Original Research Article

Farmers' Perceived Effectiveness of Agricultural Technology Transfer Hub (AgriTecH) in the Dissemination of Improved Oil Palm Production Technologies in Western Regions of Tanzania

Abstract

This study aimed at evaluating farmers' perceived effectiveness of AgriTecH in the dissemination of improved oil palm production technologies in Tabora and Katavi regions in the Western zone of Tanzania. The study employed a cross-sectional mixed-methods research design involving quantitative and qualitative methodologies. A semi structured questionnaire was used to collect quantitative data from a sample of 120 respondents while focus group discussions and key informant interviews were employed to obtain qualitative data. Quantitative data were analysed using a Statistical Package for Social Sciences (SPSS) programme while content analysis was used to analyse qualitative data. The study found that overall, farmers' perception about AgriTecH'seffectiveness was positive with a mean score of 4.11 ± 0.03 suggesting that they perceived AgriTecH as effective in the dissemination of improved oil palm production technologies. The study concludes that while AgriTecH supports farmers with services that are accessible, responsive, and reliable; however, improvements in the physical infrastructure and upholding high standards in service delivery are necessary for effective extension delivery.

Keywords: *Perceived Effectiveness, AgriTecH, Dissemination, Oil palm, Production Technologies*

Introduction

Agricultural Technology Transfer Hub (AgriTecH) is an organized facility that facilitates the dissemination of improved agricultural technologies to farmers, extension workers and other agricultural stakeholders (TARI, 2020). The facility was established by the Tanzania Agricultural Research Institute (TARI) to transfer improved agricultural technologies developed from its centres and other research or academic institutions. It plays a key role in disseminating knowledge, technologies, and agricultural information, andin linking farmers with other stakeholders in the agricultural sector. Agricultural technology transfer plays a significant role in transforming agricultural productivity by facilitating movements of soft and hard skills which are essential for improving farm production (Mgendi et al., 2019).Recently, there are eight AgriTecHs located in each Zonal Agricultural show grounds in Tanzania. They operate throughout the year,providing opportunity to farmers and other agricultural stakeholders to learn various improved agricultural technologies which contributes to increased productivity resulting in raising farm incomes and ensuring food security(Rutasitara&Selejio, 2008).

AgriTecH is not a Tanzanian invention; it has been effectively used in many different ways all around the world. Similar services are provided by the Agricultural Technology Information

Centre (ATIC) in India to farmers with a single point of access to better agricultural techniques (Dar *et al.,* 2014; Singh *et al.,* 2013; Kumar and Singh, 2007). Also, China's Science and Technology Backyards (STB) have played a crucial role in increasing agricultural output (LI et al., 2022) while Mexico's MasAgro Hubs have been vital in encouraging conservation agriculture among smallholder farmers (Camacho-Villa *et al.,* 2016; Schut *et al.,* 2015; Kilelu and Leeuwis, 2016)**.** Furthermore,Chinese Agricultural Technology Demonstration Centres (ATDCs) have been established in different 23 countries in Africa to disseminate improved agricultural technologies aiming at increasing agricultural productivity and food security (Nalwimba & Mudimu, 2019; Mgendi*et al.*, 2019)[1].

At the same time, although there is a large body of literature on AgriTecHs(Sherka, 2021;Wordofa&Sassi, 2017; Wonde et al 2022; Pandey &Solanki, 2012;Sankanagoudar&Nagnur, 2015; Dutta et al, 2021; Singh &Kalra, 2019; Kumar et al. 2020; Eshetu, 2018; Narayana et al, 2015; Ombati et al, 2014; Worku, 2010; Mekuria,2014; Omer et al, 2021; Setu et al,2022; Khan et al,2017) only a limited number of them have reported on the effectiveness of AgriTecHsin the dissemination of improved agricultural technologies(Ombati et al, 2014; Worku, 2010; Mekuria,2014; Omer et al, 2021; Setu et al,2022;Khan et al,2017).

Furthermore, most of the latter have limited their assessments to a single or a few components of the AgriTecHs, thus limiting the comprehensive understanding of the effectiveness of the Hub as a tool of disseminating technologies. Thus, drawing on the empirical study, this article presents a comprehensive assessment of farmer's perceived effectiveness of AgriTecH on the dissemination of improved oil palm production technologies in Western Zone of Tanzania. The article is organized in five sections; the first is the introduction, which is followed by the background to the article. The third section is on the conceptual framework adopted for the study, followed by the description of the study methodology. The fourth section presents results and discussion followed by the conclusionsin the fifth and last section.

Background

TARI is mandated to develop different improved agricultural crop technologies and disseminate them to the end users using different dissemination pathways including Agricultural Technology Transfer Hub (AgriTecH). AgriTecH is a contemporary means of disseminating agricultural innovations including the use of improved seeds/seedlings, soil and water management methods, pests and diseases control and post-harvest technologies. The AgriTecHsfacilitate information transfer from researchers to farmers (TARI, 2020). They serve as a one-stop shop where various agricultural technologies are available.

AgriTecHs were established with the mission of facilitating the continuous dissemination of improved agricultural technologies to end users, including farmers, extension workers, and other stakeholders. According to TARI (2020), AgriTecHs seek to achieve the following objectives: (i) To ensure that the dissemination of agricultural technologies and innovations extends beyond one Agricultural show event; (ii) To establish one stop centre for training and accessing agricultural technologies and innovations to end users; (iii) To enhance

[1]Similar other initiatives have been reported (see for example, Alemu,2021;Njine.,2014; Ombati et al., 2014; Wonde et al.,2022)

collaboration with public and private stakeholders in technology dissemination; and (iv) To establish shops for sale of seeds and value-added products and by-products.

FatumaMwasaAgriTecH, which is the focus of this study, is one of the eight AgriTecHs established under TARI in the country. The Hub is located in FatumaMwasa Agricultural show grounds at Ipuli in Tabora Municipality. It has been designated as a centre for technology dissemination in the Western Zone of Tanzania (TARI, 2021). The centre is administered jointly by the two TARI centres, namely, TARI Tumbi and TARI Kihinga. TARI Tumbi has a national mandate for conducting and coordinating agroforestry research. To cope with climate change and farmer's demands, the centre conducts research in various crops including oil palm, cereals, root and tubers, legumes, and horticulture. On the other hand, TARI Kihinga has a national mandate for conducting and coordinating research on oil palm. These centres provide personnel, capacity development, and improved technologies, which are important resources for the AgriTecH's operations. Apart from oil palm and agroforestry technologies, AgriTecH provides value-added products, good agronomic practices, and improved seeds/seedlings of various crops from other TARI centres. The centre is open all year round, as such, it is an important resource for farmers, extension agents, and other stakeholders to access and implement cutting-edge agricultural innovations.

In addition to acquiring, storing, and distributing technologies from TARI centres, FatumaMwasaAgriTecH also established commercial channel for certified seeds/seedlings and goods, and uses demonstration plots to highlight crop success. Additionally, it distributes promotional materials, commercializes value-added products, and conducts training sessions to stakeholders on improved agricultural technologies. In order to broaden its influence and improve dissemination of improved technologies, FatumaMwasaAgriTecH works with private agricultural enterprises, education institutions, and local governments. Furthermore, to guarantee efficient technology transfer to farmers, Agricultural Extension Officers, students and other stakeholders in the agricultural value chain, FatumaMwasaAgriTecH uses various extension methods, including exhibitions, farmer field days, demonstration plots and mass media.

Conceptual framework

Effectiveness of an organization refers to how well an organization performs its activities to attain the predetermined objectives (Mukherjee et al., 2011). Perceived effectiveness is used to describe the subjective evaluation of how effectively goods or services satisfy the requirements and expectations of users. Farmers' perceived effectiveness of AgriTecH in the dissemination of improved oil palm production technologies refers to how farmers believe that the AgriTecH is effective at transferring improved oil palm production technologies. This study draws on Service Quality Model (SERVQUAL) to assess farmer's perceived effectiveness of AgriTecH's in the dissemination of improved oil palm production technologies. SERVQUAL is a framework for assessing service quality. It was initially developed by Parasuraman, Zeithaml, and Berry in 1985 and further modified by Rana in 2013 (Parasuraman et al., 1988; Rana et al., 2013). In principle, the model constitutes several dimensions including access, assurance, empathy, reliability, responsiveness, tangibility and timeliness as indicators to measure the service quality of an organization. The SERVQUAL model has been employed by various scholars such as Sajesh and Padaria (2019) and Rana et al. (2013) to measure the effectiveness of extension agencies in the provision of extension services.

