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Effects of Agricultural Extension Services and Training in Promoting Sustainable Soybean (Glycine Max L) Production Among Smallholder Farmers in the Tolon District of Northern Region, Ghana

Braimah Tiah Abraham[1], Mohammed Mashoud Adams[2], Karim Abdul Rahaman[3]
[1,2,3] University for Development Studies, Faculty of Education, Department of Agriculture and Consumer Sciences Education

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ABSTRACT: This study was conducted to investigate the effects of agricultural extension services and training in promoting sustainable soybean (*Glycine max L*) production among smallholder farmers in the Tolon District of Northern Region, Ghana. The study anchored on the pragmatist research philosophy. Mixed method research approach was used for the study, and descriptive research design. Twelve communities across the district were purposively selected for the study. Data was collected from 260 smallholder soybean farmers, and 16 agricultural extension workers from the district department of agriculture. Statistical Package for the Social Sciences (SPSS) version 23 software was used to analyzed the data. It was revealed from the study that education on best farming practices for soybean farmers has a significant impact on technology adoption for sustainable soybean production, with a statistically significant p-value of 0.03. The study also founded the impact of extension services and its correlation with soybean yield outcomes. Education on the access and use of improved seeds has a statistically significant p-value of 0.02, indicating a notable association with yield outcomes. Education on access and use of new farming technologies also shows statistical significance with a p-value of 0.03. This study recommends that; there should be enough extension services and training given to soybean farmers on climate smart agriculture (CSA). Agricultural Extension Agents (AEAs) should assist farmers on the modern technology adoption for better soybean yield. Agricultural extension services and training should also be made accessible to local farmers to improve upon their yield.

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KEY WORDS: soybean, sustainability, technology, agricultural extension services, smallholder farmers.

INTRODUCTION

The agricultural sector contributes significantly to Gross Domestic Product (GDP), export earnings, and a source of rural employment. It also provides raw materials for the local industries in Ghana (Wordofa et al., 2021). Report from the International Food Policy Research Institute (IFPRI, 2020), agricultural extension is essential in increasing productivity, improving rural livelihoods, boosting food security, and positioning agriculture as a pro-poor economic growth engine. Soybean has the potential to enhance livelihoods and reduce poverty, through the expansion and modernization of the soybean industry (Frimpomaah et al., 2022).

The primary purpose of agricultural extension services is to serve the public interest by effectively providing rural farmers with critical knowledge on productive activities and contemporary technologies. Low level of education among smallholder farmers, the use of rudimentary technologies in production, overreliance on rainfall for production, low adoption of modern production technologies accounts for the low yield in the Ghanaian agriculture (Anang et al., 2020). Extension education aims to serve the purpose of developing and disseminating accurate knowledge to farmers at the proper moment, which is crucial in bringing about change in the agricultural sector (Bonye et al., 2012).

Agricultural extension is aimed to transfer agricultural technology and persuading farmers to adopt and use these technologies on their farms, because farmers need those new and modern technologies to increase agricultural production in various types of agricultural crops and the quantities and qualities of consumer goods on the market. These agricultural innovations and new agricultural technologies must be good and superior to the old agricultural techniques used by farmers in order to be adopted (Altalb et al., 2015). Anang (2023), farmers acquire knowledge about new technologies through extension agents, non-governmental organizations and colleague farmers. Not many smallholder farmers have the requisite knowledge of new technologies, which is a barrier limiting technology adoption and retarding productivity. Extension officers are important agents in facilitating technology adoption among farmers.

Agricultural extension activities are a crucial tool for a state's agrarian and political policies, encouraging the growth of agricultural production across the globe. The goal of agricultural extension services should be to help rural farmers become more skilled farmers, train them how to interact with producers effectively, and encourage them to learn new things. In addition to providing professional support in enhancing production and processing, extension services in agriculture are essential because they facilitate the exchange of knowledge and scientific discoveries with rural farmers, enabling them to increase output and enhance farmer income (Altalb et al., 2015).

According to Asiedu-Darko (2013), the role extension activities play in Ghana’s agriculture cannot be overemphasized. Effective dissemination of agricultural technologies is crucial in agricultural and rural development, especially the role played by agricultural extension agents. The effective dissemination of innovative technologies requires measures which ensure that agricultural extension agents acquire the needed competencies to improve their effectiveness.

