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Towards Sustainable Agriculture: Drivers of Access to Microcredit and Extension Services amongst soyabean farmer in Northern Region, Ghana

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Abstract

In this study, we examined factors that influence farmer's decision to access microcredit and extension services in Northern Region, Ghana. Through cross-sectional design with multi-stage sampling techniques, a primary data was gathered from 200 smallholder soyabean farmers using semi-structured questionnaires. The study employed descriptive statistics, the Bivariate Probit Model, and Kendall's coefficient of concordance to analyse the data. The findings show that extension service and microcredit are provided by government and private persons respectively. Also, access to credit is influenced by farmer experience, family labour and farmer size, whereas access to extension service is influenced by household size, farming experience, literacy, and family labour. Moreover, farmer's access to microcredit and extension service is constrained by high interest rates and a lack of capital. Based on the findings, we recommended that agriculture policy design and implementation through Ministry of Food and Agriculture should take the bottom-up approach to address the needs of farmers accordingly.

Keywords: Biochar, Microcredit, Extevsion service, Husk, Constrains

Introduction

Agriculture is undoubtedly instrumental to the global vision of ending hunger and achieving food security by 2050, as enshrined in the Sustainable Development Goals (SDGs) and agender for sustainable development (Mollier *et al.*, 2017). In global southern countries including Ghana, agriculture remained the main vehicle for carting these countries towards economic development through its unwavering contribution to Gross Domestic Products (Food and Agricultural Organisation, FAO, 2018). According to Praburaj (2018), agriculture has already left a positive footprint in the Global North by strategically transforming these economies through its contribution to national income, food supply for consumption, raw material supply for industrial production, capital formation, improving rural welfare, and increasing foreign exchange earnings. In continental Africa, Kiplimo *et al.* (2015) highlighted the impetus agriculture offers

for economic growth and development through its synergic stimulation of other sectors of the economy, ultimately improving food security and widespread poverty reduction. Furthermore, Anang *et al.* (2015) acknowledged the strategic role of agriculture in wheeling most African economies towards sustainable development through employment creation, income earnings, Gross Domestic Product (GDP), food security, and foreign exchange earnings.

Notwithstanding the strategic role of agriculture in charting the path of economic development, the sector has not been given the necessary priority to spur economic development in some developing countries (Mushi *et al.*, 2022). In Ghana, some policy reforms such as the Structural Adjustment Program (SAP), Vision 2020, Ghana Poverty Reduction Strategy and Growth and Poverty Reduction Strategy (GPRS I & II), Ghana Shared Growth and Development Agenda (GSGDA I & II), and Planting for Food and Jobs (PFJs) in a very recent memory call for direct government intervention to boost the performance of the sector to enhance rural livelihoods, income, and declining poverty levels (Diao *et al.,* 2019).

One of the policy interventions that needs government priority to augment the fortunes of the agriculture sector is microcredit and extension services because of their potential to spur the growth of the sector (Anang *et al.*, 2020). However, smallholder farmers in some parts of Ghana, particularly the northern region of Ghana, are behind the wheel of microcredit and extension services that can help them improve their production capacities (Abdul-Hanan and Abdul-Rahaman, 2016). Soyabeans are an arable crop in the northern region that requires special support schemes of microcredit and extension services due to their demand for industrial and domestic uses (Asodina *et al.,* 2021). According to Asodina et al. (2021), the domestic and industrial demand for soyabeans in Ghana is in a deficit of 150,000 MTs according to Asodina *et al.* (2021), and smallholder soyabean farmers, who made enormous contributions to fill this demand gap, particularly in the northern region, have limited access to credit and extension services to muscle this high demand gap for soya beans (Mohammed *et al.*, 2018).

Despite the recognized role of credit and extension services in augmenting agricultural production in developing countries (Mohammed *et al.*, 2018), access to these services still lags in some countries, including Ghana (Moahid *et al.*, 2021). This access gap is evident among smallholder farmers in Ghana, considering that about 80% of the overall agricultural production comes from this sub-production group, out of which 76.1% are from rural communities (Abdul-Hanan & Abdul-Rahaman, 2016) It is worth questioning how access to these services could affect the production of soya -beans in the extant literature.

Whereas the available literature unveiled the determinants of access to extension services among smallholder farmers (Abdul-Hanan & Abdul-Rahaman, 2016), the income effects of extension services (Anang *et al.*, 2020), and the influence of smallholder farmers' access to microcredit (Anang *et al.*, 2015), in the Northern region, there still exist some grey areas on the factors that influence smallholder soya bean farmers' decision to access microcredit and extension services and its effect on soybean production in the knowledge frontier in the Northern region. Thus, this study fills this gap in the frontier of knowledge.

Literature Review

According to Hitomi and Selva (2015) credit can be defined as a strategy used to assign credit to a low-level persons based on each solution it generates. Agricultural

credit can be defined as a source of credit used for agricultural activities. In the view of Hitomi and Selva (2015), agricultural credit can take the forms such as loans, inputs, bills among others. Described credit as a business transaction between one people to two or more people usually conducted as a favour made for it to be paid in the future by the borrower. Transferring knowledge from scientists to farmers, assisting farmers with decision-making, and finally educating farmers on how to make better decisions that will enable them to clear up some misconceptions that will lead to the development of agriculture are some of the objectives of extension service (Danso-Abbeam *et al.,* 2018). Accordingly, the logit model used by Owusu (2017) to examine the impact of credit availability on agricultural productivity in the Afigya-Kwabre District of Ghana revealed that factors such as Sex, age, household size, education level, size of farm, hired labour, and extension services, and farmer-lender distance had a significant impact on access to credit.

