

Received:  
15 October 2018  
Revised:  
19 February 2019  
Accepted:  
17 April 2019

Cite as: Essossinam Ali,  
Nadège Essossolim Awade.  
Credit constraints and soybean  
farmers' welfare in  
subsistence agriculture in  
Togo.  
Heliyon 5 (2019) e01550.  
doi: [10.1016/j.heliyon.2019.e01550](https://doi.org/10.1016/j.heliyon.2019.e01550)



# Credit constraints and soybean farmers' welfare in subsistence agriculture in Togo

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## Abstract

This study assesses the impact of credit constraints on soybean farmers' welfare in subsistence agriculture in Togo. In order to control potential sample selection bias, the endogenous switching regression method was adopted and data collected from a random sample of 500 soybean farmers were used. The results showed that farmers' age, being a member of the soybean organization and selling the soybean to a recognized NGO or to a private organization and growing cotton or cashew are the main determinants of access to full amount of credit. The results show a discrimination against gender in accessing the full amount of credit. Formal education and participating in the extension programs would increase farmers' welfare. Increasing land cultivation would increase women's welfare compared to men. Adopting intercropping technique as conservation agriculture has positive and significant impact on women's welfare. Moreover, having access to the full amount of credit increases soybean production by 1.35% and farmers' revenue by 1.32%, compared to farmers without having access to the full amount of credit. These results suggest the rethinking of the role of agricultural credit in soybean farmers' welfare in the study areas with great attention to the gender dimension.

Keywords: Agriculture, Economics

## 1. Introduction

Soybean is a crop being promoted throughout the world for its high protein content and its ability in fixing nitrogen leading to the minimization of fertilizer costs in subsistence agriculture (Zortea et al., 2018; van Vugt et al., 2018; Pagano and Miransari, 2016; Sinclair et al., 2014; Devi and Sinclair, 2013). In West Africa soybean has become a major industrial food crop and source of income generation, hence its important role in farmers' welfare (Khojely et al., 2018; Sinclair et al., 2014). It is very nutritive and plays an important role in the livelihood of population. The role of soybean in fulfilling food security at the household level and its contribution in generating revenue within the value chain actors continue to attract farmers in soybean production (Shin and Jeong, 2015; Bationi et al., 2011; Odendo et al., 2011; Sanginga et al., 1999). Soybean constitutes a cash crop for most farmers in subsistence agriculture like Togo with an important involvement of women in term of labor allocation and value chain (Palacios-Lopez et al., 2017; Stagnari et al., 2017; Dionco-Adetayo et al., 2002; Thomas-Slayer and Sodikoff, 2001).

The average yield was about 528.86 kilogram per hectare with the highest level reaching 1185.3 kilogram per hectare in West Africa (FAOSTAT, 2017). In Togo, the cultivated area of soybean represents about 7% of the total cultivated land and the average soybean production reached 1,073 tons per year since 2004, with the highest level of production reaching 2,002 tons in 2016 (FAOSTAT, 2017). The International Trade Centre (ITC, 2017) has reported that apart from the local consumption, the revenue generated from soybean export reached \$250,000 in 2017 and constitutes a form of insurance against cotton, coffee and cocoa's price volatility at the international market. The revenue from soybean farming depends not only on agricultural practices such as intercropping and mono-cropping techniques, but also on the access to financial resources such as agricultural credit (van Vugt et al., 2018; Manda et al., 2017). Increasing credit facilities could increase the adoption of new technology such as resistant and high yielding soybean varieties for sustainable soybean production in the context of climate change adaptation (Adjognon et al., 2017; Porgo et al., 2017; Awotide et al., 2015; Fletschner and Kenney, 2014; Golait, 2007). However, the access to financial resources for agricultural activities, especially credit, whether it comes from formal or informal source has been constrained until now and is not homogenous regarding to the gender dimension in developing countries (Blackden et al., 2007; Pitt and Khandker, 1998; Yaron et al., 1997).

