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Building appropriate strategy for improving the capabilities of agricultural extension services in Indonesia

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Abstract

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Agricultural extension plays a crucial role in providing technical assistance and advisory services to farmers, which directly affects their productivity and livelihoods. This study aimed to analyze the factors affecting agricultural extension performance in South Kotabumi and Abung Semuli. The study utilized a mixed-methods approach, including a survey questionnaire, interviews, and data analysis techniques, such as the Spearman correlation, IFAS, EFAS, and QSPM analyses. Our findings revealed that education, motivation, competencies, and social factors significantly influence the performance of agricultural extension agents. On the other hand, age, work experience, extension agent's household, covering area, availability of infrastructure, economy, and environment had no significant correlation with their performance. Furthermore, the IFAS and EFAS analyses identified several internal weaknesses and external threats that may hinder the performance of extension agents, such as the effects of climate change and complicated administration problems. To address the identified weaknesses and threats, the QSPM analysis suggested that the WT strategy, which aims to improve weaknesses by utilizing external opportunities, was the most appropriate strategy. This study's findings provide valuable insights for policymakers, stakeholders, and practitioners to improve the performance of agricultural extension agents and, ultimately, enhance the agricultural sector's productivity and sustainability.

Keywords: Agricultural Extension; Spearman; SWOT; QSPM; Climate Change

Introduction

Increasing world population up to 9.1 billion in the 2050s will require double food demand compared to the current situation, which can threaten national food security when production cannot fulfill the demand (Tomlinson, 2013). Moreover, climate and land use changes will disrupt agricultural production due to crop growth and yield correlating highly with them. This situation can be solved by increasing agricultural land area or escalating the productivity of the current agricultural farm using suitable technologies for increasing food production (Ansari et al., 2021). Nowadays, the rapid development of 4.0 technologies, it influenced the development of agricultural sector, referred to as agriculture 4.0, that started to use emergent technologies such as big data, internet of Things (IoT), robotics, remote sensing, artificial intelligence, sensors, machine learning, blockchain and others (Rose et al., 2021). Those technologies are being presented as solutions to increase food production, reduce agricultural input, and achieve food security through handily plan, control, and analyze of the farm using data-rich services and applications (Fielke et al., 2020; Rose et al., 2021), compared to traditional agriculture that uses combination among past data, experience and fewer technologies (Charatsari et al., 2020; Wolfert et al., 2017).

In response, agricultural extension services worldwide are responsible for promoting the use of Agriculture 4.0 to smallholder farmers. In such a context, a farm advisor has the responsibilities to transfer knowledge and maintain the environment and smallholder farmer society (Charatsari et al., 2022). They become source of information in developing countries for the most smallholder farmers in rural areas with limited access to literacy and indigent connection to Information and Communication Technology (ICT) (Anderson & Feder, 2004; Maake & Antwi, 2022). Farmers in rural areas can quickly get information regarding cropping schedules, the availability of fertilizers, climate predictions, market value of the crop, and crop management practices for various crops (Charatsari et al., 2022; Maake & Antwi, 2022). The agricultural extensions lead the farmers to manage their farms from preparation until harvesting and maximize the ability of farmers using local resources (Nataliningsih et al., 2020). Besides as managers, they are positioned as facilitators, motivators, and educators for farmers to execute agricultural development programs (Klerkx, 2022; Klerkx et al., 2019). Therefore, the existence and participation of agricultural extension services are important to successfully introduce Agriculture 4.0 for smallholder farmers, especially in developing countries with limited access to current technologies.

The ability to conceive and transfer new knowledge of technologies becomes a fundamental skill that needs to behave by the farm advisor since their role as a bridge, connecting researchers and farmers (Maake & Antwi, 2022). However, the transition to Agriculture 4.0, which emphasizes data-driven rather than processes-driven, will alter workmotifs, professionalism, and ethics because it radically transforms from physical-farming systems into cyber-social systems, likely establishing a new socio-technical role in their organizations (Charatsari et al., 2022; Klerkx et al., 2019). On the other hand, their performance as a bridge was also affected by several factors, such as education level, technical and managerial competency, job satisfaction, age, financial, socio-economic culture, physical and mental health (Charatsari et al., 2022; Klerkx, 2022; Nataliningsih et al., 2020). Hence, it arises several farmers' perceptions about their performance due to less communication among them, excluding the farmers in the agricultural development program, misunderstanding about the purpose of extension, and inappropriate persons who get physical and economic beneficiary. Therefore, there may be a knowledge gap between the researcher or government and farmers due to the misperformance of agricultural extension advisory in terms of knowledge delivery. Nevertheless, active participation of farmers also influenced the performance of advisors in building two-way communication.