The conceptual framework in Figure 1 depicts the perceived effectiveness of AgriTecH as a multifaceted construct, with several indicators grouped in concentric rings around the idea of overall effectiveness at the centre. Seven essential aspects of service quality such as timeliness, tangibility, responsiveness, empathy, reliability, assurance, and accessibility may have an effect on the effectiveness of AgriTecH. All of these factors work independently to influence the main outcome variable, which is the perceived effectiveness of AgriTecH. Accessibility refers to how simple it is for users to utilize the platform. Assurance is theconfidence of farmers that AgriTecH has the required skills, expertise, resource and infrastructure to meet farmers' requirements. Empathy is the measure of the interest and concern of the AgriTecHin addressing needs of individual farmers and within their context. Reliability is the ability to provide relevant and quality services in an accurate and cost-effective manner. Responsiveness is the measure of concern and supportive service of the AgriTecH. Tangibility implies physical facilities and materials for the benefit of farmers. Timeliness is the measure of timely provision of response and service.

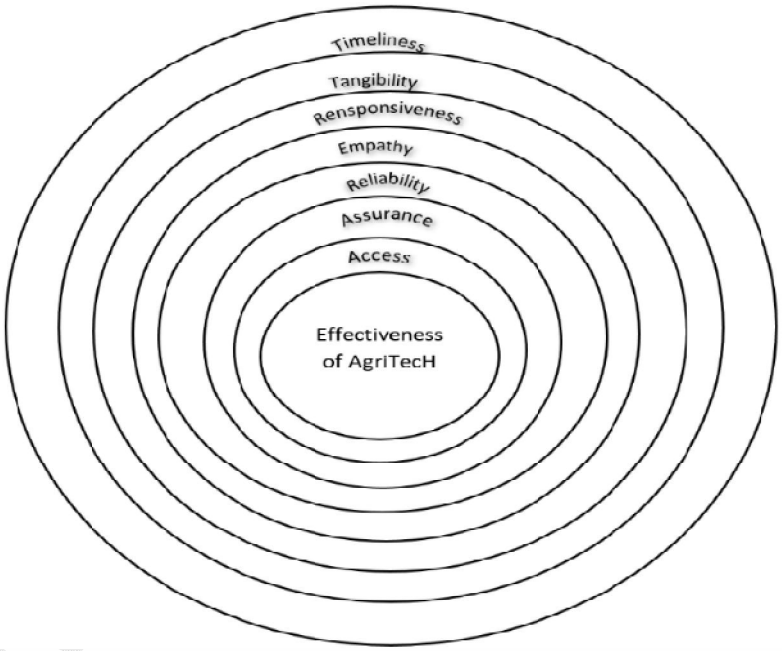

Figure 1: SERVQUAL Dimension

METHODOLOGY

The study was conducted in Tabora Municipality, Urambo and KaliuaDistricts in Tabora Region andin Tanganyika District in Katavi Region located in the western zone of Tanzania.Tabora and Katavi regions were chosen because they are ecologically suitable for oil palm production and are among the regions which are served by FatumaMwasaAgriTecH.According to the 2022 National Census, the populations of Katavi and Tabora Regions are1, 152,958 and 3,391,679 respectively. Katavi Region is situated between Latitudes 5° 15' and 7° 03' South and Longitudes 30° and 33° east. The region receives between 700 and 1,300 millimetres of rainfall annually. On the other hand, Tabora

Region lies between latitudes 4° and 7° south of the Equator and receives an average of 1,010 millimetres of precipitation annually.

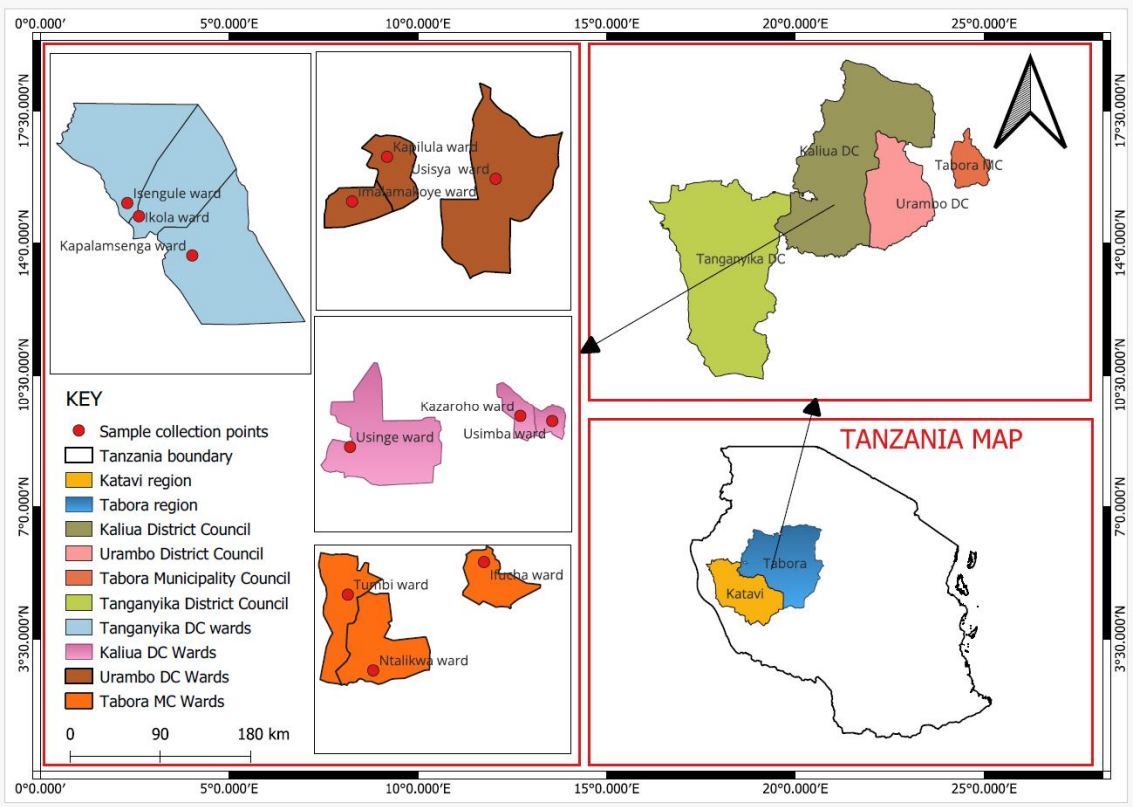

Figure 2. A map showing the study area

The study employed mixed methods research design involving both qualitative and quantitative research methods. The use of mixed research method facilitates triangulation, which improves validity and depth of the results. Oil palm farmers were the population of interest in this study.Both men and women farmers were included in the study to determine gender contribution in the oil palm production. Purposive sampling technique was used to select thirty farmers from each district making a total of 120 oil palm farmers. Literature revealed that a sample size of 80-120 respondents is sufficient for conducting socio-economic studies in sub-Saharan African countries, including Tanzania (Gbawoquiya, 2019; Iddi et al., 2022; Masanja et al., 2023). The study selected farmers who visited and registered in the FatumaMwasaAgriTecH visitors' book. Furthermore, the District Agriculture, Livestock, and Fisheries Officer (DALFO), AgriTecH Staffs, and Ward Agricultural Extension Officers (WAEO) served as Key Informants in this study. These officials were selected as Key Informants because of their knowledge and experience in the dissemination of improved agricultural technologies.

The primary data were collected from 120 respondents using a semi structured questionnaire with the KOBO Collect v2022.3.6 software, which enable responses to be entered directly into a digital format. This minimize errors resulting from manual data entry, thereby streamlining data administration and guaranteeing data accuracy. The study also used Key Informant Interviews (KIIs) and Focus Group Discussion (FGD). Eight KIIs were

conducted involving the DALFO and the WAEO from each district. Further, four Focus Group Discussions (FGDs) with the oil palm farmers, one FGD from each district were conducted in the study areaFGDs were conducted to respondents who did not take part in the questionnaire survey.Each FGD composed of 6 individuals with a composition of elders, youth, women, and men. To ensure credibility and consistence, FGDs were guided by a standardized checklist regarding the effectiveness of AgriTecH in the dissemination of technologies.

