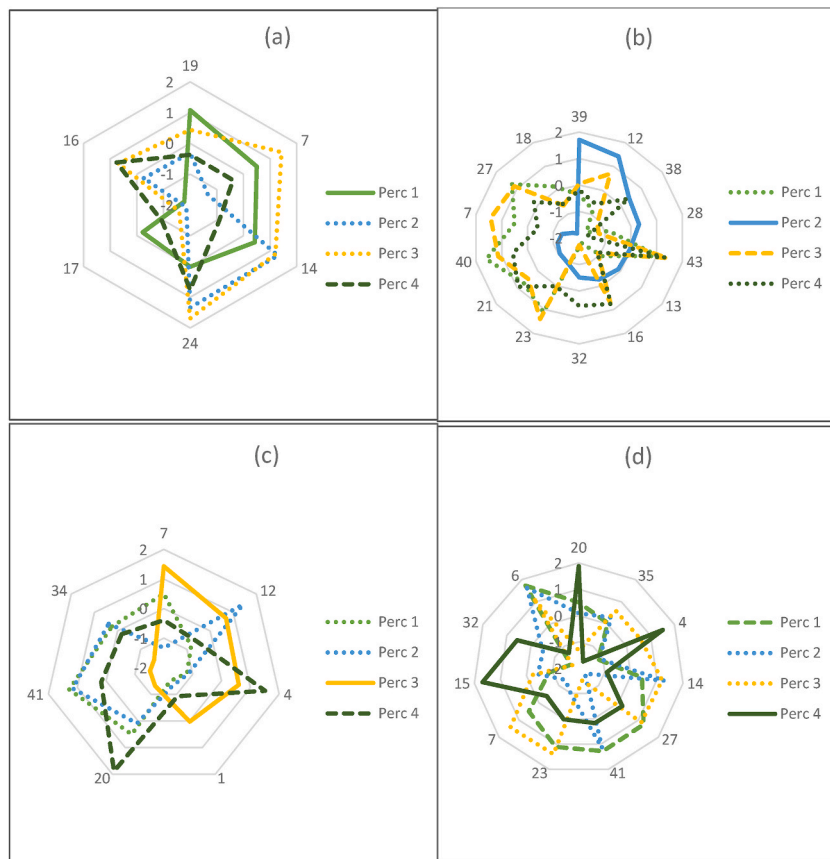

Fig. 3. Distinguishing statements for each perception category.

advisory services by showing that public advisory services were accessible but only few services were delivered to farmers. The limited services offered resulted to food secure farmers implying that, most livelihood outcomes would have improved had the services been sufficient.

3.3.5. Perception 5: Poor timing of agricultural advisory services

The PC4, which emanated from PCA did not match with any perception category in the Q-method. This factor was linked to the statements that farmers had phone contacts of pluralistic providers and that the service providers were available during the production seasons. However, farmers perceived that advisory services were offered at inappropriate time and consider it as wastage of time. Farmers under PC4 did not intend to work with providers in the next production season. This implied that farmers perceived that production seasons were not favorable times for provision of agricultural advice. Therefore, PC4 was anchored on the poor timing for agricultural advice. Timely access to agricultural advice to farmers is very crucial since agriculture is a seasonal activity [65].

3.4. Consensus and distinguishing statements

Z-scores were used for cross-factor comparison [46]. The z-scores which were relatively similar among the factors results to consensus statements. These are statements with common agreement among all the perception categories. Distinguishing statements for a factor have significantly different z-scores from all other factors; such statements characterize specific perception category.

Five statements had common agreement along the four perception categories. These statements were not significantly different across all the factors at $p > 0.01$ while statements 8 and 26 were not significantly different at $p > 0.05$. Farmers agreed that they received agriculture credit directly from advisory service providers (statement 8). In addition, farmers agreed that service providers were the main source of market price information for farm outputs (statement 26). On contrary, farmers did not enjoy the advisory services and had no intention to work with providers in the next production season (statements 30 and 3). All farmers were silent on encouraging other farmers to work with advisory service providers (statement 2). The consensus statements show that provision of agricultural credit and market price information were not sufficient to meet farmers' advisory needs and hence, farmers opted not to work with providers. For instance, farmers were provided with exotic goats on credit by the service providers. The quantity of milk expected from the goats was low (3 L per day) compared to the milk they obtained from the cows (5 L per day). Therefore, the advisory services did not meet farmers' needs and expectations.