As one the most significant contributor of growth domestic product (GDP) in Indonesia, agricultural sector plays an essential role in national economic growth through poverty alleviation, income and employment in rural areas, preservation of natural resources and the environment, as well as national food security. Agricultural extension advisory becomes the government's spearhead in terms of succeeding national agricultural programs (Rusliyadi et al., 2018). Nevertheless, the role of agricultural extension advisory needs to be improved regarding technical and managerial competency along with the development of technologies (Nataliningsih et al., 2020; Rosnita et al., 2017; Rusliyadi et al., 2018; Sabir et al., 2019; Walangadi et al., 2021). Electing appropriate strategies to improve the capabilities of agricultural extension services based on factors that influence their performances are needed to smoothly launch the introduction of agriculture 4.0 in Indonesia. Therefore, the aims of this study are to identify the factors related to the performance of agricultural extension agents and to develop appropriate alternative strategies using SWOT-QSPM method for increasing agricultural extension agents performance, which further can establish sustainable agriculture toward Agriculture 4.0 easily.

Methodology

Study Area

This study is carried out in South Kotabumi and Abung Semuli Districts, North Lampung Regency, Lampung Province, Indonesia, which is geographically located in 4º20′24″ – 5º3′46″ S and 104º18′ – 105º4′47.99″ E (Figure 1). North Lampung Regency consists of 23 districts and 247 villages with a total area of 272 .563 ha. Generally, this area is characterized as a lowland area, varied between 15 masl – 339 masl, and geographically situated in a tropical monsoon climate with two seasons throughout the year, namely rainy and dry seasons. The total precipitation is approximately 2300–3100 mm annually, with the highest and lowest precipitation in December and July or August (BPS, 2021). The average annual temperature is 27.8°C with a maximum and minimum temperature of 30.3°C and 23.5°C, respectively. The agricultural sector contributed 36.90% of the total gross regional domestic product (GRDP) in 2020, making it the highest contributor to GDRP. However, we focused on two districts, namely South Kotabumi and Abung Semuli districts, which have a total of 69 987 and 26 036 populations, respectively, since these districts have high contributions to the agricultural sector in North Lampung Regency. Therefore, the role of agricultural extension services in these districts were significantly contributed to agricultural activities (Figure 1).

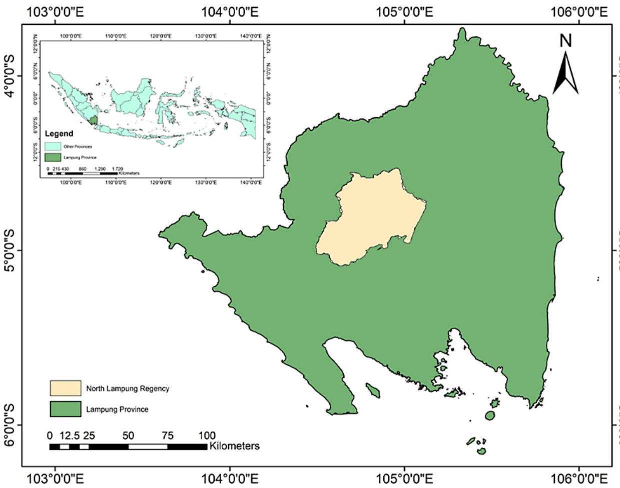

Fig. 1. Study area for improving the capabilities of agricultural extension agents

Research Design

A survey method utilizing a combination of qualitative and quantitative research design approaches was utilized to investigate the factors that influence agricultural extension performance and its effect on agriculture sustainability. The primary data collection tools consisted of questionnaires, interviews, structured note reviews, and observations. To ensure participant convenience, all stages of the quantitative approach were carried out in local languages. Furthermore, secondary data were employed to complement the primary data. Prior to data collection, validity and reliability tests were conducted to ensure that the questionnaire accurately measured the intended indicators and produced consistent results. The questionnaire underwent review by subject matter experts in the field of agricultural extension to ensure accuracy of the indicators. Internal consistency reliability was assessed through Cronbach's alpha, with a value greater than 0.6 being considered an acceptable level of reliability for research purposes.