Women are generally more constrained to resources such as land and credit, while their contribution to agricultural development could be significant (Doss et al., 2018; Solano and Rooks, 2018; Druzza and Peveri, 2018; Moro et al., 2017). For instance, Doss et al. (2018) find that women contribute up to 60% of World's food production, but own only 1% of land, hence transformative change of women

via supporting projects is needed to assure global food security (Jones et al., 2017; Palacios-Lopez et al., 2017; Johnson et al., 2016). Rao et al. (2019) find also that, supporting women's work in the agriculture sector would reshape the socio-economic status of the farm households in South Asia with positive impact on child and maternal nutrition. Women are also more involved in the agricultural commodity value chain compared to men (Oduol et al., 2017). Moreover, a survey across developing countries has shown that 46% of men have a formal account, but only 37% of women do, with a persistent gender gap of 6–9 percentage points across income groups within developing economics (Taylor and Boubakri, 2013; Honohan, 2008).

The lack of adequate financial products could influence household welfare, including agricultural productivity, food security and nutrition (Awotide et al., 2015; Asiedu et al., 2013 Diagne and Zeller, 2001). The evaluation of the impact of access to agricultural credit on rural farm households' welfare needs not only an emphasis on gender, but also a sound methodological approach. Most of studies dealing with the impact of agricultural credit (Porgo et al., 2017, 2018; Awotide et al., 2015; Asiedu et al., 2013 Diagne and Zeller, 2001) focus only on whether a farmer has access to credit or not (yes or no), while it may be constrained in getting the full amount of credit that is requested. Farmers' welfare does not only depend on the access to agricultural credit, but also on the socioeconomic characteristics (Ngeno, 2018; Solano and Rooks, 2018; Moro et al., 2017; Abdulai, 2016; Oh et al., 2008). This study aims to assess the impact of access to the agricultural credit on soybean farmers' welfare in terms of economic utility (soybean production and net revenue) in subsistence agriculture in Togo by focusing on gender aspects. The focus on gender is justified by the involvement of women in the legume crops value chain such as soybean (Coles and Mitchell, 2011; Sanginga et al., 1999). Soybean production in Togo is also among the government strategies to enhance food security and reduce poverty. The study uses exhaustive impact evaluation method and suggests policy concerning the gender access to financial resources in promoting soybean farming in subsistence agriculture in Togo. The rest of the paper is organized as follows: the material and methods are given in section 2 and section 3 presents the results and discussion. Section 4 concludes this paper with policy implications.

## 2. Material and methods

### 2.1. Theoretical and empirical approaches

Having access to credit can facilitate the purchase of equipment and inputs such as labor, improved seeds and planting materials. This will increase soybean productivity and help in fulfilling food security. As industrial foods crops, increasing soybean

productivity could increase farmers' revenue and reduces poverty. Access to credit could also facilitate crop processing and marketing services. These are the pathways through which access to credit might affect farmers' welfare. Assume that the soybean farmers have rational behavior in their activity. Thus, they allocate the available resources and use efficiently the available technology in order to maximize the expected utility. A rational farmer decision of application for a credit should be based on the fact that the utility for having access to credit and getting the full amount that is requested ( $U_1$ ) is greater than the utility for not having access to the full amount that is requested ( $U_0$ ). Following the direct elicitation approach of credit constraint that uses information on credit market participation (Diagne and Zeller, 2001; Ali et al., 2014), only those who get the full amount are considered as credit unconstrained famers, while the others constitute a group of credit constrained farmers. Then, it follows:

$$U_1 > U_0 \Leftrightarrow U_1 - U_0 \Leftrightarrow (\alpha_1 - \alpha_0)X + (\varepsilon_1 - \varepsilon_0) > 0 \tag{1}$$

With:

$$U_1 = \alpha_1 X + \varepsilon_1 \tag{2}$$

$$U_0 = \alpha_0 X + \varepsilon_0 \tag{3}$$

Where the utility function ( $U$ ) is a function of set of independent variables ( $X$ ) that would affect the credit unconstrained soybean farmers and  $\varepsilon$  the error term.