Further, a five-point Likert scale covering seven dimensions (accessibility, assurance, reliability, empathy, responsiveness, tangibility, and timeliness) was used to measure farmer's perceived effectiveness of AgriTecH. To assess respondent's perception, mean scores for each indicator were computed and a cut off score of 3.0 as suggested by Wanjohi and Syokau (2021) was used, with the above 3.0 indicating positive perception and below 3.0 indicating negative perception.

The calculation of the mean score was as follows:

$$Mean\ score = \frac{\sum_{i=1}^{n} Score_i}{n}$$

Where:

$\sum_{i=1}^{n} Score_i$Represents the sum of all scores for a particular indicator, n represents the total number of respondents who rated that particular measure.

The collected quantitative data were arranged, coded, and cleaned in MS excel and then imported into SPSS 27 for further analysis. Descriptive statistics such as mean, and standard error was used to analyse quantitative data. Content analysis was used to analyse qualitative data from KIIs and FGDs. The data were coded and similar patterns were categorized to cast experiences and perspectives of farmers. The categories developed were then validated by an expert review to make sure they appropriately reflected farmers' experiences and viewpoints. Content analysis was utilized to delve into particular issues, recommendations for improvement, and comprehensive input about the effectiveness of AgriTecH (Xu &Zammit, 2020).

Results and Discussion

Socio-Economic Characteristics of Respondent

Results in Table 1 show that the majority (83.3%) of the respondents were males; similarly,the majority (95.8%) of the respondents were married. Moreover, a large proportion (59.2%) of the respondents had primary education, and that about 96.7per cent of them, which is the majority, were involved in agriculture as their main occupation with about 72.5 per cent of them having more than ten years of farming experience. Furthermore, results in Table 1 revealed that apart from oil palm, the majority (91.7%) of the respondents produced maize.

Table 1: Socioeconomic characteristics of the respondents

Socioeconomic characteristics	Category	Frequency	Percent %
Sex	Female	20	16.7
	Male	100	83.3

Marital status	Single	5	4.2
	Married	115	95.8
Level of education	No formal education	2	1.7
	Primary Education	71	59.2
	Secondary education	25	20.8
	Tertiary/college education	22	18.3
Occupation	Government employee	14	11.7
	Farmer	116	96.7
	Local leader	6	5.0
	Business/trade	18	15.0
	Others (religious leader, plumber, carpenter)	4	3.3
How many years have you been engaged in agricultural activities?	Less than 3 years	10	8.3
	3 to 5 years	8	6.7
	6 to 10 years	15	12.5
	More than 10 years	87	72.5
For how long have you been growing oil palm?	Less than 3 years	82	68.3
	3 to 5 years	12	10.0
	6 to 10 years	5	4.2
	More than 10 years	21	17.5
Crops other than oil palm	Maize	110	91.7
	Tobacco	40	33.3
	Sweet potatoes	17	14.2
	Rice	64	53.3
	Others such as beans	55	45.8

Farmer's Perceived Effectiveness of AgriTecH in the Dissemination of Improved Oil palm Production Technologies

According to AgriTecH reports, various improved oil palm production technologies have been disseminated to the farmers through the AgriTecH. These include improved oil palm seedlings (Tenera), the criteria for selecting oil palm field, land preparation methods, nursery management practices, transplanting techniques, irrigation methods, pruning techniques, fertilizer application methods and pest control methods.

Access

The findings in Table 2 show that respondents perceived AgriTecHas being very accessible. In particular, the highest mean score of 4.21 ± 0.06 shows that the respondents perceived that it is easy to get in touch with AgriTecH staff and that the information from the AgriTecHis easily accessible. However, the approachability of AgriTecH staff had the lowest mean score of 4.18 ± 0.06, which is nevertheless still good. Both results show that farmers had a positive perception about effectiveness of AgriTecH services despite their variation in the mean score. During key informant interview with Ward Agricultural Field Officer, the following observation was made,

> "…*When we encounter any production challenge like crop pest it is easy to approach and contact the AgriTecH staffs for assistance; and they usually attend the reported*

cases on time…"(KII with Ward Agricultural Field Officer at Ikola Ward on July 11, 2024)

These findings, however, are in contrast with the findings in a study by Andersen (2017) who reported of famers' low access to extension services (17%) in Dodoma, Tanzania.

Table 2: Perceived Effectiveness of AgriTecH on Accessibility

Description	Mean	Std. Error
AgriTecH personnel are easily approachable	4.18	0.06
AgriTecH staff are easy to contact	4.21	0.06
AgriTecH information are easily accessible	4.21	0.06
AgriTecH have quick feedback mechanisms	4.20	0.06

The findings in Table 2 imply that the provision of friendly services tofarmers by AgriTecHand ease accessibility of AgriTecHstaff, might be contributing to the closing of the services gap and an increase of accessibility to contemporary agricultural technologies by a broader range of smallholder farmers. This has the potential of significantly increasing agricultural output, especially among smallholder farmers who may not get the same level of assistance from conventional support channels.

According to Figure 3, the majority of the respondents agreed that AgriTecH was effective in terms of accessibility particularly the rapid feedback mechanisms, information accessibility, and easy access to staff contacts. The fact that fewer respondents disagreed suggests that their perceptions were mostly positive. The disagreement about AgriTecH's accessibility, however slight, is attributed to the fact that the services are located far from the clientele as a male oil palm farmer during FGD remarks,

''…AgriTecH is very useful but what limits our regular visits to the Hub is the distance from our homes to the AgriTecH. We are requesting TARI and the government to find possibilities of bringing these services more closely to our places…'' (Male Oil palm farmer during FGD at Ikola village on July 11, 2024)

These remarks are in line with the findings from a study by Alemu (2021) who reported that famers who are relatively far from the Farmer Training Centres (FTC) are less participating in FTC based extension because it takes their time, energy and additional cost to travel there.

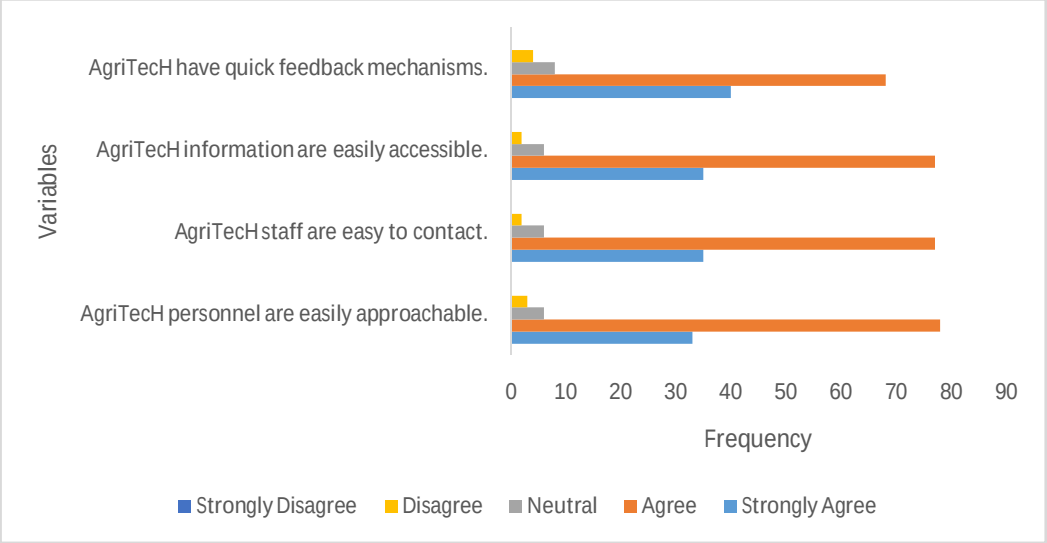

Figure 3: Distribution of respondents based on their perceived effectiveness of AgriTecH regarding accessibility