Materials and methods

Research Design

We adopted the positivist research philosophy in this study, and based on deductive logic, mathematical equations were used to answer the research questions and draw conclusions (Kivunja & Kuyini, 2017). A cross-sectional survey design was used to generate quantitative information on the influence of the predictor variables on the outcome variable. The target population for this study was smallholder soybean farmers in northern Ghana. According to the MoFA (2016), smallholder farmers hold less than two hectares (five acres) of land. Additionally, Chamberlin (2007) states that smallholders are those who produce few crops, sell less, and are most likely to use purchased inputs. The population was drawn from three districts, Tolon, Mion, and Nanton, out of the 12 districts in the Northern Region. Based on the scholarly definition of smallholder farmers, the target farmers who qualified for this study were those with a farm size of 0–7.5 acres. Having defined the target population, a sample size of 200 smallholder soybean farmers was drawn from the selected district using the formula developed by Kumar (2011). Thus, we desired a 93% confidence interval with a 7% margin of error based on Taherdoost's (2017) recommendation of 5% and 7% margins of error in social science research. Based on a multi-stage sampling technique, which was done by first conducting a purposive technique followed by stratified and the simple random technique was finally employed to arrive at sa sample sixe of 200 smallholder soybean farmers.

Thus, we proceeded with data collection after determining the appropriate sample size. Therefore, the questionnaire was used as a data collection tool, and the researcher administered the questions to the respondents. We relied on previous research tools (Kiplimo *et al.*, 2015; Anang *et al.*, 2020), that were adopted and modified to fit the purpose of this study. Primary data collected from the survey were analyzed using SPSS version 22, Stata, and Microsoft Excel. The analysis was performed in accordance with the study objectives. Each objective was analyzed using the appropriate econometric model. Cronbach's alpha was used to test the reliability of the Likert-scale constructs and variable inter-correlations. Each objective was achieved using an appropriate tool. Objective one was analyzed using descriptive statistics, where requency frequency, percentage, mean, and standard deviation were used. The frequency percentage was used to analyze specific sociodemographic variables such as age, level of education, level of income, crops cultivated, and farm size, among others. In addition, the mean and standard deviation, skewness, and kurtosis were used to analyze the responses on the Likert scale constructs that determine the effects of the predictor variables on the outcome variable.

Analytical framework

The bivariate probit regression model was used in this study to assess the factors that influence smallholder soya bean farmers' access to credit and extension, which is objective two. The bivariate probit model was used in this study because it has the power to limit the utility value of the outcome variable (access to microcredit and extension) to lie between zero and one, and the ability to resolve the problem of heteroscedasticity (Adams, 2018), hence it is the perfect model for this study. In addition, a bivariate probit was used under the assumption that farmers who have access to microcredit also have access to extension services. This means that a rational farmer who decides to access microcredit will also opt for extension services to maximize gains from the soya bean field. Due to the binary nature of the two dependent variables, which are joints/complements, the bivariate probit is used to analyze the joint decision of farmers accessing microcredit and extension services. The bivariate probit model also accounts for possible correlations that may exist between the error terms of microcredit access and extension service variables. Suppose the dependent variables are binary with only two possible outcomes (1 for credit access and 0 otherwise; 1 for extension service and 0 otherwise); then, the bivariate probit model is expressed as

$$y_{1i}^{*} = \beta_1 X_{1i} + \varepsilon_{1i}$$
$$y_{2i}^{*} = \beta_2 X_{2i} + \varepsilon_{2i}$$

Equ. [3]

where y_{1i}^{*} and y_{2i}^{*} represents latent (unobserved variables), X_1 and X_2 is a vector of explanatory variables assumed to influence y_1 and y_2, βs represents a vector of unknown parameters to be estimated, and ε_1 and ε_2 represents the error terms of the Extension Service access and microcredit access models. The residuals are assumed to follow a bivariate normal distribution with a mean of 0 and a constant variance of 1, and the correlation coefficient ρ is a measure of the correlation between the two variables:

$$\begin{bmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right)$$

Equ. [4]

The latent variable y_{1i}^{*} and y_{2i}^{*} represents the likelihood that a farmer would access microcredit and extension services delivered together. The two dependent variables are not measured directly, but are measured through the latent variable y_{1i}^{*} and y_{2i}^{*}, which is observed through the measurement model:

$$y_1 = \begin{cases} 1, \textit{ if } \; y_{1i}^{*} > 0 \\ 0, \textit{ otherwise} \end{cases} \; \textit{and} \; \; y_2 = \begin{cases} 1, \textit{ if } \; y_{2i}^{*} > 0 \\ 0, \textit{ otherwise} \end{cases}$$

Equ. [5]

The empirical specification of the bivariate probit model for this study is expressed as follows:

$$y_1 = \beta_0 + \beta_x \_ Demographic \_ factors + \beta_y \_ Socioeconomic \_ factors + \beta_z \_ Institutional \_ factors + \varepsilon_1$$

Equ. [6]

$$y_2 = \beta_0 + \beta_x \_ Demographic \_ factors + \beta_y \_ Socioeconomic \_ factors + \beta_z \_ Institutional \_ factors + \varepsilon_1$$

Equ. [7]

Kendall's Coefficient of Concordance

Objective three was achieved through the use of this method. Kendall's coefficient of concordance was used to rank the constraints of smallholder farmers with regard to the adoption of access to microcredit and extension. This model was chosen because it measures the agreement among various responses in a rank order ranging from zero to one, representing no agreement to complete agreement. It represents the ratio of the variability of the

total rank for the ranked entities to the maximum possible variability of the total rank; a small ratio implies disagreement between judges (Herrmann & Bucksch, 2014).

Kendall's W is given as;

$$W = \frac{12S}{m^2(n^3 - n) - mT}$$

Equ. [9]

where W is Kendall's coefficient of concordance (agreement among observers), m is the number of respondents ranking the constraints, n is the number of constraints, T is the correction factor for tied ranks, and S is the sum of squares deviation over the row sum of ranks R_i.