All agricultural extension services in South Kotabumi and Abung Semuli districts were interviewed by using purposive sampling technique to identify 'expert' agricultural extension agents (indigenous specialist in agricultural technology, climate change to participate in the survey. A total of 40 experts were selected for the study based on their expertise and experience in the agricultural field. The selection criteria included years of experience in agricultural extension services, educational background, and specific knowledge of agriculture 4.0 and climate change. The respondents were identified through recommendations from key stakeholders in the agricultural industry, such as government agencies, non-governmental organizations, and other agricultural experts. They represented different sectors of agriculture, such as livestock, crop production, and fisheries. The respondents also had experience working with various communities, including rural and urban communities, and with different

Table 1. Definition of each variable that influences agricultural extension services performances

Variables	Description
Dependent variables	
Performances	Agricultural extension performance in conveying agricultural agendas
Explanatory variables	
Age	Age of agricultural extension agents
Education	Education level of agricultural extension agents
Work Experience	Working experience of agricultural extension agents
Motivation	Encouraging to reach the purpose of extension services
Family size	Number of household member
Covering Area	The total area of extension services
Number of assisted farmers	Total farmers who get extension services from agricultural extension agents
Technique and method of counseling	A way to convey extension services
The availability of facilities and infrastructures	Facilities and infrastructures that can be used for supporting extension program
Competencies	The ability of agricultural extension agents in their role
Economy	Support local economies by promoting the use of local resources and reducing reliance on external inputs such as synthetic fertilizers and pesticides.
Environment	Minimize the negative impact of farming on the environment by reducing greenhouse gas emissions, conserving water, and preserving soil quality.
Social	Promote social well-being by supporting the livelihoods of farmers and farm workers, promoting food security, and fostering community engagement.

cultural and ethnic backgrounds. A total of 13 variables that influence agricultural extension services performance and sustainable agriculture were constructed, including age, education, work experience, motivation, household member, covering area, number of assisted farmers, technique, and method counseling, the availability of infrastructure, competencies, economy, environment and social. The list of explanatory variables is presented in Table 1.

Spearman's rank correlation analysis

A nonparametric statistical technique, Spearman's rank correlation analysis (Rs values, ranges from -1 to 1) with the two-tailed test at the significance level of 0.05 and 0.1, was used as a statistical test to measure the relationship between independent variables and dependent variables (agricultural extension services performances) (Gebremariam et al., 2021; Thamrin et al., 2020). The Rs value equal to 1 indicates a perfect positive correlation, while the Rs value equal to -1 indicates a perfect negative correlation between dependent and independent variables (Creswell & Creswell, 2017). The detailed Spearmen rank correlation steps include: making the hypotheses test, establishing the significance level, calculating the statistics test, coding the rank, and substituting the data into the equation (Zhao et al., 2022). The Spearman rank coefficient can be calculated using the following equation:

$$Rs = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)},$$

where n is the number of data, and d_i is the rank of order difference of pair of variables (dependent and independent) when sorting the values of two variables in order of size. Further, we categorized the result into five criteria, namely very strong ($0.80 \leq Rs \leq 1.00$), strong ($0.60 \leq Rs \leq 0.79$), moderate ($0.40 \leq Rs \leq 0.59$), weak ($0.20 \leq Rs \leq 0.39$), and very weak ($0.00 \leq Rs \leq 0.19$) based on the previous study (Zhao et al., 2022)particularly shale reservoirs, demands accurate information on the formation composition, mineralogy, and mechanical parameters for effective exploitation. The development of geochemical and geophysical logging technology allows the investigation of the correlations between the elemental, mineral contents, and the mechanical parameters of shale. Taking the Lower Cambrian Niutitang Formation shale in the Fenggang block in northeastern Guizhou as an example, 889 data sets of the main elemental (Si, Ca, Fe, S, Ti, Gd, K, Mg, and S.