Assurance

The results in Table 3 and Figure 4 show that farmers have positive perception about AgriTecH's effectiveness in terms of assurance. AgriTecH's extension services and products, personnel knowledge, and financial resources were all scored over 4.0 by the respondents, indicating a high degree of trust in these areas. According to the findings, AgriTecH is well trusted for its dependability and capacity to satisfy farmer's needs; dependability and capacitysatisfy farmer's needsare essential elements of assurance. During FGD a female oil palm farmer was quoted saying,

> *"… AgriTecH has enough capital resources and sufficient number of staff with varied expertise who are capable of delivering the services and products at the required quality to facilitate our agricultural production activities…" (Female Oil palm farmer during FGD at Imalamakoye village on 02 July, 2024)*

Generally, the findings from this study are supported by the findings in a study by Kannur et al. (2020) who reported that more than a half (51.11%) of the respondents had morefavourable attitude followed by favourable attitude (28.89%) towards agricultural extension services provided by Agricultural Technology Information Centre of UAS, Bangalore. These findings, however are in contrast with the findings in a study by Meja and Geta (2015) who reported skills and attitudinal problems of some of the development agents in Farmer Training Centres in Damote Gale District in Ethiopia.The findings from this study have important ramifications because they emphasize how crucial assurance of service availability is to the uptake and ongoing usage of AgriTecH services (Bewong*et al.,* 2023). Farmers are more inclined to trust and depend on a service when they believe that the provider has the needed resources and knowledge (Jakku *et al.,* 2019). Because agricultural tasks are typically very important and involve high risks, the farmers' perceived confidence toAgriTecH may increase farmer's involvement and the possibility of integrating recommended practices into regular routines. Moreover, better results in terms of agricultural production and sustainability might result in positive perception regarding the assurance of AgriTecH services.

Table 3: Perceived effectiveness of AgriTecH regarding assurance

Description	Mean	Std. Error
Extension services and products are highly useful to farmers	4.15	0.04
AgriTecH has enough capital resources	4.06	0.06
AgriTecH staff have the necessary expertise	4.06	0.06

The study by Antwi-Agyei and Stringer (2021) pointed out that smallholder farmers perceive extension services and products as useful when efficiently fulfil their requirements especially when providing them with workable solutions that improve their operations. As reported by Davis et al. (2019), robust financial resources might guarantee the ongoing development and enhancement of these extension services, which increase customer trust even further. Another important consideration is the expertise of the AgriTecH workforce. According to Dunne et al. (2019), professionals with good expertise and experience are better able to provide insightful counsel and assistance, which helps farmers feel more assured.This was supported by remarks by AgriTecH supervisor during the Key Informant Interview when he said,

> *"…The AgriTecH has the sufficient number of qualified and experienced scientists in various specialization for effective operation…" (KII with Supervisor at FatumaMwasaAgriTecH on July 30, 2024).*

Research has repeatedly shown that people are more inclined to accept and utilize technology frequently when they believe in the assurance of the service provider (Brown *et al.,* 2018; Kassem *et al.,* 2021; Taylor and Bhasme, 2018).

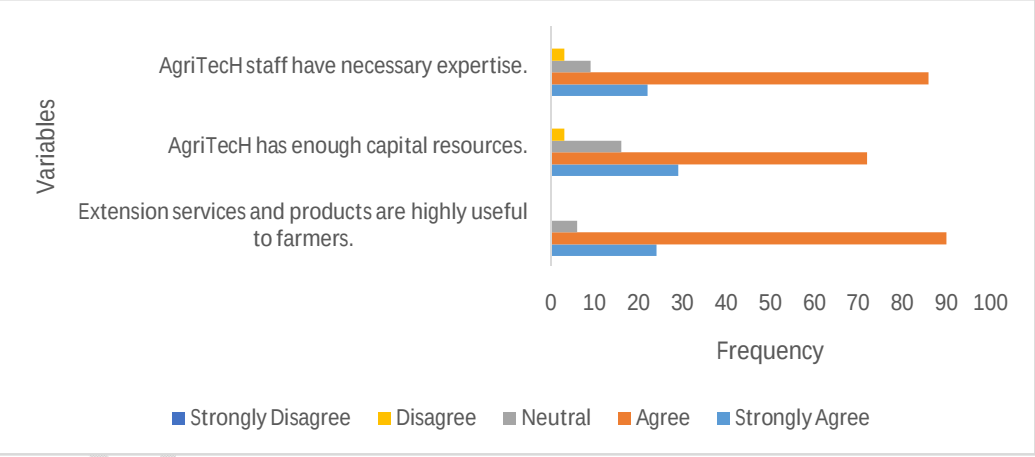

Figure 4: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding assurance

Empathy

In this study, respondents rated high the regular interactions and localized solutions provided by AgriTecH. The findings in Table 4 show that the perceived effectiveness of AgriTecH regarding empathy was high with a mean score of 4.15 ± 0.06. This issomehow higher given the fact that AgriTecH provides localized solutions than the 4.09 ± 0.06 for regular interaction offered. The high mean scores indicate that farmers place high importance on regular

interaction and solution customization which are the two essential components of empathy in service delivery (Bahadur *et al.,* 2018). The findings from this study are in line with the findings in a study by Wonde et al. (2022) who reported that close supervision, special attention and follow-up of the programme by experts in Farmers Training Centres motivated trainees into seriously attending training programmes and develop the necessary technical skills required for modern wheat and maize production, which further lead them to an increase in the yield and in annual net income.

Table 4: Farmers perceived effectiveness of AgriTecH regarding empathy

Description	Mean	Std. Error
AgriTecH offers regular interaction	4.09	0.06
AgriTecH provides localized solutions	4.15	0.06

Through individualized care and targeted local solutions, AgriTecH probably makes its services more relevant and efficient (Duncan *et al.,* 2021). Farmers may therefore accept AgriTecH solutions at a faster rate as a result of feeling more supported and understood in their particular circumstances. Offering customized solutions shows that Fatma MwasaAgriTecH is cognizant of the many agricultural contexts in which farmers work, reaffirming the AgriTecH's dedication to tackling specific problems. According to the findings in Figure 5, most respondents perceive AgriTecH as compassionate in general, especially when it comes to offering solutions that are localized and personalized for specific local circumstances. These findings emphasize how crucial empathy is for successful dissemination and adoption of agricultural technology. This is because understanding farmers' particular demands and issues requires empathy which increases the applicability and adoption of technical solutions. Providers of agricultural technology that exhibit empathy are more likely to interact personally with farmers, which enables the latter to customize solutions that take into account particular regional circumstances and customs (Kaimowitz et al., 2019).

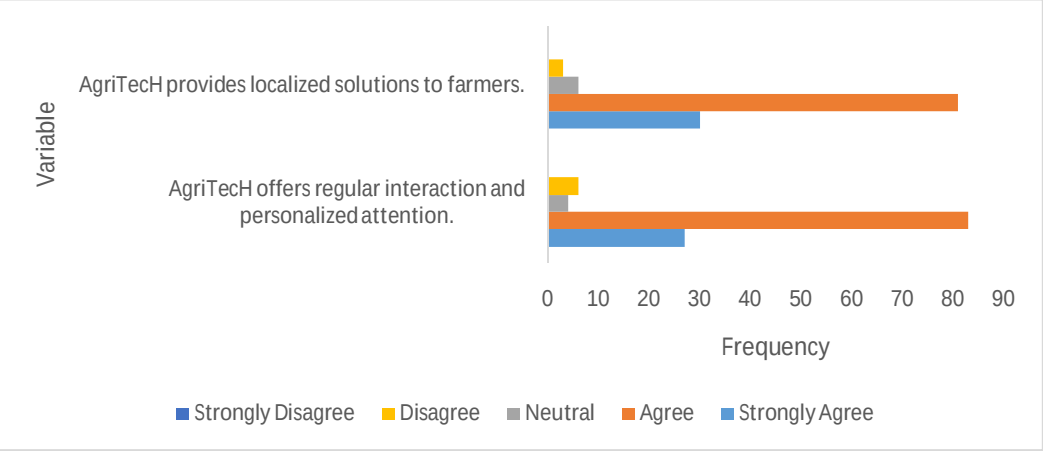

Figure 5: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding empathy

Reliability

The results in Table 5 illustrate how reliability about AgriTecH is perceived by farmers, with mean ratings of over 4.0 for a number of factors including cost-effectiveness, accuracy of

information, quality of services, and dependability of extension services. In particular, the correctness of AgriTecH's information and the dependability of its extension services had mean ratings of 4.16 ± 0.04 and 4.13 ± 0.04, respectively. These high ratings show that respondents see AgriTecH as very dependable overall, especially when it comes to providing correct information and consistently high-quality services. This finding aligns well with the finding in a study by Sajesh and Padaria (2019) who reported the highest score in reliability dimension for Farm Science Centre called Krishi Vigyan Kendra (KVK) in Akola, India. Despite their positive perception toward this indicator, one male oil palm farmer during FGD provided a different observation regarding the availability and the cost of the improved oil palm planting material. He reported,