The sum of the square deviation is given as Where R_i is the row sum of ranks

$$R_i = \sum_{j=1}^{n} r_{ij}$$

Equ. [10]

$\bar{R}$ Is the mean of the row sum of ranks; given as $\bar{R}_i = \frac{1}{n}\sum_{i=1}^{n} R_i$ Equ. [11]

Results and Discussion

Sources of Extension Service and Microcredit to Smallholder Soya Bean Farmers

The majority of respondents (44.17%) received extension services from the government, while 31.67% obtained their services via farmer-based organizations. Furthermore, 23.33% of smallholder soya bean farmers in the northern region receive extension services from NGOs, with only 0.83% of them depending on their fellow farmers. Overall, (60%) of smallholder soya bean farmers access extension services in the Northern Region, while (40%) do not access any form of extension service.

An equally significant aspect of this study is the source of microcredit for smallholder soya bean farmers in the Northern Region. Our findings, based on sources of microcredit to farmers, highlight that (23.5%) of smallholder soya bean farmers access microcredit from private individuals, (21.5%) from farm household savings, and (21%) from agro-industry dealers. Another striking finding was that 13.5%) of smallholder farmers accessed microcredit from formal micro-institutions. In contrast, this finding reflects the true picture of smallholder farmers in the Northern Region, as the majority (83%) lack formal education, which could be a driving factor for low access to formal microcredit (Sekyi *et al*., 2017; Abdallah *et al.*, 2018).

Table 1: Sources of Extension Services

Sources of extension service	Freq.	Percentage
Colleague Farmer to Farmer	1	0.83
Government	53	44.17
NGO's	28	23.33
Farmer Based Organization	38	31.67
Total	120	100.00

Source: Field Survey, 2022

Farmers' Microcredit and Extension Services Access: Influencing Factors

A Bivariate Probit model was used to assess the relationship between access to microcredit and extension services by smallholder soya bean farmers. Our analysis produced a correlation coefficient of 0.5003, which is significant at the 1% level, indicating that access to Microcredit

and Extension Services is correlated. Furthermore, the likelihood ratio (LR) chi-square value of 184.66, which is significant at the 1% level, indicates that the explanatory variables both contributed to explaining variations in access to microcredit and the decision to use extension services.

Nineteen variables were hypothesized to influence the response variables (access to microcredit and access to extension services). However, our analysis indicates that nine variables influence the response variables. First, the gender of smallholder soya bean farmers was found to have a negative effect on access to extension services and microcredit access at a significance level of 5% (0.9402) and 1% (2.0099), respectively. This result corroborates Abdallah *et al.* (2018), who found that sex is a factor that influences farmers' access to microcredit. On the other hand, the marginal effect that measures the joint probabilities of extension service access and access to microcredit is negative but significant at the 1% level with a negative probability value of 0.3583.

Second, farmers' age significantly determines their access to extension services. Age has a significant negative effect on access to extension services at the 1% level, implying that farmers' age increases, with a decreasing likelihood of access to extension services. However, access to microcredit and the marginal effects of the two response variables were statistically insignificant. This finding contradicts Abdul-Jalil (2015), who found age to be a significant factor in accessing credit in the Karaga district of the northern region.

In addition, household size (measured as the number of people per household) was positive in accessing extension services (coefficient value of 0.0775) and negative in accessing microcredit (coefficient value of 0.0436) at the 1% and 5% significance levels, respectively. The implication is that an increase of 1% and 5% in the house size of the farmer increases the likelihood of accessing extension services and decreases the likelihood of accessing microcredit, respectively. The study's findings support Abdul-Jalil (2015), who found that household size is a determining factor in accessing microcredit in the Karaga district. However, the marginal effect was not statistically significant at the 1%, 5%, and 10% levels.

Furthermore, our analysis revealed farmers' experience in soya bean farming (measured in years) as a significant factor in accessing extension access and microcredit at a 1% significance level. The findings imply that a 1% increase in soybean farming increases the likelihood of farmers accessing microcredit and extension services. The current findings resonate well with Owusu (2017), who found that farmers' experience in farming influences their access to microcredit. Again, the marginal effect, which measures the probability of extension services and microcredit access, was also significant at the 1% level with a probability value of 0.0214. This implies that an increase in farmer experience by 1% has a corresponding increase of 0.0214 probability in accessing microcredit and extension services.

The size of a smallholder soya bean farm (measured in hectares) did not significantly influence farmers' access to extension services at a 5% significance level. However, this significantly influences farmers' access to microcredit. The findings here contradict those of Nkegbe *et al.* (2012) and Abdallah *et al.* (2014), who considered farm size to be a significant determinant of access to extension services. At 10%, the marginal effect analysis returned a probability value of 0.0316, implying that, with every hectare increase in farm size, the probability that a farmer will access both extension and microcredit

increases by 3.16%. This finding was supported by (Akudugu 2012; Abdul-Jalil 2015; Owusu, 2017; Abdallah *et al*.,2018).

The results of our analysis indicate that family labor has a significant effect on access to extension services and microcredit at different significance levels. Whereas family labor (coefficient 0.4769) was significant at 10% in access to extension services, it was significant at 1% in access to microcredit in the model estimation. The implication is that an increase in family labor by 10 increases the chances of accessing extension services. Similarly, an increase in family labor by 1 scales the chances of the household accessing microcredit by the same margin. This result is supported by Abdallah *et al.* (2018), who also found labor as a significant factor influencing farmers' access to microcredit.