Six statements distinguished perception 1 from the rest of the perception categories as shown on Fig. 3 panel (a). These statements were significantly different across the four perceptions at $p < 0.05$ while statement 16 was different at $p < 0.01$. Farmers indicated that it was costly to consult service providers when there was a need (statement 19). The farmers were silent concerning having phone contacts of advisory service providers (statement 24) and showed that it was uncommon to communicate to the providers via phone (statement 16). Therefore, this means it was costly for farmers to access the pluralistic advisory service providers. Other statements that distinguished perception 1 was that farmers understood well the advisory services provided but they were neutral on how correct the advisory services were (statements 7 and 17).

The perception 2 is distinguished by 14 statements as shown on Fig. 3 panel (b). These statements were statistically significantly at $p < 0.05$ while ten statements were significant at $p < 0.01$. Different from other perception categories, the advisory service providers required feedback regarding the services they offered (statement 39). Farmers obtained services such as training on food and nutrition security and post-harvest handling information (statements 12 and 28). They also facilitated farmers to form farmers' groups (statement 38). This aligns well with diverse services offered to farmers as indicated in perception 2. However, farmers were silent on conflicting advice from pluralistic service providers (statement 43). Different from other perceptions, farmers under perception 2 reported that advisory services were not delayed as they were offered at appropriate time (statement 27 and 40). The service providers could be easily accessed and farmers easily understood the advisory services offered (statements 23 and 7).

The perception 3 was distinguished by seven statements as shown on Fig. 3 panel (c). The statements were significant at $p < 0.05$ while four of them were significant at $p < 0.01$. Farmers easily understood the information provided by service providers (statement 7). However, the providers were not available during production seasons and were less concerned with agricultural markets (statements 20, 41 and 34). This is consistent with the findings obtained on perception 3 that it was difficult to access the providers and services demanded by farmers were not offered. Advisory services resulted to food secure farmers (statements 12 and 4). Nonetheless, farmers were neutral on ability of advisory services to increase productivity of farmers (statement 1).

About 11 statements distinguished perception 4 as shown on Fig. 3 panel (d). About six statements were significant at $p < 0.01$ while the rest were significant at $p < 0.05$. The providers were available and farmers working with these service providers were food secure (statements 20, 15 and 4). Farmers were willing to work with providers in the next production seasons (statement 32). However, farmers had difficulty in understanding the information given by providers and this is due to delivery methods used (statement 7 and 35). In addition, extension officers were less concerned with physical availability of farm inputs to farmers (statement 14). This is similar to perception 4 that it was easy to access the providers but advisory demands were not met. Farmers were neutral on timeliness of advisory services, difficult of reaching providers and access to markets (statements 27, 41 and 23).

3.5. Factors influencing farmers' perceptions on agricultural advisory services

The results from PCA were used to identify the demographic, institutional and socio-economic factors influencing perceptions by using a binary logit model and results are shown in Table 10. The results showed that male-headed households were more likely to have favorable perceptions towards accessing service providers as well as accessing diversified advisory services compared to their

counterparts. These findings align with those of [58] who showed gender gaps in accessing advisory services among farmers in Liberia. Male farmers own production resources such as land and animal draft than their counterparts and hence, can afford expenses of advisory services [16]. Farmers with access to credit were more likely to have favorable perceptions towards accessing service providers as well as diversified services. Access to credit improves farmers' liquidity hence, ability to incur transaction costs associated with accessing advisory services. However, these results are contrary to those of [14] who showed that access to credit was negatively correlated with access to private extension system. Educated farmers were more likely to face difficulties in accessing advisory service providers such as NGOs but more likely to access the public service providers. This may be due to the reason that most pluralistic providers such as NGOs and FBOs prefer to work with less educated and marginalized farmers compared to their counterparts. Farmer groups and rural cooperatives positively and significantly influenced farmers' access to diverse advisory services but not market-oriented advisory services. This finding is supported by Ref. [66] that despite the existence of diverse advisory services, providers still focus on production rather than other advisory services such as marketing. Farmers who were aware of different institutions offering advisory services were more likely to perceive that they had difficulties in reaching the providers and lacked necessary advisory services than farmers who were not aware. This may be due to the reason that providers focused on remote farmers who were less aware of the providers leaving behind those farmers near town who were aware of the providers.