> *"… The improved oil palm planting materials are not adequately available; they are sold at high cost due to increased demand. To ensure sufficient availability of improved oil palm planting materials, the government should increase support to TARI Tumbi and TARI Kihinga as the major sources of improved oil palm planting material (tenera) in Western zone as well as support and capacitate other public and private organizations which will be ready to engage inoil palm seedlings development. Also, to encourage more farmers to adopt improved planting materials they should be subsidized or sold at a relative lower prices so as farmers can afford …" (Male Oil palm farmer during FGD at Ifucha Village on July 30, 2024).*

Table 4: Farmers perceived effectiveness of AgriTecH regarding reliability

Description	Mean ± SE	Std. Error
Extension services and products provided by AgriTecH are reliable	4.13	0.04
AgriTecH provides cost-effective services and products	4.13	0.05
Extension services and products provided by AgriTecH are of high quality	4.08	0.04
AgriTecH provides accurate information	4.16	0.04

The results in Figure 6 show that most respondents agreed with every item indicating AgriTecH's reliability. Furthermore, the results suggest that extension service provider's long-term viability and sustainability depend heavily on its reliability. Being seen as trustworthy by farmers indicates that they value the services and knowledge AgriTecH offers, which is crucial for attracting repeat farmers and promoting the ongoing use of AgriTecH products. Indeed, astudy by Kieti*et al.* (2021) found that the provision of services through any channel is affected by reliability and trust. Reliable services guarantee that farmers can rely on AgriTecH to assist their farming operations, which improve results and enhance AgriTecH's image.

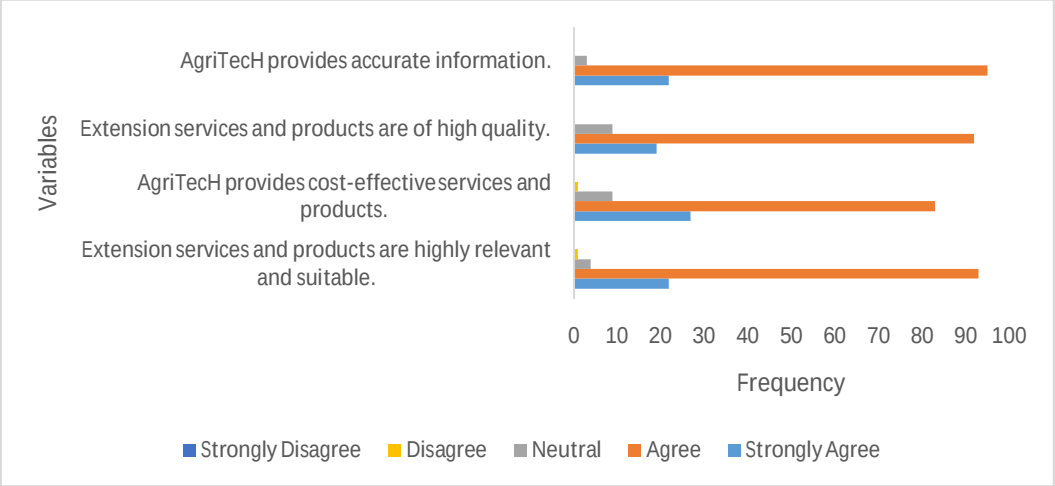

Figure 6: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding reliability

The sense of reliability is probably much influenced by the regular provision of excellent services (Van Lierop *et al.,* 2018). When farmers consistently use AgriTecH's services and obtain great outcomes, they are more inclined to perceive AgriTecH's services positively (Fox *et al.,* 2021). Furthermore, it is critical to provide correct information since false or misleading information may damage credibility and have a detrimental effect on agricultural operations (Visser *et al.,* 2021). AgriTecH's dedication to the precision and excellence probably plays a part in the positive impression of reliability.

Responsiveness

Farmers' opinions regarding responsiveness on AgriTecH's effectiveness are shown in Table 6. The respondents' overall perception about AgriTecH staff is good, as seen by high mean ratings (4.17 ± 0.05), which imply a very supportive and service-minded attitude. Furthermore, as shown by somewhat higher mean score (4.19 ± 0.06), farmers equally recognize AgriTecH's proven care of their well-being. The excellent response ratings might be attributed to the customized manner in which AgriTecH employees engage with farmers. Farmers feel appreciated and understood in this setting, which is probably more engaging and encouraging (Kassem *et al.,* 2021).A similar observation is made by Tefera et al (2011) who reported that responsiveness to farmer's interest, which was demonstrated by the majority (62%) of Development Agents in Farmer Training Centres in Ethiopia called for a need for additional training to improve effectiveness of such agents in the delivery of extension services. This might be attributed to their service-minded behaviour and concern about farmer's well-being.These findings are in contrast with findings in a study by Meja and Geta (2015) in Ethiopiawho reported poor concern of Farmer Training Centre to Farmers' wellbeing due to the longer duration of classroom session as opposed to practical and training sessions during summer season with noconsideration of farmers' working times.

Table 5: Farmers perceived effectiveness of AgriTecH regarding responsiveness

Description	Mean	Std. Error
AgriTecH personnel are highly service-minded and supportive	4.17	0.05
AgriTecH demonstrates concern for farmers' well-being	4.19	0.06

The data in Figure 7 demonstrate that most respondents believed that AgriTecH was beneficial in improving responsiveness in all of the statements. These results imply that AgriTecH has been effective in creating a service culture that meets the expectations of farmers, that is likely to increase mutual trust and collaboration. These observed positive perceptions regarding responsiveness indicated in Table 6 have important ramifications for future development of AgriTecH. Sustaining and enhancing responsiveness is attributed to increased farmers satisfaction (Kassem *et al.,* 2021), which is essential for AgriTecH solutions to be adopted over time.

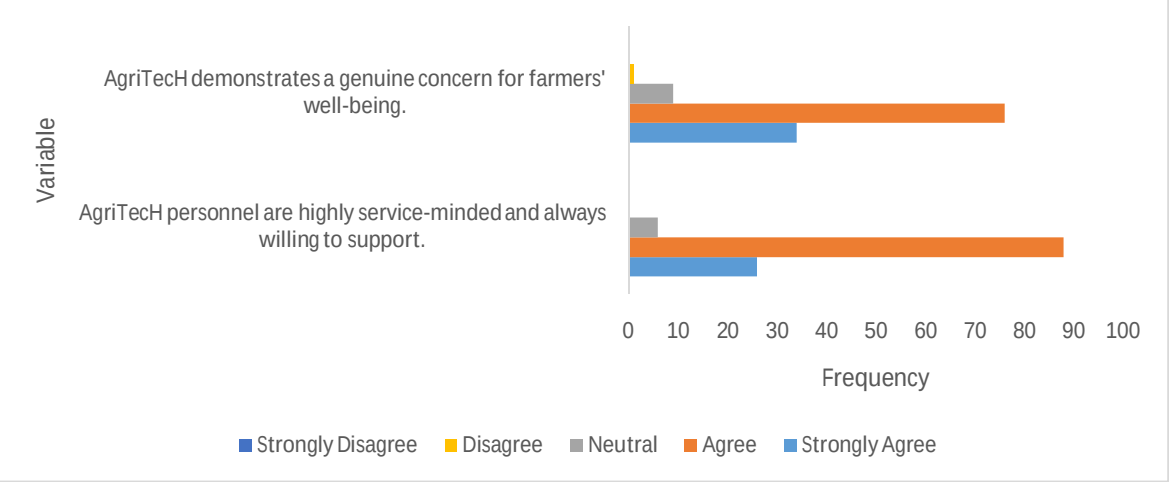

Figure 7: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding responsiveness

Tangibility

Results in Table 7 present farmers' perceptions regarding AgriTecH's effectiveness on tangibility indicator, with particular reference to the actual facilities and resources. The average ratings, which vary from 3.70 ± 0.05 to 4.20 ± 0.06, show that farmers perceive AgriTecH as generally effective in terms of availability and preservation of the physical infrastructures required for operations. The fact that, maintenance of materials and facilities received the highest score indicates that farmers place a high value to AgriTecHin terms of preservation and repair of their available resources. Figure 8 further emphasizes this observation by demonstrating that most respondents agreed with all AgriTecH tangibility assertion. Farmers' positive perception aboutAgriTecH'sdemonstrablephysical facilities and communication materials can be credited to the organisation's strategic investment in infrastructure.