The study further revealed that farmers' cultivation of maize, rice, and groundnuts has some effect on access to credit and extension services. With maize cultivation, the analysis indicates that, a farmer who cultivates maize as an additional crop has a negative probability value on access to extension service and a positive value on access to microcredit at 10% (0.8081) and 1% (1.3427) respectively. In contrast, rice cultivation has a positive probability value for access to both extension services and microcredit at 5% (0.6246) and 1% (1.0679), respectively. The marginal effect analysis indicated that was significant for the two variables at 1%, with a probability value of 0.1984. In addition, groundnut cultivation as an additional crop has a negative probability value on extension service access and a positive value on access to microcre dit at 1% (0.6683) and 5% (0.5920) respectively. This implies that a farmer cultivating groundnut as an additional crop decreases their chances of accessing extension services by 1% and increases the chances of accessing microcredit by 5%. We further established farmer literacy to have a positive probability value of 0.6628, significant at the 10% level in extension service access. This means that when a farmer's access to education and the ability to read and write increases by 10%, their chances of accessing extension services will increase. Literacy was not a significant factor in accessing microcredit. Contrary to this finding, Sekyi *et al*. (2017) and Abdallah *et al.* (2018) found that literacy influences farmers' access to microcredit.

Table 2: Bivariate Probit estimates of extension access, microcredit access and marginal effects

Variable	Extension access	Credit access	Marginal effect
Sex	-0.9402**	-2.0099***	-0.3583***
	(0.3811)	(0.4102)	(0.0799)
Age	-0.0411***	0.0137	-0.0006
	(0.0144)	(0.0138)	(0.0024)
Household size	0.0775***	-0.0436**	-0.0015
	(0.0175)	(0.0205)	(0.0039)
Years in formal education	-0.0490	0.0321	0.0016
	(0.0331)	(0.0362)	(0.0062)
Experience in soya bean farming	0.1138***	0.0948***	0.0214***
	(0.0383)	(0.0352)	(0.0069)
Farm size	-0.0415	0.2313**	0.0316*
	(0.1039)	(0.1013)	(0.0176)
TV ownership	-0.2193		-0.0141
	(0.2539)		(0.0167)
Radio ownership	0.4310**		0.0276*
	(0.2197)		(0.0149)
Phone ownership	0.3234		0.0207
	(0.2984)		(0.0181)
Farmer award	-0.6707**	-0.1377	-0.0634

	(0.2643)	(0.2678)	(0.0495)
Family labour	0.4769*	0.8444***	0.1558***
	(0.2436)	(0.3253)	(0.0508)
Hired labour	-0.5036*	0.2054	-0.0018
	(0.2630)	(0.2900)	(0.0502)
Maize	-0.8081**	1.3427***	0.1473**
	(0.3565)	(0.3751)	(0.0659)
Rice	0.6246**	1.0679***	0.1984***
	(0.2880)	(0.2588)	(0.0516)
Groundnut	-0.6683***	0.5920**	0.0449
	(0.2431)	(0.2678)	(0.0491)
Ownership of livestock	1.4038***	0.5938**	0.1780***
	(0.2966)	(0.2849)	(0.0552)
Market access	1.1693***	0.4713	0.1448**
	(0.2803)	(0.3347)	(0.0571)
Literacy	0.6628*	-0.0291	0.0382
	(0.3545)	(0.4026)	(0.0635)
Distance from farm to credit institution		0.0014	0.0002
		(0.0132)	(0.0020)
Constant	-0.0591	-3.7374***	0.5498***
	(0.6638)	(0.9237)	(0.1674)
rho	0.5003***		
	(0.1255)		
Wald $chi^2(34)$	184.66***		
Observations	197	197	197

Source: Field Survey, 2022

Wald test for rho = 0: chi^2 (1) = 10.7877***

*** p<0.01, ** p<0.05, * p<0.1

NB: Values in brackets are robust standard Errors

Marginal Effect Estimates

Table 4 shows the marginal effect of joint probabilities. Here, it is assumed that a rational farmer will want access to both extension services and microcredit to maximize output. Therefore, the variables are tested by joining both extension service access and microcredit at various levels: accessing both extension services and microcredit accessing extension services without microcredit, accessing microcredit without extension services, and finally not accessing both extension services and microcredit. Therefore, the findings revealed that the age of smallholders was significant at the 5% level, with probabilities p ($y_1 = 0$, $y_2 = 0$). This means that a smallholder farmer in the Northern Region does not have access to extension services and microcredit. This indicates that when the age of a farmer increases by one, their chances of not accessing either extension or microcredit increase by 1.2%. for p ($y_1 = 0$, $y_2 = 1$), which is also significant at 5%, indicating that when the age of a smallholder farmer increases, the chances that the farmer will not access extension service but accessed microcredit will increase by 0.4% points. Likewise, at p ($y_1 = 1$, $y_2 = 0$), which is also significant at 1%, it indicates that when the age of a farmer increases by 1, the chances of a smallholder farmer accessing extension service without microcredit decreases by 1.5% points. Finally, for p ($y_1 = 1$, $y_2 = 1$), age was not statistically significant at any level.

The household size of smallholder soya bean farmers was significant at the 1% level, with a negative *P* value at p ($y_1 = 0$, $y_2 = 0$). This means that smallholder farmers do not have access to extension services and microcredit. This indicates that when there is an increase in a farmer's

household size by one person, their chances of not accessing both extension and microcredit decrease by 2.1%. For p (y_1 = 0, y_2 = 1), which is significant at the 1% level, it indicates that when the household size increases by one person, the chances that the farmer will not access extension services but will access microcredit will decrease by 0.9% likewise at p (y_1 = 1, y_2 = 0), which is also significant at the 1% level. This indicates that when the household size of a farmer increases by 1, the chances of a smallholder farmer accessing extension services without microcredit increases by 3.1%. Finally, at p (y_1 = 1, y_2 = 1), household size was not statistically significant at any level.