Problem Statement

According to Danso-Abbeam et al. (2018), role play by the agriculture sector of the nation has not been sufficient enough to elevate many people above the poverty line, especially the rural population who contribute immensely to agricultural production in Ghana. Inadequate extension services have been identified as one of the main limiting factors to the growth of the agricultural sector and rural community development at large. Now with the recent threats of climate change and the rapid advancement in technology, more farmers require capital investment in agriculture and human capacity development to at least continue to make their living out of farming. Thus, the role of agricultural extension today goes beyond the transfer of technology and improvement in productivity. Agricultural extension programmes have been identified as the main conduits of addressing rural poverty and food insecurity in the rural communities.

One of the main reasons for the low agricultural productivity in Ghana is low adoption of modern agricultural production technologies amongst rural farmers in Ghana (Abunga et al., 2012). Wordofa et al. (2021) claims that, adoption of improved agricultural technologies among rural farmers remains to be a promising strategy to achieve food security and poverty reduction in many developing countries.

Asodina et al. (2020), at all levels of the agriculture sector, a variety of strategies that address the needs and priorities of farmers must be examined and put into practice in order to achieve agricultural sustainability in the nation. Growing the output of agriculture is one of the most reliable strategies to combat poverty in the developing countries. The low productivity of Ghana's agriculture sector, particularly for key crops like rice, maize, and soybeans, is a significant concern.

In Ghana, smallholder farmers account for the majority of the agricultural industry, especially when it comes to the production of food crops. They typically use traditional farming methods to cultivate two hectares of land. Intercropped agriculture systems are popular, in part because they lower the probability of total crop failure (Asodina et al., 2020). Farmers typically get seeds from the previous harvest. It is uncommon for large farms and plantations to grow food crops like rice, soybeans, and maize. Since irrigation systems are uncommon and only small amounts of fertilizer and agrochemicals are administered, the productivity of Ghana's smallholder cropping systems is primarily dependent on the organic fertility of the soil and the current weather (MoFA, 2010).

Despite the crop's potential to increase income and improve nutrition, especially for those living in rural areas, many people have persisted in their quest to understand why Ghana's soybean production is so low (Plahar, 2006). It is important to introduce crops with high yields, a ready market, and high-quality protein in an effort to solve these problems. Thankfully, farmers in the area have been exposed to soybean, which possesses all of the aforementioned attributes. The primary goal of the bean's introduction to the region is to motivate farmers to diversify their crop production in order to eventually contain the issues related to the cultivation of low-yielding and low-income crops (FAO, 2004).

Research Objectives

- To assess the major challenges confronting smallholder farmers in the Tolon district regarding sustainable soybean production.
- To determine how access to extension services and training affect agricultural technology adoption among smallholder farmers in the Tolon district.
- To examine the relationship between access to agricultural extension services and soybean yield in the Tolon district.

- To assess the major challenges of agricultural extension services delivery in the Tolon district regarding sustainable soybean production.

LITERATURE REVIEW

In Ghana's rural communities, agricultural extension services have been identified as one of the primary means of tackling food insecurity and rural poverty. This is due to the fact that agricultural extension can help farmers solve problems, encourage adult learning in rural areas, transmit contemporary technology, and engage farmers in the agricultural knowledge and information system (Danso-Abbeam et al., 2018). Food and Agriculture Organization (FAO, 2010) maintained that agricultural extension is a system that facilitate the access of farmers, their organizations, and other market actors to knowledge, information, and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions; and assist them to develop their own technical, organizational, and management skills and practices. According to this definition, an extension is considered a key instrument for improving the effectiveness and efficiency of agriculture, allied industries, and other economic endeavors in order to satisfy the demands of the populace. As a result, it is seen as a tool for policymakers to improve the quality and safety of agricultural products.

It is impossible to overstate the significance of extension initiatives for Ghana's agricultural economy (Asiedu-Darko, 2013). Extension agents are especially crucial to the effective distribution of agricultural technologies, which is crucial for agricultural and rural development (Bonye et al., 2012). For new technologies to be distributed effectively, it is essential that extension agents have the skills they need to become more effective. In order to bring about change in the agricultural sector, extension education seeks to produce and disseminate accurate knowledge to farmers at the appropriate time.