3.6. Comparison of PCA and Q-methodology

Despite the incompatible sample size used in both approaches, the results show convergence in farmers' positive perception of diversified advisory services. Moreover, both approaches show that farmers had unfavorable perceptions towards accessing private providers and good perceptions towards reaching public providers. This means with 23 participants it was possible to get comparable results as with 627 respondents. Similarly [67], found that the results of the two approaches were consistent. However, a few discrepancies were noted due to differences in nature of the two approaches, variations in the data collection process, analysis and interpretation (Table 11). For example, both approaches identified market-oriented advisory services as shown in perception 1. However, Q-methodology further revealed that the market-oriented advisory services were ineffective. This is because Q-methodology unlike PCA is subjective in nature. In Q-methodology, subjectivity is empirically assessed by identifying different perceptions, beliefs, opinions and attitudes [68]. As noted by Ref. [46] Q-methodology unpacks the attitudes, perceptions, opinions and behavior of farmers compared to the PCA approach. This way, the Q-method unravels existing discourses in the society of farmers and provides a large amount of information on pluralistic advisory services than the PCA method.

The Q-methodology uses a grid in data collection process while PCA uses a Likert scale. In this study, the grid had nine points which ranked from −4 (strongly disagree) to 0 (neutral) to 4 (strongly agree). On the other hand, a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree) was used in the PCA. One advantage of using a grid versus Likert scale is the fact that respondents are not able to select the same response for each statement [68]. Contrarily, in a Likert scale, respondents for some reasons may choose to rank the statement as strongly agree/disagree. Thus, a grid provides more accurate data. However, the use of a grid in data collection requires more time in explaining to farmers the procedures of sorting the statements before they can do meaningful sorting; this is a key limitation of Q-methodology.

In Q-methodology, the qualitative statements and factor arrays which are statistical parameters showing how strongly farmers agree or disagree with a statement are used concurrently in interpretation. As such, the Q-methodology gives results which are systematic, in-depth and holistic in nature [38]. In PCA on the other hand, the reduction process leads to data loss. For instance, none of the six principal components indicated that farmers worked with multiple providers. This means the issue of pluralistic or multiple service providers would have been missed, had the study used the PCA method alone. This is supported by Ref. [72] that Q-methodology reveal latent views that do not emerge through other methods because the views are controversial or participants are not vocal about them.

The extracted factors in Q-methodology were comprised of statements that farmers strongly agree and those that they strongly disagree on pluralistic advisory services. Contrarily, in PCA such statements showing strong agreement and disagreement fell into two different principal components as shown by PC3 and PC5 versus factor 3. This gives a reason for extracting more principal components (six) versus the four factors in Q-methodology. This is because data interpretation in PCA approach involved five main statements that strongly describe each principal component. However, as noted by Ref. [27], interpretation of each factor in Q-methodology considered the placement of each statement in relation to others and in relation with placements of statements in other factors.

The PCA results can be subjected for further analysis to determine socio-economic and institutional factors that influence the extracted principal components. In this study, the binary logit model was used to analyze the results obtained from PCA approach. The results from the model showed that access to agricultural credit improved perceptions towards accessing public providers (PC6). Unlike PCA, results from Q-methodology cannot be statistically analyzed to determine associations between extracted factors and participants' characteristics. Nonetheless, Q-methodology provides consensus and distinguishing statements which gives a deeper understanding of the perceptions of farmers.

The results from PCA showed that farmers' groups enhanced farmers' access to diverse advisory services. Thus, results from PCA can be generalized to the entire population because of a relatively large and representative sample size as opposed to the small, non-statistically representative sample used in Q-methodology. As noted by Refs. [73,74] the results from Q-methodology cannot be generalized to the entire population as they are directly related to individuals who participated in a study. Nonetheless, the results from Q-methodology reveal the shared viewpoints, perceptions and the likely behavior in the population of farmers [30]. In our study, having used the PCA method to confirm the results obtained from Q-methodology enables generalization of the results.

Table 10

Factors influencing perceptions of farmers.