Table 3: Marginal effect estimates for the respective outcomes of microcredit and extension access

Variable	P (y_1 = 0, y_2 = 0)	P (y_1 = 0, y_2 = 1)	P (y_1 = 1, y_2 = 0)	P (y_1 = 1, y_2 = 1)
Sex	0.5019***	-0.1407**	-0.0030	-0.3583***
	(0.1323)	(0.0582)	(0.1434)	(0.0799)
Age	0.0118**	0.0040**	-0.0152***	-0.0006
	(0.0049)	(0.0019554)	(0.0047)	(0.0024)
Household size	-0.0205***	-0.0093***	0.0313***	-0.0015
	(0.0064)	(0.0031)	(0.0056)	(0.0039)
Years in formal education	0.0125	0.0064	-0.0205*	0.0016
	(0.0119)	(0.0044)	(0.0107)	(0.0062)
Experience in farming	-0.0459***	0.0022	0.0224*	0.0214***
	(0.0135)	(0.0037)	(0.0120)	(0.0069)
Farm size	-0.0098	0.0258**	-0.0476	0.0316*
	(0.0372)	(0.0119)	(0.0340)	(0.0176)
TV ownership	0.0702	0.0141	-0.0702	-0.0141
	(0.0809)	(0.0167)	(0.0809)	(0.0167)
Radio ownership	-0.1380*	-0.0276*	0.1380*	0.0276*
	(0.0714)	(0.0149)	(0.0714)	(0.0149)
Phone ownership	-0.1035	-0.0207	0.1035	0.0207
	(0.0977)	(0.0181)	(0.0977)	(0.0181)
Farmer award	0.2285**	0.0292	-0.1943**	-0.0634
	(0.0996)	(0.0263)	(0.0780)	(0.0495)
Family labour	-0.2371***	0.0538	0.0275	0.1558***
	(0.0887)	(0.0356)	(0.0816)	(0.0508)
Hired labour	0.1407	0.0528	-0.1917**	-0.0018
	(0.0955)	(0.0332)	(0.0841)	(0.0502)
Maize	0.1244	0.1860***	-0.4577***	0.1473**
	(0.1317)	(0.0607)	(0.1259)	(0.0659)
Rice	-0.3067***	0.0667**	0.04167	0.1984***
	(0.0987)	(0.0340)	(0.09427)	(0.0516)
Groundnut	0.1547*	0.1020***	-0.3017***	0.0449
	(0.0911)	(0.0341)	(0.0858)	(0.0491)
Ownership of livestock	-0.5087***	-0.0306	0.3613***	0.1780***
	(0.1065)	(0.0332)	(0.0906)	(0.0552)
Market access	-0.4214***	-0.0278	0.3044***	0.1448**
	(0.0969)	(0.0389)	(0.0959)	(0.0571)
Literacy	-0.2093*	-0.0454	0.2165*	0.0382
	(0.1172)	(0.0488)	(0.1313)	(0.0635)
Distance from farm to credit institution	-0.0001	0.0001	-0.0002	0.0002
	(0.0013)	(0.0013)	(0.0020)	(0.0020)
Observations	197	197	197	197

Source: Field Survey, 2022

Wald test of rho=0: chi^2 (1) = 10.7877***

NB: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In addition, Years of Formal Education of smallholders was significant at 10%, with probability p ($y_1 = 1$, $y_2 = 0$), indicating that an increase in formal education of farmers will lead to a decrease in smallholder soya bean farmers accessing extension services by only 2.1%. The years of formal education were not statistically significant at any level at p ($y_1 = 0$, $y_2 = 0$), p ($y_1 = 1$, $y_2 = 0$), and p ($y_1 = 1$, $y_2 = 1$).

Experience in soybean farming was significant at 1%, 10%, and 1% for p ($y_1 = 0$, $y_2 = 0$), p ($y_1 = 1$, $y_2 = 0$), and p ($y_1 = 1$, $y_2 = 1$), respectively, but was not significant at p ($y_1 = 0$, $y_2 = 1$). At p ($y_1 = 0$, $y_2 = 0$), the coefficient was negative. This implies that an increase in experience in soya bean farming by a year will lead to a decrease in farming not choosing to access extension and microcredit service by 4.6% points.

Also, an increase in the experience of soya bean farmers by one year will not result in smallholder farmers accessing the Extension Service and without Microcredit by 2.2% points. Finally, the results at p ($y_1 = 1$, $y_2 = 1$) indicate that when there is an increase in experience of soya bean farming by 1, the chances of smallholder soya bean farming accessing both extension and microcredit increases by 2.1%.

Farm size measured in hectares was significant at the 5% level at p ($y_1 = 0$, $y_2 = 1$), indicating that when farm size increases by a hectare, the chances of smallholder farming accessing only microcredit services will only increase by 2.6%. In addition, farm size was significant at 10% at p ($y_1 = 1$, $y_2 = 1$), indicating that an increase in hectares of farm size will increase the chances of smallholder soya bean farmers accessing both extension services and microcredit by 3.2% points.

In addition, when a smallholder farmer owning a Radio Set increases by one, the probability p of a smallholder soya bean farmer not accessing extension services as well as microcredit increases by approximately 1.4% points, and the probability of a farmer accessing microcredit without extension services decreases by approximately 2.8% points. The findings also indicate that the probability p ($y_1 = 1$, $y_2 = 0$) of a smallholder farmer influencing access to extension services and not accessing microcredit increases by roughly 1.4% points. The probability of a smallholder farmer's influence in accessing extension and microcredit increases by approximately 2.8%. The difference was statistically significant at the 10% level for all p levels.