Even though tangibility was shown to be generally good, it is crucial to take into account the lower mean score of 3.70 ± 0.05 and 3.98± 0.05 in communication materials and required physical facilities respectively. These lower rankingson the two aspects indicate that while physical facilities are kept up well, there should be some improvement to increasing AgriTecH effectiveness in communication materials and the required physical facilities.The findings of the current study align with the findings in a study by Sajesh and Padaria (2019) who reported the highest score in tangibility dimension for Farm Science Centre called Krishi

Vigyan Kendra (KVK) in Akola, India. The highest score of AgriTecH in tangibility dimension shows that farmers are satisfied with the available physical facilities and communication materials and how these facilities are maintained. These findings however, are incontrast with the findings in a study by Meja and Geta (2015) who reported unavailability of some physical facilities including living houses for development agents, electricity, television, appropriate teaching materials, metrology,workshopand field equipmentin the Farmer's Training Centres in Damote Gale District in Ethiopia.The remark given by AgriTecH Supervisor during the key informant interview revealed the following,

> *"…Despite that the AgriTecH has important physical facilities and training materials for continuing with its operations, some of the physical facilities are not available including living houses for resident supervisor, storage facilities, shop, fencing as well as officespace and their facilities.We also have insufficient water supply for irrigation especially during dry seasonbecause AgriTecH operates throughout the year as well as insufficient communication materials including printed materials such as posters, leaflets, booklets, brochures, banners for communicating improved technologies and audio-visual aids such as Public Address System, LCD projectors, Video camera, Laptops, printers, photocopy machine for preparing and disseminating improved technologies...." (KII with Supervisor at FatumaMwasaAgriTecH on July 30, 2024)*

On the other hand, during the FGD one female oil palm farmer had this to say,

> *"…There is a limited availability of the communication materials in the AgriTecH especially leaflets containing information about improved oil palm production technologies. Leaflets are good at reminding learners of what has been learnt after getting back to their homes" (Female Oil palm farmer during FGD at Usinge Village on July 3, 2024).*

Table 6: Farmers perceived effectiveness of AgriTecH regarding tangibility

Description	Mean ± SE	Std. Error
AgriTecH has all the required physical facilities for effective operations	3.98	0.05
AgriTecH uses good communication materials	3.70	0.05
AgriTecH facilities and materials are well maintained	4.20	0.06

The findings have two major implications for the AgriTecH. Firstly, keeping physical infrastructure updated is crucial to preserving farmers' confidence and contentment. Secondly, there is an opportunity to improve effectiveness and calibre of physical and communication materials, making sure that farmers can easily access and comprehend them in addition to being instructive.

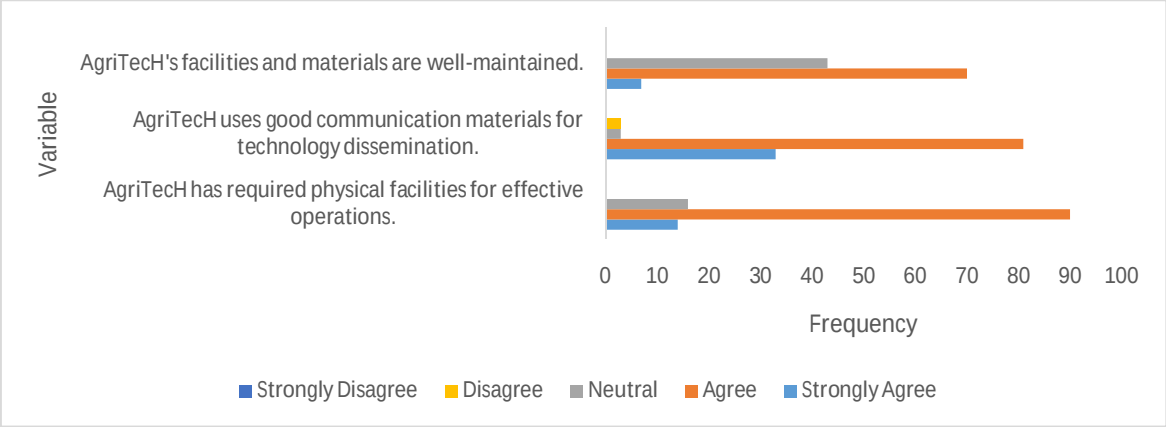

Figure 8: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding tangibility

Timeliness

The findings in Table 8 present farmers' assessments of AgriTecH's timeliness, with particular emphasis on the promptness and consistency of the response. The average ratings, which vary from 4.02 ± 0.07 to 4.18 ± 0.05, show that farmer's perceptions were positive. AgriTecH's capacity to provide replies within the specified period received the highest rating. This shows that AgriTecH can generally be relied upon to fulfil its promises to farmers on schedule. Moreover, results in Figure 9 show that every farmer agreed with every statement about how quickly AgriTecH delivers its services. This effectiveness probably boosts farmers' general contentment and motivates them to keep using AgriTecH services. These findingsare in line with findings in a study by Agholor et al. (2013) who reported that a good percentage of women (18.14%) were satisfied with timeliness of the delivery of extension services as compared to (14%) of men. As commented by Mabofu and Elia(2017), access to timely and reliable agricultural information has the potential of improving agricultural production. Furthermore Elia (2014) and Gue'ye (2010) revealed that the provision of timely agricultural research information to stakeholders is important in influencing agricultural development.

Table 7: Farmers perceived effectiveness of AgriTecH regarding timeliness

Description	Mean	Std. Error
AgriTecH provides consistent response within promised timeframe	4.18	0.05
AgriTecH provides timely responses to farmers' inquiries	4.02	0.07

However, despite the higher scores, there is still potential for improvement, especially in terms of guaranteeing timely response to farmer's inquiries. The findings in Table 8 emphasize the need for consistency in the provision of agricultural services. For AgriTecH to continue serving farmers with confidence and pleasure, it is imperative that all contacts be completed in the timeframes that have been promised. Furthermore, by recognizing and

resolving any delays, AgriTecH's services further increase efficacy by improving the general sense of timeliness.