Soybean (*Glycine max L.*) is a leguminous plant native to tropical and mildly temperate regions of Asia. It grows well on moist alluvial soils with a high organic matter content and in climates with few periods of intense precipitation. The resistance of soybean crops to water logging is negligible. The ideal temperature range for producing soybeans is between 20 and 30 degrees Celsius; any temperature below or beyond that will seriously impair the crop's growth and yield. The soybean crop matures three to four months after planting. It needs to be harvested before pods shatter and cause large losses in productivity. Soybean seeds contain 29% carbohydrates, 6% ash, 18% fat, and 40% protein (Ahiabor et al., 2015).

Growing the output of agriculture is one of the most reliable strategies to combat poverty in the developing countries. The low productivity of Ghana's agriculture sector, particularly for key crops like rice, maize, and soybeans, is a significant concern. The Ministry of Food and Agriculture reports that the average soybean yield in the country is 1.3 Mt/ha, whereas potential yields are 3.0 Mt/ha (MoFA, 2017a; 2017b). According to this, Ghana's soybean yields are still far lower than they could be (Mahama et al., 2020). Lower capacity building to embrace and employ upgraded technology by soybean farmers is the reason for this underperformance (MoFA, 2017a; 2017b).

Smallholder farm households, who use traditional farming tools with little to no adoption of better technologies for soybean production, dominate the district's commodities cultivation. While some academics and farmers blame the district's low cash crop prices for this problem, others point the finger at pest and diseases in addition to processing and marketing-related issues (MoFA, 2009b). It would be very difficult, if not impossible, to meet MoFA's principal goal of improving the nutritional status and income levels of farmers and households especially those in rural regions if these impediments continue to persist. An examination of the effects of agricultural extension services in the current production of this cash crop is crucial since it would be extremely difficult to remedy a problem of this kind without first determining its underlying causes.

The low rates are not due to a lack of use of technologies and extension services by farmers in the study area; rather, district-wide extension efforts are hampered by subpar methods of delivering extension services, a shortage of extension personnel, and a lack of supplies and logistics. Due to the subpar performance of many public extension services, certain countries are progressively moving toward the privatization of extension services or the transfer of accountability to farmer groups or non-governmental organizations (Anang et al., 2020).

MATERIALS AND METHODS

Study Area

The study was conducted in the Tolon district which is located between Latitudes 9015` and 10002` North and Longitudes 0053` and 1025` West. The district was created from the former Tolon/Kumbungu district in 2012, by the Legislative Instrument (LI) 2140, with Tolon serving as the district capital. It “shares boundaries to the North with Kumbungu district, North Gonja district to the West, Central Gonja district to the South, and Sagnarigu Municipality to the East” Ghana Statistical Service (GSS, 2010). The district is situated in the Guinea savanna zone which exhibits the Guinea savanna vegetation characteristics, and per the 2021 Population and Housing Census (PHC) it has a total population of 118,101, out of which 58,512 (49.5%) are males and 59,589 (50.5%) females (GSS, 2021). Tolon district which is located in the northern region of Ghana, is home to a large number of soybean growers (Osman et al., 2018).

Agriculture serves as a predominant economic activity for the people in the area. The soils in the area are generally low in fertility due to the long dry season, coupled with high temperatures and frequent bush fires. Climate change and its effects are more intense in the area with severe impact such as; pest and disease incidences, flooding of farm lands, severe drought, changes in the onset of the rainy season and planting dates for major crops (Anang, 2023).

Research Philosophy

This study is anchored on the pragmatist philosophy or paradigm. Pragmatism is a philosophical tradition that considers words and thought as tools and instruments for prediction, problem solving, and action. Research paradigm refers to the theoretical philosophical ground for the research work. It is viewed as a research philosophy (Khatri, 2020). It is the fundamental beliefs, ideas, lenses and or worldviews of researchers concerning what to study, and how to conduct research studies to find answers to their research questions, Creswell (2015) identified pragmatism and transformative emancipatory philosophy as the main lenses utilized by mixed method researchers. According to Creswell (2014), Pierre Bourdieu, Mead and Dewey are the main pioneers of the pragmatist philosophy. The pioneers defined pragmatic research as a tradition that combines positivist and interpretivist perspectives in research projects. According to Khatri (2020), the term "pragmatic" is used to describe things that are realistic and grounded. Pragmatism is a philosophy of practicality that has been applied to education.