Similarly, for every increase in a farmer winning an award, the probability significant at 5% of a smallholder soya bean farmer not accessing extension services as well as microcredit increased by approximately 2.3% points and the probability significant at 5% of a smallholder farmer influencing access to extension services and not accessing microcredit decreased by roughly 19.4%.

In addition, for every increase in family labor, the probability significant at 1% of a smallholder soya bean farmer not accessing extension service as well as microcredit decreases by approximately 22.9% points and the probability significant at 1% of a smallholder farmer influencing the access to extension service and microcredit increases by approximately 15.8%. The probabilities at and were not significant and had no effect on access to extension services and microcredit with respect to family labor.

On another note, for a 1% increase in hired labor, the probability of a smallholder soya bean farmer influencing their access to extension services without microcredit being significant at 5% decreases by 19.2%. The probabilities p ($y_1 = 0$, $y_2 = 0$), p ($y_1 = 0$, $y_2 = 1$) and p ($y_1 = 1$, $y_2 = 1$) were statistically not significant and has no influence on a smallholder farming choosing those service when Hired labour increases.

For a smallholder farmer to cultivate maize alongside soya bean, the probability p ($y_1 = 0$, $y_2 = 1$) is significant at the 1% level, which indicates that for a 1% increase in smallholder farming maize alongside soya bean, the chances that the farmer will access microcredit without extension service increases by approximately 18.6%. The probability p ($y_1 = 1$, $y_2 = 0$) significant at 1% indicates that an increase in a farmer cultivating maize alongside soybean will influence a farmer's decision to access extension services without microcredit, with a decrease of approximately 45.8%. Finally, the probability p ($y_1 = 1$, $y_2 = 1$) is significant at 5%, indicating that an increase in smallholder soya bean farming cultivating maize alongside soya bean will increase their chances of accessing extension services and microcredit by approximately 14.7%. However, it was not significant and had no influence on farmers not accessing extension credit and microcredit [p ($y_1 = 0$ $y_2 = 0$)].

In addition, for a smallholder farmer cultivating rice alongside soya bean, the probability p ($y_1 = 0$, $y_2 = 0$) is significant at 1%, which indicates that for a 1% increase in smallholder farming rice alongside soya bean, the chances that the farmer will not access both extension services and microcredit decreases by approximately 30.7%. The probability p ($y_1 = 0$, $y_2 = 1$) significant at 5% indicates that an increase in a farmer cultivating rice alongside soya bean will influence a farmer's decision to access microcredit without extension services, with an approximately 6.7% increase. Finally, the probability p ($y_1 = 1$, $y_2 = 1$) is significant at the 1%, levelindicatin that, an increase in smallholder soya bean farming cultivating rice alongside soya bean will increase their chances of accessing extension services and microcredit by approximately 19.8%. However, it was not significant and had no influence on farmers not accessing extension credit and microcredit [p ($y_1 = 1$, $y_2 = 0$)].

Conversely, for a smallholder farmer cultivating groundnut alongside soya bean, the probability p ($y_1 = 0$, $y_2 = 0$) is significant at 10%, which indicates that for a 1% increase in a smallholder farming groundnut alongside soya bean, the chances that the farmer will not access both extension services and microcredit increases by approximately 15.5%. The probability p ($y_1 = 0$, $y_2 = 1$) significant at 5% indicates that an increase in a farmer cultivating groundnut alongside soya bean will influence a farmer's decision to access microcredit without an extension service, with an approximately 10.2% increase. In addition, the probability p ($y_1 = 1$, $y_2 = 0$) is significant at the 1%, levelindicatin that, an increase in smallholder soya bean farming cultivating rice alongside soya bean will decrease their chances of accessing extension services and microcredit by approximately 30.2%. However, it was not significant and had no influence on farmers not accessing extension credit and microcredit [p ($y_1 = 1$, $y_2 = 1$)].

On the other hand, for smallholder farmers owning livestock alongside soya bean cultivation, the probability p ($y_1 = 0$, $y_2 = 0$) is significant at 1%, indicating that for a 1% increase in smallholder farming owning livestock alongside soya bean, the chances that the farmer will not access both extension service and microcredit decreases by approximately 50.9% points. The probability p ($y_1 = 1$, $y_2 = 0$) significant at 1% indicates that an increase in a farmer owning a livestock alongside soya bean

farming will influence a farmer's decision to access extension services without microcredit, with an increase of approximately 36.1% points. In addition, the probability p ($y_1 = 1$, $y_2 = 1$) is significant at 1%, indicating that an increase in smallholder soya bean farmers owning livestock alongside soya bean farming will increase their chances of accessing both extension services and microcredit by approximately 17.8%. However, it was not significant and had no influence on farmers not accessing extension but microcredit [p ($y_1 = 0$, $y_2 = 1$)].

In addition, when smallholder farmers access the market increases, the probability p ($y_1 = 0$, $y_2 = 0$) is significant at the 1% level, indicating that for an increase in a smallholder farmer getting access to the market, the chances that the farmer will not access both extension service and microcredit decreases by approximately 42.1%. The probability p ($y_1 = 1$, $y_2 = 0$) significant at 1% indicates that an increase in a smallholder farmer accessing the market will influence the farmer's decision to access extension services without microcredit, with an increase of approximately 30.4%. In addition, the probability p ($y_1 = 1$, $y_2 = 1$) is significant at the 5%, levelindicatin that, an increase in smallholder soya bean farmers accessing the market will increase their chances of accessing both extension services and microcredit by approximately 14.5%. Finally, it was not significant and had no influence on farmers not accessing extension credit but accessing microcredit [p ($y_1 = 0$, $y_2 = 1$)].