SWOT and QSPM methods

Additionally, we also developed a strategy to improve agricultural extension agent performances using SWOT (strength, weakness, opportunity, and threat) and QSPM (Quantitative Strategic Planning Matrix) methods. SWOT summarize the internal operational management and potential of opportunity and threats from the external organization of agricultural agents, which further provide more comprehensive alternative strategies based on the observed data (Helms & Nixon, 2010; Oladele & Sakagami, 2004; Prasetyo & Hariani, 2018). The interview results from all respondents will be arranged into Internal Strategic Factor Summary (IFAS) and External Strategic Factors Summary (EFAS) tables by calculating the weight and rating for each factor which will further compile into a SWOT diagram—consist of four quadrants— to generate SWOT matrices, containing alternative strategies (Helms & Nixon, 2010; Prasetyo & Hariani, 2018). Finally, QSPM method was used to determine the feasibility and sustainability of alternative strategies by considering the imperative internal and external factors from SWOT matrices. It can highlight the strengths and the opportunities, correct the weakness and prevent or minimize the threats, thereby the implementation priority of each one was determined.(Riahi Dorcheh et al., 2021)

Results

Spearman's rank correlation analysis

Table 2 shows the results of the Spearman correlation rank analysis for various variables in the agricultural extension agent survey, including the correlation coefficient, p-values, category, and conclusion thereof for each variable. The results indicate that age has a very weak correlation (0.009) with the performance of agricultural extension agents and is not significant ($p = 0.980$). Education, on the other hand, has a strong correlation (0.649) and is significant ($p = 0.042$). Work experience has a very weak correlation (0.186) and is not significant ($p = 0.607$). Motivation has a strong correlation (0.695) and is significant ($p = 0.026$). The family number and covering area have weak and very weak correlations, respectively, and are not significant ($p > 0.05$). Number of assisted farmers, technique and method of counseling, competencies, and social factors have very strong correlations (0.954, 0.787, 0.943, and 0.775, respectively) and are significant ($p < 0.05$). The availability of infrastructure, economy, and environment have moderate to weak correlations (0.408, 0.435, and 0.269, respectively) and are not significant ($p > 0.05$). Overall, the results indicate that education, motivation degree, number of assisted farmers, technique and method of counseling, competencies, and social factors are important factors that influence the performance of agricultural extension agents, while age, work experience, extension agent's household, covering area, availability of

Table 2. The result of Spearman correlation rank

Variables	Correlation coefficient	p-values	Category	Conclusion thereof
Age	0.009	0.980	Very weak	Not significance
Education	0.649*	0.042	Strong	Significance
Work Experience	0.186	0.607	Very weak	Not significance
Motivation Degree	0.695*	0.026	Strong	Significance
Extension agent' Household	0.317	0.373	Weak	Not significance
Covering Area	0.080	0.826	Very weak	Not significance
Number of assisted farmers	0.954**	0.000	Very Strong	Significance
Technique and method of counseling	0.787**	0.007	Strong	Significance
The availability of infrastructure	0.408	0.241	Moderate	Not significance
Competencies	0.943**	0.000	Very Strong	Significance
Economy	0.435	0.209	Moderate	Not significance
Environment	0.269	0.269	Weak	Not significance
Social	0.775**	0.008	Strong	Significance

Note: One and doubles starred represent significant level at $\alpha = 5$ % and 1 %, respectively

infrastructure, economy, and environment have no significant correlation with their performance.

IFAS and EFAS

The IFAS (Internal Factor Analysis Summary) calculation in Table 3 provides an analysis of the strengths and weaknesses of the agricultural extension agents performance, including the weight, rating, and score. A higher IFAS total score indicates better performance, while a lower score indicates areas for improvement and the score column is calculated by multiplying the weight and the rating for each variable. The analysis shows that the high motivation of extension agents is a strength, with a weight of 0.4 and a rating of 3.3, resulting in a score of 1.32. It indicates that the extension agents are motivated to perform their duties and are likely to deliver quality extension services to farmers. Extension agents who are motivated are more likely to go the extra mile to help farmers and work towards achieving the objectives of the organization. Another strength identified by the analysis is that the extension agents join workshop and training programs, with a weight of 0.2 and a rating of 2, resulting in a score of 0.4. This is an indication that the extension agents are willing to learn and develop their skills, which is crucial in ensuring that they are up-to-date with the latest trends and technologies in agriculture. By doing so, they can provide better advice and support to farmers.