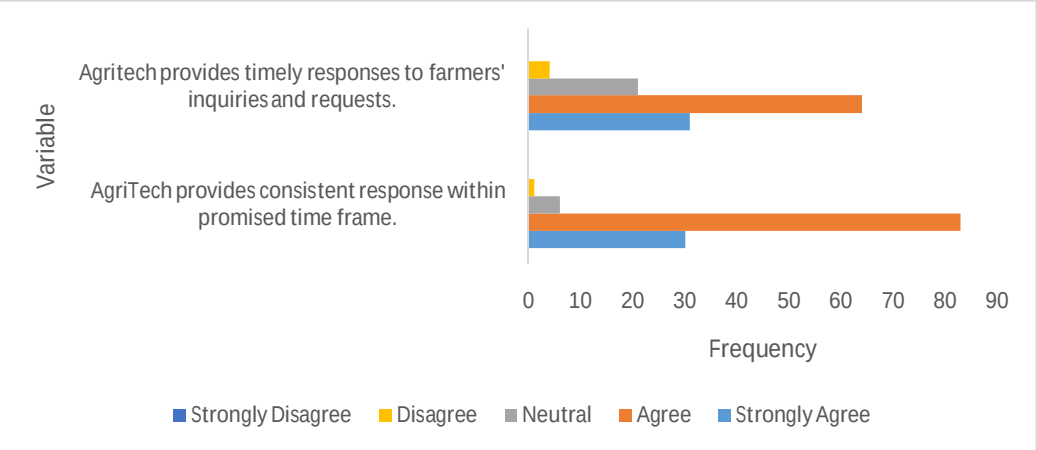

Figure 9: Distribution of the respondents based on their perceived effectiveness of AgriTecH regarding timeliness

Overall perceived effectiveness

The study findings in Table 9 show that AgriTecH was perceived well by all measures, with the mean score ranging from 3.96 ± 0.04 to 4.20 ± 0.05. Access to AgriTecH scored higher mean score (4.20 ± 0.05), while tangibility indicator scored low mean score (3.96 3.96 ± 0.04). This implies that farmers have perceived positively the effectiveness of AgriTecH's in disseminating improved oil palm production technologies. Somewhat lower score on tangibility suggests that the provision of services in some areas should be enhanced. This includes but not limited to increasing infrastructure spending or providing greater upkeep for the already-existing infrastructures. The findings confirm the SERVQUAL model of the theoretical framework, which holds that indicators such as access, assurance, reliability, empathy, responsiveness, tangibility, and timeliness are essential for the total service quality and overall effectiveness. This is reflected in high ratings in almost all the indicators under investigation. The observation regarding tangibility emphasizes the necessity for the ongoing enhancements of the tangible components of service delivery in order to sustain farmer's satisfaction over time. The lower score for tangibility within the context of SERVQUAL model underscores the need for continuous improvement of the physical aspects of service delivery, such as investing in infrastructure and maintaining the existing ones.

Table 8: Overall farmers perceived effectiveness of AgriTecH

Indicator	Mean	Std. Error
Access	4.20	0.05
Assurance	4.09	0.04
Empathy	4.12	0.05
Reliability	4.13	0.03
Responsiveness	4.12	0.04
Tangibility	3.96	0.04
Timeliness	4.10	0.05
Overall	4.11	0.03

Conclusion and recommendations

Overall, the article shows that farmers' perceived effectiveness about AgriTecH in the dissemination of improved oil palm production technologies was good across all measures such as access, assurance, empathy, reliability, responsiveness, timeliness and tangibility. However, tangibility indicator has the low mean score as compared to other indicators. Although it is good because of being above the cut-off point, it implies that there is a need of improving tangibility component to raise farmers' perception about AgriTecH's effectiveness. The improvement in tangibility aspect can be done by renovating the available physical infrastructures such as training room and constructing unavailable physical infrastructures including house for resident supervisor, shop for products, fencing, storage facilities as well as offices.This will improve the working and learning environment for both AgriTecH staffs and farmers respectively. Furthermore, there should be improvement in water supply system for irrigation and the availability of communication resources both printed materials and audio-visual aids that can be utilized to disseminate improved agricultural technologies to farmers, extension staffs and other stakeholders. Additionally, there is a need of ensuring that these physical resources are not only well cared for but also meet the changing demands of farmers to improve the overall efficacy of the services provided by the AgriTecH.

References

Agholor, I.A., Monde, N., Obi, A &Akinwumi, O (2013): Quality of Extension Services: A Case Study of Farmers in Amathole

Alemu, A (2021). Determinants of Participation in Farmers Training Centre Based Extension Training in Ethiopia

Andersen, J.R. (2017). Access to and benefit of agricultural extension in Tanzania a study from the Dodoma Region, Tanzania. Doctoral dissertation, University of Copenhagen.

Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from north-eastern Ghana. Climate Risk Management, 32, 100304.

Bahadur, W., Aziz, S., & Zulfiqar, S. (2018). Effect of employee empathy on customer satisfaction and loyalty during employee–customer interactions: The mediating role of customer affective commitment and perceived service quality. *Cogent Business & Management* 5(1): 1491780.

Bewong, M., Ho Leung Ip, R., Lewis, C., Krivokapic-Skoko, B., Islam, Z., Al-Saggaf, Y., Medway, J., Ali, B., & Dixon, E. (2023). *Potential implications and benefits for the agricultural technology sector from the introduction of the Australian Agricultural Data Exchange*. Food Agility CRC, Sydney, NSW Australia.

Brown, B., Nuberg, I., & Llewellyn, R. (2018). Constraints to the Utilisation of conservation agriculture in Africa as perceived by agricultural extension service providers. *Land Use Policy* 73: 331-340.

Camacho-Villa, T. C., Almekinders, C., Hellin, J., Martinez-Cruz, T. E., Rendon-Medel, R., Guevara-Hernández, F.., Beuchelt, T. D., & Bram, G. (2016). The evolution of the

MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context. *The Journal of Agricultural Education and Extension* 22(5): 455-470.

Dar, M. A., Alam, S., Kaur, J., Ram, D., Islam, S. &Tantray, A. M. (2014). *Farmers' Perception*. Agricultural Technology Information Centre

Davis, K., Swanson, B., &Amudavi, D. (2019). Review and recommendations for strengthening the agricultural extension system in Ethiopia. Gates Open Res, 3(1164), 1164.

Duncan, E., Glaros, A., Ross, D. Z., & Nost, E. (2021). New but for whom? Discourses of innovation in precision agriculture. *Agriculture and Human Values* 38: 1181-1199.

Dunne, A., Markey, A., & Kinsella, J. (2019). Examining the reach of public and private agricultural advisory services and farmers' perceptions of their quality: the case of county Laois in Ireland. *The Journal of Agricultural Education and Extension* 25(5): 401-414.

Dutta, C., Borah, D., & Das, P (2021). Farmers' Level of Satisfaction on Agricultural Technology Information Centre of AAU, Jorhat, Assam.

Elia, E. F. (2014). *Information dissemination for adaption to change and variability in the Agriculture sector: The case of Maluga and Chibelela villages in central Tanzania.* KwaZulu Natal, South Africa, PhD Thesis Unpublished, University of KwaZulu Natal.

Eshetu, G. (2018). The Impacts of Farmers Training Centres in Enhancing the Livelihoods of Rural Farmers; the Case of Kutcha Wereda, SNNPR Regional States: A Thesis Submitted to the College of Education and Behavioural Studies Department of Curriculum and Instruction in Partial Fulfilments of the Requirements for the Degree of Master of Arts in Adult Education and Community Develop, Addis Ababa University.

Fox, G., Mooney, J., Rosati, P., & Lynn, T. (2021). AgriTech innovators: A study of initial adoption and continued use of a mobile digital platform by family-operated farming enterprises. *Agriculture* 11(12): 1283.

Gbawoquiya, P. D. (2017). Effectiveness of farmer field schools in improving agricultural productivity in Tanzania: A case study of smallholder rice farmers in Mvomero district, Morogoro region. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 125pp.

Guèye, E.F. (2010). Family poultry research and development in low-income food-deficit countries: Approaches and prospects. *Outlook on Agriculture* (31), 13- 21.

Iddi, H., Nyamba, S., &Busindeli, I. (2023). Accessibility of improved chicken farming business information to women improved chicken farmers through mobile phones in Misungwi District, Tanzania. *European Journal of Agriculture and Food Sciences* 16: (2): 1-7.

Innovations and agricultural extension.

Jakku, E., Taylor, B., Fleming, A., Mason, C., Fielke, S., Sounness, C., & Thorburn, P. (2019). "If they don't tell us what they do with it, why would we trust them?" Trust, transparency and benefit-sharing in Smart Farming. NJAS-Wageningen *Journal of Life Sciences* 90: 100-285.

Kaimowitz, D., Snyder, M., & Engel, P. (2019). A conceptual framework for studying the links between agricultural research and technology transfer in developing countries. In Making the Link (pp. 227-269). CRC Press.

Kassem, H. S., Alotai bi, B. A., Muddassir, M., &Herab, A. (2021). Factors influencing farmers' satisfaction with the quality of agricultural extension services. *Evaluation and Program Planning* 85: 101912.

Kannur C., Nagaraj K.H &Ganesamoorthi S (2020). Attitude of Farmers towards Agricultural Technology Information Centre of UAS, Bangalore.