Finally, the variables included literacy. This indicates that at probability p ($y_1 = 0$, $y_2 = 0$) significant at 10% means, for an increase in the smallholder soya bean farmer literacy rate, the chances that it will influence the farmer not accessing both extension services and microcredit decreases by approximately 20.9% points. The probability p ($y_1 = 1$, $y_2 = 0$) significant at 10% indicates that an increase in the literacy rate will influence the farmer's decision to access extension services without microcredit, with an increase of approximately 21.7% points. However, it was not significant that an increase in literacy rate would influence farmers not to access extension but to access microcredit [p ($y_1 = 0$, $y_2 = 1$)] or access to both extension service and microcredit [p ($y_1 = 1$, $y_2 = 1$)].

The following variables were not statistically significant at all probabilities [p ($y_1 = 0$, $y_2 = 0$), p ($y_1 = 1$, $y_2 = 0$), p ($y_1 = 0$, $y_2 = 1$), and p ($y_1 = 1$, $y_2 = 1$)] and had no influence on smallholder farmers. The variables include TV ownership, phone ownership, and the distance from the farm to the credit institution.

Constraints of Accessing Microcredit and Extension Service among Farmers

Smallholder soya bean farmers were asked to rank their constraints on accessing microcredit and extension services on a scale of one to ten. Constraints to accessing microcredit include lack of formal education, lack of information on microcredit, unaffordability of collateral, high interest rate, unavailability of credit institution, sex of a farmer, late approval of loans, bureaucratic bottlenecks, stringent demands for guarantors, and location of the community. High interest, which was ranked highest, is consistent with the findings of Tetteh and Adams (2020), who found high interest rates to be a challenge faced by rural farmers in accessing credit. Similarly, factors that constrained farmers' access to extension services were ranked by smallholder farmers. The key constraint factors identified include illiteracy among farmers, information or communication challenges, lack of resources or capital, lack of knowledge, being a smallholder farmer, gender, poor road network, extension officers not on duty, lack of interest in extension services, and insufficient

extension officers. Based on the ranking results, lack of resources or capital was the first constraint, with a mean value of 3.19. The above finding is consistent with previous research that revealed funding problems and low incomes as impediments to accessing agricultural extension (Langyintuo, 2020), insufficient rural information access as a key factor that restricted extension services (Kelil *et al.*, 2020), top-bottom communication approach of extension service limiting acceptance (Emodi, 2012), bad road network affecting constant extension office contact (Oyegbami, 2018), lack of knowledge (Assafo-Adjei and Buabeng, 2016; Langyintuo, 2020), and insufficient number of extension officers (Hasan *et al.*, 2017; Dev *et al.,* 2017).

Table 4.4: Constraints to extension access in Northern Region

Constraint	Mean	Std. Dev	Mean Rank	Rank
Illiteracy among farmers	4.40	2.977	4.43	3rd
Information or communication challenges	3.51	2.538	3.53	2nd
Lack of resources or Capital	3.19	2.253	3.19	1st
Lack of Knowledge	5.74	2.394	5.73	6th
Smallholder farmer	5.42	2.549	5.42	5th
Gender	6.34	2.227	6.36	7th
Poor Road Network	4.51	2.502	4.51	4th
Extension officer not on duty	6.80	2.985	6.79	8th
Lack of interest in extension services	7.49	2.100	7.50	9th
Insufficient Extension Officers	7.56	2.012	7.55	10th
Number of observations (N)	200			
Kendall's W[a]	0.267			
Chi-Square	480.272***			

Source: Field Survey, 2022

Table 5: Constraints to microcredit access in Northern Region

Constraints	Mean	Std. Dev.	Mean rank	Rank
Lack of formal education	3.53	2.290	3.52	2nd
Inadequate information on microcredit	4.28	2.103	4.26	3rd
Unaffordability of collateral	5.82	2.451	5.80	6th
High interest rate	2.71	2.506	2.70	1st
Unavailability of credit institution	5.05	2.825	5.04	4th
Gender	5.65	2.499	5.65	5th
Late approval and disbursement of loans	6.28	2.297	6.27	7th
Bureaucratic bottlenecks	7.48	1.897	7.48	9th
Stringent demands for guarantors	7.98	2.233	7.98	10th
Location	6.32	2.803	6.30	8th
Number of observations (N)	200			
Kendall's W[a]	0.302			
Chi-Square	543.359***			

Source: Field Survey, 2022

Conclusions

Sources of extension to smallholder soya bean farmers are dominated by government extension officers, with the least source being colleague farmers to farmers. In addition, agro-input dealers are the lead institutions in terms of giving credit to smallholder farmers, with the least source being formal credit institutions. The quantity of seeds, family labor, and farm size were all important factors in determining soybean output. In terms of

constraints faced by farmers in their production activities, higher interest rates accounted for the major constraint for smallholder soya bean farmers in accessing credit, while stringent demand for guarantors was the least constraint. Finally, a lack of resources or capital is the major constraint for smallholder soya bean farmers in accessing extension services, while mist trust in the information from extension officers accounted for the least constraint.

Based on the conclusions drawn, the following recommendation where suggested for policy purposes:

The government, through the Ministry of Food and Agriculture, should ensure an increase in the number of extension officers in the Northern Region (the Tolon and Karaga Districts). In addition, the leading source of microcredit is personal savings, with formal credit institutions being the least important. It is therefore recommended that microcredit institutions try to establish a mini soft loan service to extend their hands in terms of soft credit to smallholder soybean farmers. On the other hand, extension services significantly improve soybean output for smallholder farmers. It is therefore recommended that district extension officers intensify their work to help achieve more increment.