However, the weaknesses identified in the IFAS analysis have an impact on the performance of the extension agents. For example, a limited number of extension agents, with a weight of 0.4 and a rating of 3.7, resulting in a score of 1.48, can negatively affect the performance of the extension agents. When there are a limited number of extension agents, they may have to cover a large area, which can result in inadequate support to farmers. This can also lead to burnout and high turnover rates among extension agents. Moreover, the limited budget for extension programs, inadequate facilities and infrastructure, and lack of monitoring performance can also negatively impact the performance of extension agents. Without adequate resources and support, extension agents may struggle to deliver quality extension services and meet the needs of farmers.

In this case, the IFAS calculation reveals that the agricultural extension agent's performance has more weaknesses (2.97) than strengths (2.77), with a total score of 5.74. This suggests that the weaknesses of the program need more attention and improvement. The IFAS analysis suggests that the performance of agricultural extension agents is influenced by both strengths and weaknesses. Addressing the identified weaknesses can help to improve the performance of extension agents and enhance their ability to provide quality extension services to farmers. Therefore, the organization should consider allocating more resources to improve facilities and infrastructure, increase the number of extension agents, and implement effective monitoring and evaluation systems. By doing so, the organization can create an enabling environment that promotes the performance of extension agents and ultimately benefits farmers. It is also essential to continue providing opportunities for training and development to ensure that extension agents remain motivated and up-to-date with the latest agricultural technologies and practices.

The EFAS analysis presented in Table 4 highlights the opportunities and threats faced by agricultural extension agent's performance. The EFAS analysis indicates that agricultural extension agents have several opportunities to

Table 3. The result of IFAS calculation

No	Variable	Weight	Rating	Score
	Strength			
1	Clarity of extension work programs	0.1	1.8	0.18
2	Using internet as a tool for collecting information	0.3	2.9	0.87
3	High motivation of extension agents	0.4	3.3	1.32
4	Join workshop and training programs	0.2	2	0.4
	Total	1		2.77
	Weakness			
1	Limited budget for extension programs	0.1	1	0.1
2	Inadequate facilities and infrastructure	0.2	2	0.4
3	Lack of monitoring performance	0.3	3.3	0.99
4	Limited number of extension agents	0.4	3.7	1.48
	Total	1		2.97
	IFAS Total	5.74		

enhance their performance. Firstly, government policies on supporting extension programs are considered a significant opportunity with a weight of 0.1667 and a rating of 1.4, giving a score of 0.233. This suggests that the government is willing to support and invest in extension programs, which can potentially increase the resources and facilities available to extension agents. Secondly, collaboration with relevant agencies is also considered an opportunity with a weight of 0.5 and a rating of 2.3, giving a score of 1.15. It implies that extension agents should explore ways to take advantage of these opportunities by building stronger relationships other government agencies, NGOs, or private sector entities and working closely with policymakers to ensure that government policies are aligned with their extension work. Actively participating in the development of new technologies in agriculture (with a weight of 0.3333 and a score of 2.3) is also an important opportunity, as it can help agricultural extension agents stay up to date with the latest advances in the field.

On the other hand, the EFAS analysis also shows that agricultural extension agents are facing several threats that could potentially hinder their performance. The most significant threat identified is changes in policies and provision in extension agents' organizations (with a weight of 0.4 and a score of 3.5). This suggests that the organizational structures and policies that support extension activities are subject to change, which could impact the funding, structure, and objectives of extension programs, potentially reducing the effectiveness of extension agents. Complicated administration problems (with a weight of 0.1 and a score of 2.3) and heterogeneity of farmers' background (with a weight of 0.2 and a score of 1.8) are also threats that agricultural extension agents need to address. Additionally, climate change effects on agricultural production are also considered a threat, with a weight of 0.3 and a rating of 2.4, giving a score of 0.72. This indicates that the effects of climate change could reduce agricultural production and impact the services provided by extension agents, as unpredictable weather patterns and extreme weather events can affect agricultural productivity and livelihoods. In conclusion, the EFAS analysis suggests that agricultural extension agents need to take advantage of the opportunities available to them while mitigating the threats they face. By collaborating with relevant agencies, participating in the development of new technologies, and leveraging government support, extension agents can potentially enhance their performance. At the same time, addressing complicated administration problems, the heterogeneity of farmers' background, and the effects of climate change can help extension agents mitigate the threats they face and improve their performance.