Pragmatism research philosophy accepts concepts to be relevant only if they support action and research question is the most important determinant of the research philosophy. Pragmatist philosophy was used for the study because it can integrate more than one research approaches and research strategies within the same study, such as personal observation, unstructured interviews, and questionnaire administration, which allowed the researcher to realize the study's objectives. Also, the research approach for the study is mixed methods research (quantitative and qualitative), hence the need for pragmatism research philosophy. Pragmatist philosophy helps researchers to choose the right research methodologies and approaches depending on the goals of their studies rather than just the kind and scope of their research (Creswell, 2013; Fieldings, 2012). The study was motivated by the strong belief that reality (ontology) regarding the effects of agricultural extension services and training in promoting sustainable soybean (*Glycine max L*) production among smallholder farmers in the Tolon District is not only “external,” but also “multiple and constantly renegotiated and interpreted” (Haruna, 2019, p. 19; Creswell, 2014, 2015).

Research Design

Descriptive research design was used for this study. The goal of descriptive research is to meticulously observe and record a phenomenon of interest, in this case agricultural extension services effect on soybean production. These observations ought to be precise and reproducible, according to the scientific process and as a result, are more trustworthy than haphazard observations made by inexperienced individuals (Bhattacherjee, 2012). Research that involves seeing and analyzing patterns in a particular environment without any form of intervention is known as descriptive research (Erickson, 2017).

According to Kirub (2015), observation is a method of data collecting used in descriptive research. It attempts to define a standard by examining the conditions. It is foreseeable that such condition will happen again in the same circumstances. Research that is descriptive characterizes, explains, and elucidates the current situation, which in this study talks of effects of agricultural extension services on soybean production. Most typically, surveys or descriptive research are used for this kind of study. Observation or the use of an observational tool can be used.

Research Instruments

Questionnaires, interview guide and personal observations were the main data collection instruments. Questionnaires consists of well-structured questions to elicit responses from target population. In this study, both structured and semi-structured questionnaires were employed to collect quantitative data on major challenges of soybean production, how extension services and training affect technology adoption, relationship between agricultural extension services and soybean yield, and major challenges of agricultural extension services delivery in the district.

An interview guide was designed to take information on the research questions and the four main thematic areas of the research; which include major challenges confronting smallholder farmers regarding soybean production, how access to extension services and training affect agricultural technology adoption among smallholder farmers in the district, relationship between agricultural extension services and soybean yield, and major challenges of agricultural extension services delivery on sustainable soybean production in the Tolon district. The kind of data collected using interview guide was qualitative data to support the quantitative data during analysis.

Personal or direct observation is the systematic and meticulous examination of unforeseen events in our everyday lives via the lens of observation. The four main thematic areas such as major challenges confronting farmers regarding the production of soybean, access to extension services and training on agricultural technology adoption, agricultural extension services and soybean yield relationship, and major challenges of agricultural extension services delivery on sustainable soybean production in the Tolon district were all monitored and keenly observed by the researcher. The kind of data collected by the researcher through personal or direct observation of respondents was a qualitative data used to support the data analysis and the research findings.

Research Approach

In order to address the research questions, the study used the mixed methods (quantitative and qualitative) research approach because of its multiple functions. According to Creswell et al. (2018), mixed methods research involves researchers collecting more types of data and analyzing more types of information than either quantitative or qualitative research alone. This encourages the use of multiple worldviews, or paradigms, rather than the typical association of certain paradigms with quantitative research and others with qualitative research. It is also practical in nature and the researcher is free to use all methods possible to address a research problem. The practical nature also helps individuals to solve problems using both numbers and words.