Khan, S., Rahman, M.H & Uddin, M.N. (2017).Effectiveness of Agricultural Information and Communication Centre in Technology Transfer to the Farmers in Bangladesh.

Kieti, J., Waema, T. M., Ndemo, E. B., Omwansa, T. K., & Baumüller, H. (2021). Sources of value creation in aggregator platforms for digital services in agriculture-insights from likely users in Kenya. *Digital Business* 1(2):100007.

Kilelu, C. W., Laurens, K., & Cees, L., (2016). *Supporting Smallholder Commercialisation by Enhancing Integrated Coordination in Agrifood Value Chains*: Experiences with Dairy Hubs in Kenya. Experimental Agriculture. 19pp.

Kumar, V., & Singh, B. (2007). Impact of the agricultural technology information centre of central marine fisheries research Institute: success cases. *Indian Journal of Extension Education* 43(12):16-19.

Kumar, A., Shehrawat, P.S, Malik, A, Rajesh Kumar, R., Yadav, K.K, Singh,S& Kumar, R (2020) . Awareness and Satisfaction Level of Cotton Growers Caller about ATIC Toll Free Number.

Li, J., Cees, L., Nico, H., &Weifeng, Z. (2022). The Science and Technology Backyard as a Local Level Innovation Intermediary in Rural China.

Li, J. (2010). Sino-Africa Agricultural Cooperation Experience Sharing, Foreign Economic Cooperation Centre, Ministry of Agriculture of the People's Republic of China. In: Proceedings of the Agriculture, Food Safety and Rural Development for Growth and Poverty Reduction.

Listman, M. (2023).The Mexican government-supported research-for-rural development initiative MasAgro has raised maize and wheat yields and farm profitability while mitigating farmers' risk and agriculture's ecological and climate impacts. [https://www.cimmyt.org] site visited on 29/10/2023

Mabofu,C and Elia, E (2017). Disseminating Agricultural Research Information: A case study of farmers in Mlolo, Lupalama and Wenda villages in Iringa district, Tanzania

Masanja, I., Shausi, G. L., &Kalungwizi, V. J. (2023). Factors influencing rural farmers' access to agricultural extension services provided by private organizations in Kibondo District, Tanzania. *European Journal of Agriculture and Food Sciences* 5(5): 115-122.

Meja, F.M and Geta, E (2015).Analysing Farmers' Training Centres through Integrated Innovative Capacity Building and Technologies Transfer. A Case Study of Damote Gale District Woliata Zone Ethiopia.

Mekuria, W (2014). Effectiveness of Modular Training at Farmers' Training Centre: Evidence from Fogera District, South Gondar Zone, Ethiopia

Mgendi, G. & Cheng, X. (2019). A Review of Agricultural Technology Transfer in Africa: Lessons from Japan and China case projects in Tanzania and Kenya. *Sustainability* 2019: 1 – 11.

Mukherjee, A., Bahal, R., Burman, R., Dubey. S. K. & Jha, G. K. (2011). Effectiveness of Tata Kisan Sansar in Technology Advisory and Delivery Services in Uttar Pradesh.

Narayana, C, Abdurahman, M & Suresh, P (2015). Impact of Training of Farmers Training Centres on Farmer's Productivity: The case of Dire Teyara and Sofi Woredas of Harari Region-Ethiopia. International Journal of Agriculture Innovations and Research 3:2319-1473.

Nalwimba N, Qi. G and Mudimu. G. T. (2019). ATDC and Peasant Empowerment in Zambia: The Reality, Narrative, and Discourse

NjineM.W (2014).The Role of Agriculture Training Centres in Promoting Sustainable Rural Development in Kenya

Ombati J.M, Nyamwamu R. O, & Mwangi J.G (2014). Effectiveness of Agricultural Training Centres' Curriculum in Promoting Adoption of Agricultural Technologies: Evidence from Small-scale Potato Farmers in Nyandarua County, Kenya.

Omer, S.A, Tefera T.L & Kenee F, B (2021). Relevance and Effectiveness of Farmer Training Centres (FTCs) Based Training in Gurewa District, East Hararghe Zone, Oromia Regional State, Ethiopia

Pandey, M &Solanki,D. (2012). Utilization of Agricultural Technology Information Centre (ATIC) Facilities by Farm Families in Udham Singh Nagar District (Uttarakhand)

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing* 49: 41-50.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing* 64(1): 12-40.

Rana, A. S., Reddy G. P., &Sontakki, B. S., (2013). Perceived service quality of agricultural organizations comparative analysis of public and private sector. *International Journal of Advanced Research in Management and Social Sciences*.

Rutasitara, L. &Selejio, O. (2008). Export of Fresh Fruits and Vegetables and Stakes of Small holder Farmers in Tanzania: Policy and Research Issues. *Utafiti Journal* 8(1).

Sajesh, V. K., &Padaria, R. N. (2019). Effectiveness of extension agencies: A Case of Cotton Farmers in Akola District of Maharashtra, India. *Indian Journal of Extension Education* 55(3): 43-48.

Sankanagoudar, S &Nagnur, S. (2015). Impact of agricultural technology information centre (ATIC) on the farming community in Dharwad, Karnataka

Schut, M., Laurens, K., Murat, S., Dieuwke, L., Mariette, M. C., Ifeyinwa, O., Pawandeep, K., Atta-Krah, K., & Cees, L. (2015). *Innovation Platforms: Experiences with their.* Institutional Embedding in Agricultural Research for Development, 25pp.

Setu, S.B, Ali, S. & Kabir, M. H. (2022). Effectiveness of Agricultural Information and Communication Centre for Disseminating Agricultural Information

Sherka, T.D., (2021). Impact of Farmers Training Centres Based Training on Major Crops Productivity and Households Welfare: the case of Gurage Zone, Central Ethiopia.

Singh, D & Kalra, R.K. (2019). Level of Satisfaction of Farmers from the Services Provided by Agricultural Technology and Information Centre (ATIC) Run by Punjab Agricultural University

Singh, K. M., Meena, M. S., & Swanson, B. E. (2013). Role of State Agricultural Universities and Directorates of Extension Education in Agricultural Extension in India. [https://mpra.ub.uni-muenchen.de /49108/1/MPRA_paper_49108.pdf] site visited on 10/10/2023.

TARI (2020). Proposal for Establishment of Agriculture Technology Transfer Hubs (AgriTecH).

TARI (2021). Report on the Official Launch of the FatumaMwasa Agricultural Technology Transfer Hub in Western zone.

Taylor, M., &Bhasme, S. (2018). Model farmers, extension networks and the politics of agricultural knowledge transfer. *Journal of Rural Studies* 64, 1-10.

Tefera, T.L, Sehai, E. and Hoekstra, D. (2011). Status and Capacity of Farmer Training Centers (FTCs) in the Improving Productivity and Market Success (IPMS) Pilot Learning Woredas (PLWs)

Van Lierop, D., Badami, M. G., & El-Geneidy, A. M. (2018). What influences satisfaction and loyalty in public transport? A review of the literature. *Transport Reviews* 38(1): 52-72.

Visser, O., Sippel, S. R., & Thiemann, L. (2021). Imprecision farming? Examining the (in) accuracy and risks of digital agriculture. *Journal of Rural Studies* 86: 623-632.

Wanjohi, A. M., &Syokau, P. (2021). How to conduct Likert scale analysis. Kenya Projects Organization. https://www.kenpro.org/how-to-conduct-likert-scale-analysis/

Wonde K. M, Tsehay A.S & Lemma S.E. (2022). Training at farmers training centres and its impact on crop productivity and households' income in Ethiopia: A propensity score matching (PSM) analysis.

Wordofa, M.G, & Sassi, M. (2017).Impact of Farmers' Training Centres on Household Income: Evidence from Propensity Score Matching in Eastern Ethiopia.

Worku, B.T. (2010). Effectiveness of Modular Training at Farmers Training Centres: The Case of Miíeso Woreda, Oromia Region, Ethiopia. MSc. Thesis

Xu, W., & Zammit, K. (2020). Applying thematic analysis to education: A hybrid approach to interpreting data in practitioner research. *International journal of qualitative methods* 19: 1609406920918810.