Table 4. The result of EFAS calculation

No	Variable	Weight	Rating	Score
	Opportunity			
1	Government policies on supporting extension program	0.1667	1.4	0.233
2	Collaboration with relevant agencies	0.5	2.3	1.15
3	Actively participated on development of new technologies in agriculture	0.3333	2.3	0.767
	Total	1		2.15
	Threat			
1	Complicated administration problems	0.1	2.3	0.23
2	Heterogeneity of farmers' background	0.2	1.8	0.36
3	Climate change effects on agricultural production	0.3	2.4	0.72
4	Changes of policies and provision in extension agents' organizations	0.4	3.5	1.4
	Total	1		2.71
	EFAS Total	4.86		

SWOT Analysis

After conducting IFAS and EFAS analyses, the SWOT matrix was created to determine the appropriate strategies for improving the performance of the agricultural extension program. Based on the IFAS and EFAS analysis, it is evident that the extension services program has more strengths and opportunities compared to weaknesses and threats. The IFAS score of 5.74 and EFAS score of 4.86 indicate that the program is doing relatively well, and there is a potential for further growth and improvement. One of the key strengths of the extension services program is the clarity of extension work programs (IFAS S1), which allows farmers to understand the goals and objectives of the program. Furthermore, the program utilizes ICT (IFAS S2) to collect information and data, making it easier to provide accurate and up-to-date information to farmers. The high motivation of extension agents (IFAS S3) and their participation in workshops and training programs (IFAS S4) also contribute to the program's success. In terms of opportunities, collaboration with relevant agencies (EFAS O2) and actively participating in the development of new technologies in agriculture (EFAS O3) can further enhance the program's effectiveness. The government's policies on supporting extension programs (EFAS O1) also provide an opportunity for the program to receive more funding and support.

However, there are also weaknesses and threats that need to be addressed. The limited budget for extension programs (IFAS W1) and inadequate facilities and infrastructure (IFAS W2) can hinder the program's progress. The lack of monitoring performance (IFAS W3) and limited number of extension agents (IFAS W4) also require attention. Complicated administration problems (EFAS T1) and heterogeneity of farmers' background (EFAS T2) can pose challenges to the program's implementation. Climate change effects on agricultural production (EFAS T3) and changes in policies and provision in extension agents' organizations (EFAS T4) also require attention. To address the weaknesses and threats, appropriate extension programs that suit the cultural background of farmers (IFAS SW1) and optimizing the motivation of extension agents in the use of ICT (IFAS SW2) can be implemented. Utilizing relevant agencies for gathering funding (IFAS SW2) and improving facilities and infrastructure (IFAS SW2) can also help address the weaknesses. Furthermore, utilizing ICT (IFAS SO2 and SO3) and all related

Table 5. SWOT matrix

Internal / External	Strengths (S)	Weakness (W)
	1. Clarity of extension work program (0.1)	1. Limited budget for extension programs (0.18)
	2. Using internet as a tool for collecting information (0.4)	2. Inadequate facilities and infrastructure (0.87)
	3. High motivation of extension agents (0.99)	3. Lack of monitoring performance (1.32)
	4. Join workshop and training program (1.48)	4. Limited number of extension agents (0.4)
Opportunities (O)	SO	SW
1. Government policies on supporting extension program (0.233333)	1. Increasing the number of workshop and training programs in collaboration with relevant agencies. (S4), (O2)	1. Improving and enhancing the facilities and infrastructure for increasing agricultural production (W2), (O1), (O3)
2. Collaboration with relevant agencies (1.15)	2. Utilizing ICT as a tool for collecting the newest programs or agendas about counseling information by using support from government (S2), (S3), (O1), (O3)	2. Utilizing relevant agencies for gathering funding (W1), (O1)
3. Actively participated on development of new technologies in agriculture (0.76667)	3. All related agencies involved in the extension services programs (S1), (O1), (O2)	
Threats (T)	ST	WT
1. Complicated administration problems (0.46)	1.Making appropriate extension programs that suit with cultural fostered farmers (S1), (T2)	1. Government make a clear policy in terms of extension funding to realize "one village one agents" (W1), (W4), (T1)
2. Heterogeneity of farmers' background (0.18)	2.Optimizing the motivation of extension agents in the use of ICT for handling administration, analyzing the effect of climate change and increasing the rate of successful farmer business (S2), (S3), (T1), (T3)	2. Improving the facilities and infrastructure by applying automatic weather station to analyze climate change effects on agriculture (W2), (T3)
3. Climate change effects on agricultural production (0.72)		
4. Changes of policies and provision in extension agents' organizations (0.14)		