Sampling Procedure and Techniques

A multi-sampling technique was used to sample 260 smallholder soybean farmers in 12 communities across the district for the study. At stage one, disproportional stratified sampling was employed to structure the district into 6 strata according to the number of area councils in the district. At the second stage, 12 communities were purposively selected from the Tolon district with the assistance of the head of agricultural extension unit, which was made up of 2 communities from each of the 6 area councils in the district. The 12 communities were selected because they are well known for the production of soybean in the Tolon district. Proportional sampling was used to determine the sample size of each community in the various area councils (extension zones). Finally, 260 smallholder soybean producers were selected using simple random sampling from the twelve 12 communities with the help of local farm leaders.

Purposive sampling was also used to select 16 agricultural extension agents (AEAs) at the district department of agriculture for their responses on the challenges affecting effective extension services delivery in the Tolon district. The agricultural extension workers were purposefully selected on the grounds of their experience and degree of involvement in the area of crops as extension staff. Key informants such as the community chief, assembly member and community chief Iman in the selected communities were also purposively selected for the key informant interview using the interview guide based on their experiences and involvement in farming activities in the district.

Sample Frame

Data from the district agricultural extension unit shows that there were 806 active smallholder soybean farmers in the 12 selected communities. This number was used as a sample frame for the research.

Determination of Sample Size

Krejcie and Morgan (1970) provides a simplified formula to calculate sample sizes. To calculate the sample size of smallholder soybean farmers to be interviewed for the study in the Tolon district using the Krejcie and Morgan formula:

$n = (Z^2 \times N \times P \times (1-P)) / (E^2 \times (N-1) + Z^2 \times P \times (1-P))$

where; n = sample size, Z = Z-score, N = population size (total number of soybean farmers in the selected communities of the district), P = estimated population proportion, E = desired margin of error.

Assumptions; 95% confidence level (Z) = 1.96 was used for the study with 5% desired margin of error (E) = 0.05, population size (N) = 806, estimated population proportion (P) = 0.5 (maximum variability).

Calculation of sample size using the formula:

$n = (Z^2 \times N \times P \times (1-P)) / (E^2 \times (N-1) + Z^2 \times P \times (1-P))$

$n = (1.96^2 \times 806 \times 0.5 \times (1-0.5)) / (0.05^2 \times (806-1) + 1.96^2 \times 0.5 \times (1-0.5))$

$n = (3.8416 \times 201.5) / (0.0025 \times 805) + 3.8416 \times 0.25)$

$n = 774.0824 / 2.0125 + 0.9604$

$n = 774.0824 / 2.9729 \approx \mathbf{260}$

Approximately, a sample size value of 260 soybean farmers was gotten using the above formula.

Table 1 below indicate the distribution of respondents by area councils and communities.

Table 1: Distribution of Respondents by Area Councils and Communities

Area Council (Extension Zone)	Name of Community	Sample Frame of Soybean Farmers	Sample Size of Soybean Farmers
Nyankpala	Galinkpegu	66	21
	Tingoli	67	22
Tolon	Kambonaayili	64	21
	Yipelgu	78	25
Tali	Gburimani	86	28
	Nagbligu	60	19
Yoggu	Dabogshei	63	20
	Wayamba	68	22

Kasuliyili	Nyujagyili	55	18
	Kasuliyili	80	26
Lungbung	Gundaa	62	20
	Wala	57	18
Total	**12**	**806**	**260**

Source: *Field Survey, 2023*

Data Collection and Analysis

Data collected was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 23 and Microsoft Excel. Data analysis was done using descriptive statistics and chi-square, and the results presented in frequencies, percentages, means and tables.

RESULTS AND DISCUSSION

Table 2: Major Challenges Affecting Smallholder Soybean Farmers

Variable	Frequency	Percentage	Mean
Lack of funding support	10	3.8	1.0
Lack of access to extension services	13	5.0	1.3
Lack of access to quality farm inputs	14	5.4	1.4
High cost of labour	17	6.5	1.7
Lack of access to improved technologies	17	6.5	1.7
Lack of storage facilities	18	6.9	1.8
Lack of machinery for planting and harvesting	19	7.3	1.9
Pest and diseases infestation	22	8.5	2.2
Low prices and exploitation by aggregators	36	13.8	3.6
Climate change	94	36.2	9.4