References

Abdallah, A. H., Ayamga, M., & Awuni, J. A. (2018). Impact of agricultural credit on farm income under the Savanna and Transitional zones of Ghana. *Agricultural Finance Review*, 79(2). DOI:10.1108/AFR-02-2018-0009

Abdulai, Y., & Seidu, A. (2016). Effects of contract farming on small-holder soybean farmers' income in the Eastern Corridor of the Northern Region, Ghana. *Journal of Economics and Sustainable Development,* 7(2), 2016

Abdul-Hanan, A., & Abdul-Rahaman, A. (2016). Determinants of access to agricultural extension services: Evidence from smallholder rural women in Northern Ghana. *Asian Journal of Agricultural Extension, Economics & Sociology*, 9(3), 1-8.

Abdul-Hanan, A., Ayamga, M., & Donkoh, S. A. (2014). Smallholder adoption of soil and water conservation techniques in Ghana. *African Journal of Agricultural Research,* 9(5), 539-546.

Abdul-Jalil, M. A. (2015). *Determinants of access to credit and its impact on household food security in Karaga district of the Northern region of Ghana* (Master's Thesis, Kwame Nkrumah University of Science and Technology).

Adams, B. A. (2018). *The effect of predictor variables on savings behaviour of rural smallholder farmers in Karaga District of Northern Region of Ghana* (Master's Thesis report). Tamale: udsspace.

Akudugu, M. A. (2012). Estimation of the determinants of credit demand by farmers and supply by rural banks in Ghana's Upper East Region. *Asian Journal of Agriculture and Rural Development,* 2(2), 189-200.

Akudugu, M. A., Guo, E., & Dadzie S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? *Journal of Biology, Agriculture and Healthcare,* 2(3), 1-13.

Anang, B. T., & Asante, B. O. (2020). Farm household access to agricultural services in northern Ghana. *Heliyon,* 6(11), e05517.

Asafo-Adjei, E. & Buabeng, E. (2016). An evaluation of challenges facing smallholders in Ghana: A case study for the Aowin Suaman

District. *Journal of Biology, Agriculture and Healthcare,* 6(3).

Asodina, F. A., Adams, F., Nimoh, F., Asante, B. O., & Mensah, A. (2021). Performance of smallholder soybean farmers in Ghana; evidence from Upper West Region of Ghana. *Journal of Agriculture and Food Research*, *4*, 100120.

Chamberlin, J. (2007). *Defining smallholder agriculture in Ghana: Who are smallholders, what do they do and how are they linked with markets ?* Ghana Strategy Support Program (GSSP) Background Paper No. GSSP 0006, 44.

Diao, X., Hazell, P., Kolavalli, S., & Resnick, D. (2019). *Ghana's economic and agricultural transformation: Past performance and future prospects.* Oxford: Oxford University Press.

Danso-Abbeam, G, Ehiakpor, D.S. & Aidoo, R. (2018). Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. *Agric & Food Secur.,* 7,74

Emodi, A. (2012). Farmers' constraints in rice production in South-Nigeria. *Journal of Research in Agriculture,* 1(2), 114–123

FAO (2018). *The role of soybean in fighting World Hunger*. Retrieved from https://www.fao.org/3/bs958e/bs958e.pdf on 14th May, 2022

Hasan, S., Turin, M., Ghosh, M. & Khalil, M. (2017). Assessing agricultural extension professional's opinion towards sustainable agriculture in Bangladesh. *Asian Journal of Agricultural Extension, Economics & Sociology,* 17, 1-13

Hitomi, N., & Selva, D. (2015). *The effect of credit definition and aggregation strategies on multi- objective hyper-heuristics.* August. https://doi.org/10.1115/detc2015-47445.

Kelil, A., Girma, Y & Hiruy, M. (2020). Access and use of agricultural information in Africa: Conceptual review. *Information and Knowledge Management,* 10(7).

Kiplimo, J. C., Ngenoh, E., Koech, W., & Bett, J. K. (2015). Determinants of access to credit financial services by smallholder farmers in Kenya. *Journal of Development and Agricultural Economics,* 7(9), 303-313.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational context. *International Journal of High Education*, 6(5), 26-41.

Langyintuo, A. (2020). Smallholder farmers' access to inputs and finance in Africa. Security, Retrieved from https://doi.org/10.1007/978-3-030-42148-9_7 15th May, 2022

Ministry of Food and Agriculture, MoFA (2017b). *Agriculture in Ghana*. Facts and Figures 2016. Statistics, Research and Information Directorate (SRID) of MoFA. Accra, Ghana

Moahid, M., Khan, D. G., Yoshida, Y., Joshi, P. N., & Maharjan, L. K. (2021). Agricultural credit and extension services: does their synergy augment farmers' economic outcomes? *Sustainability,* 13(3758), 1-23.

Mohammed, S. A. R., Al-hassan, S. & Jatoe, J. B. D. (2018). An overview of constraints to soybean production in the Northern Region of Ghana. *UDS International Journal of Development*, 5(1), 32-40.

Mollier, L., Seyler, F., Chotte, J. L., & Ringler, C. (2017). *End hunger, achieve food security and improved nutrition and promote sustainable agriculture: SDG 2*. A Guide to SDG Interactions: From Science to Implementation; ICSU: Paris, France.

Mushi, G. E., Di Marzo, S. G., & Bugri, P. Y. (2022). Digital technology and services for sustainable agriculture

in Tanzania: A literature review. *Sustainability,* 14(2415), 1-17.

Owusu, S. (2017). Effect of access to credit on agricultural productivity: Evidence from cassava farmers in the Afigya-Kwabre District of Ghana. *International Journal of Innovative Research in Social Sciences & Strategic Management Techniques*, 4(2).

Oyegbami, A. (2018). Location and distance of farmers to agricultural extension service: implication for agricultural development in Oyo State, Nigeria. *S. Afr. J. Agric. Ext.*,46(2).

Praburaj, L. (2018). Role of agriculture in the economic development of a country. *Shanlax International Journal of Commerce*, 6(3), 1-5.