agencies involved in the extension services programs (IFAS SO1 and SO2) can take advantage of the opportunities presented. In conclusion, the IFAS and EFAS analysis provides a comprehensive overview of the extension services program, highlighting its strengths, weaknesses, opportunities, and threats. By addressing the weaknesses and threats and taking advantage of the opportunities presented, the extension services program can further enhance its effectiveness and contribute to the growth and development of agriculture in the region (Table 5).

The difference in the weighted scores of the internal factors between strengths (2.77) and weaknesses (2.97) is 0.2, with weaknesses having a slightly higher score. In contrast, the difference in the weighted scores of the external factors between opportunities (2.15) and threats (2.76) is 0.61, with threats having a significantly higher score. Therefore, the strategy chosen is WT. The WT strategy aims to improve weaknesses by utilizing external opportunities. Sometimes, a company may have significant external opportunities, but internal weaknesses prevent it from taking advantage of them. Strategies that can be used to address weaknesses and threats include improving the infrastructure and equipment to monitor weather changes.

QSPM Analysis

This study employs the QSPM as the final stage in the strategy formulation process, which aims to determine the priority strategies from the best options found in the SWOT matrix and establish the relative attractiveness of selected strategic variations. After identifying the strategic alternatives, the QSPM tool evaluates the internal and external factors that influence the implementation of these strategies by assigning weightage values to these factors based on their relative importance to the organization. Subsequently, the QSPM tool calculates the Total Attractiveness Score (TAS) for each strategic alternative using these weightage values. The alternative with the highest TAS is considered the priority strategy. The decision-making process involves comparing each formulated strategy against each key indicator with internal and external weight values. (Table 6)

The analysis of the internal strategy factors indicates that improving the training activities of extension workers through inter-agency collaboration to enhance their competencies (WT) is the first priority strategy, with a total TAS value of 10.76. This finding supports the importance of improving the competence of extension workers and highlights the need for inter-agency collaboration in achieving this goal. Our result also identifies the WT strategy as the highest alternative strategy based on the QSPM calculation of the key internal-external factors. However, it's essential to note that these results are only as good as the accuracy of the data and assumptions used in the analysis. Therefore, it's important to interpret the QSPM results cautiously and consider other factors that may influence the decision-making process.

Table 6. The value of QSPM results based on their TAS

Strategy	Total Relative attractiveness	Rank
First strategy	10.76	I
Second strategy	8.63	II

Discussion

The Spearman correlation analysis revealed that several factors were significantly correlated with the performance of agricultural extension agents. Education, motivation degree, number of assisted farmers, technique and method of counseling, competencies, and social factors were identified as important factors that influence the performance of agricultural extension agents, while age, work experience, extension agent's household, covering area, availability of infrastructure, economy, and environment had no significant correlation with their performance. These findings are consistent with previous studies that have identified education, motivation, competencies, and social factors as important predictors of agricultural extension workers' performance (Baruwadi et al., 2020; Belay & Abebaw, 2004; Ragasa et al., 2016; Ramorathudi & Terblanche, 2018; Walangadi et al., 2021). The results of the study are consistent with previous research that has identified education and training as important factors influencing the performance of agricultural extension agents. For example, a study by Ragasa et al. (2016) found that training and experience were significant determinants of the performance of extension agents in Congo. Similarly, a study by Tuchitechi & Lee (2018) in Malawi found that education and training significantly influenced the effectiveness of agricultural extension services. The finding that social factors are important for sustainable agriculture is also supported by previous research. For example, a study by Benin et al. (2011) found that social factors, such as social networks and trust, were important for the adoption of sustainable agricultural practices in Uganda.