Source: *Field Survey, 2023*

The table 2 presents data on the various challenges faced by smallholder soybean farmers. The most prominent challenge identified by respondents is "Climate change," with a frequency of 94, accounting for 36.2% of the responses, and a mean score of 9.4. This high mean score and percentage suggest that climate change significantly impacts soybean farming, likely affecting weather patterns, crop yields, and farming cycles. The study agrees with the findings of Alare et al. (2018), who claims that climate change affects the welfare and livelihood of smallholder farmers who depend on rain-fed agriculture. According to Shaw (2012), climate change over the years has proven to be a major menace to the development of many countries around the world, particularly the sub-Saharan Africa (SSA). This is followed by "Low prices and exploitation by aggregators," which has a frequency of 36 (13.8%) and a mean score of 3.6. The substantial concern here points to the economic challenges farmers face when selling their produce, as they may not receive fair prices, impacting their overall income and sustainability.

Pest and diseases infestation also poses a significant issue, with a frequency of 22 (8.5%) and a mean score of 2.2. This highlights the biological threats to soybean crops, which can reduce yields and require additional management efforts from farmers. Other notable challenges include "Lack of machinery for planting and harvesting" (7.3%), "Lack of storage facilities" (6.9%), and "High cost of labour" and "Lack of access to improved technologies," both at 6.5%. These factors indicate infrastructure and resource constraints that can hinder productivity and efficiency in soybean farming.

Less frequently mentioned issues include "Lack of access to quality farm inputs" (5.4%), Lack of access to extension services (5.0%), and "Lack of funding support" (3.8%), with respective mean scores of 1.4, 1.3, and 1.0. Although these challenges are reported by fewer respondents, they still reflect important barriers that could affect farming operations, especially regarding access to financial and technical resources.

Overall, the table suggests that climate-related and economic factors are the most pressing concerns for soybean farmers, while structural and support-related issues are also present, though less frequently reported. Addressing these challenges holistically could help improve productivity, sustainability, and the livelihoods of smallholder soybean farmers. Climate smart agricultural practices (CSAPs) are informed agronomic practices that help to reduce the negative consequences of climate change (Minx et al., 2017).

Table 3: Impact of extension services on Agricultural technology adoption

	Technology Adoption		
Variable	**Yes**	**No**	**P-Value**
Education on best farming practices	104	42	0.03
Education on the access and use of improved seeds	3	4	0.32
Education on access and use of new farming technologies	3	4	0.35
Education on access and use of new farming inputs such as chemicals, fertilizer	10	22	0.07
Education on storage and marketing opportunities	24	38	0.09
Visitations from extension agents to my farm	4	2	0.08

Source: *Field Survey, 2023* [AOR—3.0; 95% Cl (1.41-9.54), p= 0.03]

The table presents findings on the impact of extension services on technology adoption among farmers, focusing on various aspects of education and support provided to improve farming practices and resource utilization. The table measures responses to each variable in terms of "Yes" (those who received the service) and "No" (those who did not), along with p-values to assess the statistical significance of each variable's impact.

Among the listed of variables, Education on best farming practices has the highest frequency of the "Yes" responses with about 104 respondents reporting that they received this type of education, compared to 42 who did not. This variable also has a statistically significant p-value of p= 0.03, suggesting that education on best farming practices has a significant impact on technology adoption. Furthermore, at adjusted odds ratio farmers educated on best farming practices have 3 times higher likelihood of adopting new technology compared to those without this education at [AOR—3.0; 95% Cl (1.41-9.54), p= 0.03]. This makes it the variable with the highest chance of impact on technology adoption among the items measured.

Other variables, including Education on access and use of improved seeds, Education on access and use of new farming technologies, and "Education on storage and marketing opportunities," do not show statistically significant p-values, as their p-values are above 0.05 (0.32, 0.35, and 0.09, respectively). While these areas are also essential for supporting technology adoption, the lack of statistical significance suggests they may not have as strong an impact as "Education on best farming practices." This agrees with the findings of Zakaria et al. (2020), several researchers and institutions over time have advocated the need for farmers to adopt improved technologies to improve production.