Variables	PC1	PC2	PC3	PC4	PC5	PC6
Household head (1 = male)	0.106* (0.064)	0.011 (0.059)	−0.144** (0.058)	0.042 (0.059)	0.065 (0.058)	0.096 (0.059)
Years of education of the household head	−0.032*** (0.010)	0.004 (0.008)	0.036*** (0.010)	0.001 (0.008)	0.009 (0.008)	0.021** (0.009)
Access to credit (1 = yes)	0.110** (0.049)	0.054 (0.047)	−0.056 (0.046)	0.018 (0.045)	−0.102** (0.045)	0.134*** (0.044)
Land size (ha)	−0.029** (0.015)	0.004 (0.014)	0.001 (0.014)	0.003 (0.013)	−0.018 (0.013)	0.008 (0.014)
Awareness of institution(s) offering advisory services (1 = yes)	0.012 (0.050)	−0.010 (0.043)	0.105** (0.042)	0.185*** (0.041)	0.035 (0.042)	−0.052 (0.042)
Membership to rural cooperative (1 = yes)	0.460*** (0.042)	−0.226*** (0.046)	−0.042 (0.048)	0.001 (0.047)	−0.043 (0.047)	−0.035 (0.047)
Number of crops grown	0.072*** (0.023)	0.020 (0.020)	−0.016 (0.020)	−0.036* (0.019)	0.027 (0.019)	0.030 (0.020)
Observations (n)	627	627	627	627	627	627
Pseudo R^2	0.330	0.050	0.070	0.050	0.030	0.050

Note: PC1 - diversified advisory services; PC2 - market-oriented advisory services; PC3 - difficult to access private providers; PC4 - poor timing of advisory services; PC5 - lack of vital advisory services; PC6 - easy to access public providers. *, **, *** denote statistical significance of the variables at 10 %, 5 % and 1 %, respectively. Standard errors are shown in parentheses.
Source: Survey Data (2021).

Table 11

Differences between PCA and Q-methodology.

Source of variation	PCA	Q-methodology
Sample	Sample is randomly selected and represent the population of study	Sample not representative of the population but consists of few resource persons purposively selected to provide wide opinions [28,32]
	The sample size involves a large number people who receive a small number of test items [69]	A small number of people but receive a large number of test items [70]
Variables	The participants or their Q-sorts are treated as a response variable [68]	Items such as age, farm size, credit access are the response variables [71]
Data collection	Data is collected through Likert scale	Data is collected by using a grid, a process known as Q-sorting [70]
	Elicit opinions about each topic separately [34]	Respondents consider different but related topics simultaneously.
Subjectivity	Analyze perceptions of farmers objectively	Captures subjectivity of farmers [38,43]
Data interpretation	Interpretation of data considered a few statements	Statements on the extreme ends (strongly agree/disagree and agree/disagree) were used
Data	Provides qualitative data [15]	Make use of qualitative and quantitative data and methods to analyze subjective viewpoints. Qualitative and factor analysis are used followed by qualitative analysis of the statements [72,70,71]
Generalization of results	Results can be generalized to the entire population since the sample is random.	Sample not random hence, results cannot be readily extrapolated to wider populations. Generalization is made to the perspectives on the topic and not to the population [28,72,69]

4. Conclusion and recommendations

This study analyzed the perceptions of farmers on advisory service providers. The study employed Q-methodology whereby 43 statements were subjected to 23 farmers for Q-sorting. The same number of statements were used in PCA whereby a Likert scale with five points was used to rank the statements from most agreed to most disagreed. In PCA, a total of 627 farmers were involved in the study. The two approaches resulted to similar perceptions with few discrepancies. An exclusive use of the PCA method would have led to the conclusion that market-oriented and diversified services were offered to farmers. In addition, service providers were inaccessible to farmers except the public service providers. Also, there was poor timing in offering advisory services and most advisory demands were unmet. With the inclusion of Q-methodology, the results showed that farmers received market-oriented advisory services but the services were ineffective. Further, it was shown that farmers received diversified services from pluralistic service providers. Furthermore, it was difficult to access the service providers and those available lacked vital advisory services. Lastly, public service providers were available to farmers but they did not meet the advisory demands.

The use of Q-methodology uncovered the perceptions that would otherwise not be depicted under PCA. Rather than considering the two approaches as being mutually exclusive, this study recommends a complimentary application of both methods to validate results and provide more robust insights in the real behavior and perceptions of agricultural extension service users to support inclusive design of information sharing mechanisms.

The limitation of this study lies in the way farmers without access to advisory services were selected. The study assumed that external environment (absence of service providers in the village and long distance from the tarmac road) did not allow farmers to have received the advisory services. However, there might still be spillover effects due to cross-cultural linkages and other societal

interactions that allow farmers to receive advisory services regardless of the provider.

Ethics statement

This research was approved by the Tanzania Commission for Science and Technology with approval number 2021-344-NA-2021-134.

Informed consent

Written consent was obtained from all the farmers involved in the study.

Disclosure statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Annette Goodluck: Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **David Jakinda Otieno:** Writing – review & editing, Supervision, Conceptualization. **Willis Oluoch-Kosura:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Annette Goodluck reports financial support was provided by Institute of Accountancy Arusha. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e34541.

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