Furthermore, the IFAS analysis revealed that the agricultural extension agent's performance had more weaknesses than strengths, with weaknesses having a slightly higher score. This suggests that the weaknesses of the program need more attention and improvement. The EFAS analysis also identified several external threats that may hinder the performance of extension agents, such as the effects of climate change and complicated administration problems. These findings are consistent with previous studies that have highlighted the importance of addressing internal weaknesses and external threats to improve the performance of agricultural extension workers (Mansour et al., 2019; Sabir et al., 2019). The recommendation to improve facilities and infrastructure and increase the number of extension agents is also consistent with previous research (Ansari et al., 2023a; Ansari et al., 2023b). Study by Apantaku et al. (2016) and Antwi-Agyei & Stringer (2021) found that the lack of facilities and resources was a significant constraint to the performance of extension agents. Similarly, a study by Ashraf & Yousaf Hassan, (2021) found that the shortage of extension agents was a major challenge in providing quality extension services to farmers. The recommendation to address weaknesses by utilizing external opportunities is also supported by previous research. For example, a study by Prasetyo & Hariani (2018) found that collaboration with other organizations was an effective strategy for overcoming the challenges faced by extension agents.

The SWOT matrix identified the WT strategy (improving weaknesses by utilizing external opportunities) as the best strategy to enhance the performance of extension agents. This strategy aimed to reduce internal weaknesses and avoid external threats by improving the infrastructure and equipment to monitor weather changes. The strategy prioritized the improvement of the training activities of extension workers through inter-agency collaboration to enhance their competencies. The QSPM analysis further supported the WT strategy as the highest alternative strategy based on the key internal-external factors. In this case, the analysis suggests that the "WT" strategy (improving weaknesses by utilizing external opportunities) is the most suitable approach for improving the performance of extension agents. This strategy aims to address the internal weaknesses of extension agents, such as the need for more training and development, by leveraging external opportunities, such as collaborating with other agencies to improve training programs (Antwi-Agyei & Stringer, 2021; Apantaku et al., 2016; Maiangwa et al., 2010; Prasetyo & Hariani, 2018; Ragasa et al., 2016). One way to implement the "WT" strategy is to invest in infrastructure and equipment that can help extension agents monitor weather changes and provide up-to-date information to farmers (Antwi-Agyei & Stringer, 2021). For example, by providing extension agents with weather monitoring tools such as sensors or satellite imagery, they can provide farmers with real-time information on weather patterns and make informed decisions about crop management. This can help improve the quality of extension services and ultimately increase the productivity and profitability of farming activities. Another strategy that can be implemented to improve the performance of extension agents is to increase the number of extension agents in the field (Ragasa et al., 2016; Rusliyadi et al., 2018; Sabir et al., 2019). This can be achieved by hiring and training more extension agents, as well as providing them with the necessary resources and equipment to perform their duties effectively (Antwi-Agyei & Stringer, 2021; Ragasa et al., 2016; Sabir et al., 2019). For example, by providing extension agents with smartphones or tablets, they can access information and communicate with farmers more efficiently, leading to improved extension services. Additionally, collaboration with relevant agencies can also help improve the performance of extension agents (Hailu et al., 2020; Maiangwa et al., 2010; Ragasa et al., 2016; Rusliyadi et al., 2018; Sabir et al., 2019). This can be achieved by establishing partnerships with research institutions, universities, and other relevant organizations to develop new technologies and practices that can be shared with farmers (Belay & Abebaw, 2004; Nataliningsih et al., 2020; Sawitri et al., 2020). By doing so, extension agents can stay up-to-date with the latest developments in agriculture and provide farmers with innovative solutions that can help them increase productivity and profitability.

Overall, the IFAS, EFAS, SWOT matrix, and QSPM analyses provide a comprehensive understanding of the factors that affect the performance of agricultural extension agents. The identification of key strengths, weaknesses, opportunities, and threats enables organizations to develop effective strategies to improve the performance of extension agents and enhance their ability to provide quality extension services to farmers. The implementation of these strategies requires a collaborative effort from all stakeholders, including government agencies, extension workers, and farmers, to ensure the sustainable development of the agricultural sector especially for introducing agriculture 4.0 and climate change threat.

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