Education on access and use of new farming inputs such as chemicals and fertilizers also show a p-value of 0.07, indicating a moderate association but not reaching statistical significance at the 0.05 level. Lastly, "Visitations from extension agents to my farm" shows a p-value of 0.08, again indicating a positive trend but not strong enough to be statistically significant.

Table 4: Relationship Between Access to Extension Services and Soybean Yield

	Technology Adoption		
Variable	**Good Yield**	**Poor Yield**	**P-Value**
Education on best farming practices	67	79	0.53
Education on the access and use of improved seeds	4	3	0.02
Education on access and use of new farming technologies	3	4	0.03
Education on access and use of new farming inputs such as chemicals, fertilizer, etc	16	16	0.52
Education on storage and marketing opportunities	33	29	0.31
Visitations from extension agents to my farm	5	1	0.82

Source: *Field Survey, 2023*. [AOR—4.3; 95% Cl (1.51-6.54), p= 0.02], [AOR—2.1; 95% Cl (1.21-9.54), p= 0.03]

The table illustrates the impact of extension services or various educational interventions on technology adoption and its correlation with yield outcomes, categorized as "Good Yield" and "Poor Yield." The variables measured include education on best farming practices, access and use of improved seeds, new farming technologies, new farming inputs such as chemicals and fertilizers, storage and marketing opportunities, and visitations from extension agents. For each variable, the table provides the count of respondents reporting good versus poor yields, along with p-values indicating the statistical significance of each variable's impact.

Among the variables, "Education on the access and use of improved seeds" has a statistically significant p-value of 0.02, indicating a notable association with yield outcomes. This variable also has an adjusted odds ratio (AOR) of 4.3 with a 95% confidence interval of 1.51–6.54, suggesting that farmers educated on the access and use of improved seeds are over four times more likely to achieve good yields compared to those who are not. This makes it the variable with the highest chance of positively impacting yield outcomes. The findings agreed with Danso-Abbeam et al. (2018), who claims that inadequate extension services have been identified as one of the main limiting factors to the growth of the agricultural sector and rural community development at large.

Education on access and use of new farming technologies also shows statistical significance with a p-value of 0.03, accompanied by an AOR of 2.1 and a 95% confidence interval of 1.21–9.54. This indicates that farmers educated on new farming technologies have a more than twofold likelihood of achieving good yields, suggesting a strong but somewhat lesser impact compared to education on improved seeds. This support the findings of Danso-Abbeam et al. (2018), there is a positive economic gain from participating in the agricultural extension programmes.

Other variables, including Education on best farming practices (p = 0.53), "Education on access and use of new farming inputs" (p = 0.52), "Education on storage and marketing opportunities" (p = 0.31), and "Visitations from extension agents to my farm" (p = 0.82), do not demonstrate statistically significant associations with yield outcomes, as their p-values are above 0.05. These variables, while potentially valuable for other reasons, do not show a strong correlation with yield improvement in this data set.

Table 5: Major Challenges that Affect Extension Services

Variable	**Frequency**	**Percentage**	**Mean**
Poor road network to farming communities	1	6.3	0.06
High illiteracy rate among farmers	1	6.3	0.06
Insufficient funds to train farmers	1	6.3	0.06
Insufficient training for AEAs	1	6.3	0.06

High farmer to extension agent ratio	2	12.5	0.12
Government policies	2	12.5	0.12
Inadequate motorbikes and fuel to visit farms	3	18.8	0.18
Too much workload for AEAs	5	31.3	0.3
Mean			4.1

Source: *Field Survey, 2023*

The table highlights key factors affecting agricultural extension activities, as evidenced by the reported percentages and means. Starting with the factors with the lowest impact, Poor Road network to farming communities, High illiteracy rate among farmers, Insufficient funds to train farmers, and Insufficient training for AEAs each contributed 6.3% to the reported challenges. This low frequency suggests that while these factors are present, they may not be as immediately significant as other constraints faced by agricultural extension agents (AEAs).

High farmer to extension agent ratio and Government policies each accounted for 12.5% of the challenges. These factors reflect issues related to resource allocation and structural constraints within the agricultural extension framework. The relatively higher percentage compared to the previous group indicates that these are notable issues that potentially limit AEAs' capacity to provide effective support to farmers.

Inadequate motorbikes and fuel to visit farms, reported by 18.8% of the respondents, represents a considerable logistical challenge. Limited transportation resources restrict AEAs' ability to reach farming communities, hindering timely support and reducing the effectiveness of extension services. This factor's prominence underscores the importance of logistical support to bridge the gap between extension services and farmers.

The most significant factor, too much workload for AEAs, was reported by 31.3% of respondents. This high percentage indicates that AEAs are often overburdened, likely reducing the quality and frequency of their interactions with farmers. The high workload can stem from insufficient staffing, leading to overstretched resources and limited capacity to address the diverse needs of farming communities effectively.

In terms of mean values from lowest to highest, the data shows that Poor Road network to farming communities, High illiteracy rate among farmers, Insufficient funds to train farmers, and Insufficient training for AEAs each have a mean of 0.0625, representing the smallest proportionate contribution to the overall challenges. High farmer to extension agent ratio and Government policies follows, each with a mean of 0.125. Inadequate motorbikes and fuel to visit farms shows a slightly higher mean at 0.1875, while too much workload for AEAs has the highest mean of 0.3125. This distribution reflects a prioritization of challenges, with workload issues and logistical constraints standing out as the primary obstacles in the provision of effective agricultural extension services.

The field data support the findings of Farooq et al. (2010), who claimed that the major difficulties faced by the field assistants are non-availability of their offices, few extension workers, low qualification and communication skill and needs to be improved non availability of field assistant's offices, lack of teaching equipments/facilities, poor linkages between research and extension organizations, mobility/funds and dispersion among the farmers were the major obstacles hampering extension agents to contact farmers and to develop educational program. With regards to technical services difficulties such as lack of resources, poor knowledge regarding improved agricultural technologies, illiteracy among the farmers and communication problems were also identified by AEAs. Poverty, high rates of inputs, lack of resources and illiteracy were the major constrained identified by extension agents regarding the promotion/adoption of improved agricultural technologies among the farmers.

CONCLUSIONS

The most prominent challenges affecting soybean farmers in the study area according to the field data include; Climate change, Low prices and exploitation by aggregators, Pest and diseases infestation, Lack of machinery for planting and harvesting, Lack of storage facilities and many others with its respective mean scores.

The study findings revealed that education on best farming practices for soybean farmers has a significant impact on technology adoption for sustainable soybean production in the district, with a statistically significant p-value of 0.03.

The study discovered education on the access and use of improved seeds has a statistically significant p-value of 0.02, indicating a notable association with yield outcomes. Education on access and use of new farming technologies also shows statistical significance with a p-value of 0.03

The study revealed that the most significant factor affecting extension services delivery is insufficient extension officer and limited capacity compare to workload for Agricultural Extension Agents (AEAs) with the highest mean of 0.3125.

Also, it was discovered that inadequate logistics such inadequate motorbikes and fuel to visit farms shows a slightly higher mean at 0.1875.

High farmer to extension agent ratio and government policies were also noted to be the challenges affecting extension services delivery in the district with the same mean of 0.12.

RECOMMENDATIONS

The following recommendations have been suggested to help improve upon sustainable soybean production and agricultural extension services delivery in the Tolon District.

1. More extension services and training should be given to soybean farmers in the study area on the promotion and adoption of modern technology production such as climate-smart agricultural practices, in order to mitigate climate change which is the prominent challenge affecting food security and rural livelihoods in the study area.
2. Education on best farming practices for soybean farmers has a significant impact on technology adoption for sustainable soybean production in the district, it should therefore be improved upon by the Agricultural Extension Agents (AEAs) in the district.
3. The field data revealed that access to extension services and training by soybean farmers has a direct impact on soybean yield, therefore the need to strengthen extension services delivery in the district.
4. Government should recruit more agricultural extension officers to solve the main challenge of too much workload for Agricultural Extension Agents (AEAs). They should also be equipped with enough resources such as motorbikes, fuel, allowances and other logistics to improve extension services delivery in the district. NGOs and other private organizations should be encouraged to go into extension service delivery to solve the problem of too much workload on the few extension staff in the district and the region as well.

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