Indeed, the difference in expected utility in applying for credit is not directly observable. What we observe is only the decision of having applied to a credit or not. Let  $\vartheta^*$  denote the marginal net benefits of having access to full amount of credit (the binary latent variable). If  $\vartheta$  denotes the binary variable of having access to full amount of credit or not then, it follows:

$$\vartheta = \begin{cases} 1 & \text{if } \vartheta^* > 0 \\ 0 & \text{if } \vartheta^* \leq 0 \end{cases} \begin{array}{l} \text{The soybean farmer has access to full amount of credit} \\ \text{or credit unconstrained farmers} \\ \text{credit constrained farmers} \end{array} \tag{4}$$

Then a soybean farmer's utility function takes the form as:

$$\vartheta^* = X' \alpha + \varepsilon \tag{5}$$

Assuming that being credit unconstrained or having access to full amount of credit is derived from soybean farmers' maximization of expected utility subject to those typical farmers' socioeconomic characteristics.

Indeed, the propensity score matching method used as an impact evaluation technique cannot deal with selection bias from heterogeneous and unobservable

characteristics within groups that are credit constrained and the one who did not (Diagne and Demont, 2007; Maddala, 1986; Heckman, 1979) and could lead to underestimate or overestimate the real impact (Lechner, 2011; Rosenbaum and Rubin, 1983). For the purpose, Endogenous Switching Regression Method (ESRM) is used in this study (Murtazashvili and Wooldridge, 2016; Poirier and Ruud, 1981; Freeman et al., 1998). The farmer may face two regimes (Eqs. (6) and (7)).

$$Y_1 = \omega_1 X + \mu_1 \quad \text{if } \vartheta = 1 \tag{6}$$

$$Y_0 = \omega_0 X + \mu_0 \quad \text{if } \vartheta = 0 \tag{7}$$

$Y_1$  and  $Y_0$  are the revenues of credit unconstrained and credit constrained soybean farmers, respectively.  $X$  is a vector of potential exogenous variables that could affect soybean farmers' revenue.  $\omega$  is a vector of parameters to be estimated.  $\mu_1$  and  $\mu_0$  are the error terms which is assumed to be a normal distribution with zero mean and non-singular covariance matrix expressed as follows:

$$Cov(\mu_1, \mu_0, \varepsilon) = \begin{bmatrix} \sigma_{\mu_0}^2 & \cdot & \sigma_{\mu_0\varepsilon} \\ \cdot & \sigma_{\mu_1}^2 & \sigma_{\mu_1\varepsilon} \\ \cdot & \cdot & \sigma_{\varepsilon}^2 \end{bmatrix} \tag{8}$$

In Eq. (8),  $\sigma_{\varepsilon}^2$  represents the variance of the error term in the farmer's decision Eq. (5) and assumed to be equal to 1.  $\sigma_{\mu_0}^2$  and  $\sigma_{\mu_1}^2$  represent the variances of the error terms in the production functions (6) and (7).  $\sigma_{\mu_1\varepsilon}$  and  $\sigma_{\mu_0\varepsilon}$  represent the covariance of  $\mu_1$  and  $\mu_0$ , respectively. If the error term ( $\varepsilon$ ) of the selection equation is correlated with the error terms of the outcome function ( $\mu_1$  and  $\mu_0$ ), it implies that the expected values of  $\mu_1$  and  $\mu_0$  conditional on the sample selection are different from zero. It follows that:

$$E[\mu_1/\vartheta = 1] = \sigma_{\mu_1\varepsilon} \frac{\varnothing(X'\alpha)}{\Phi(X'\alpha)} = \sigma_{\mu_1\varepsilon}\lambda_1 \tag{9}$$

$$E[\mu_0/\vartheta = 0] = -\sigma_{\mu_0\varepsilon} \frac{\varnothing(X'\alpha)}{1 - \Phi(X'\alpha)} = \sigma_{\mu_0\varepsilon}\lambda_0 \tag{10}$$

In Eqs. (9) and (10),  $\varnothing(\cdot)$  and  $\Phi(\cdot)$  refer to the standard normal probability density function and the normal cumulative density function, respectively, with:

$$\lambda_1 = \frac{\varnothing(X'\alpha)}{\Phi(X'\alpha)} \quad \text{and} \quad \lambda_0 = \frac{\varnothing(X'\alpha)}{1 - \Phi(X'\alpha)}$$

The assumption to be tested is whether there is any correlation between the credits unconstrained farmer and production level or revenue. The null hypothesis is that there is no any sample selection bias. If  $\sigma_{\mu_0\varepsilon}$  and  $\sigma_{\mu_1\varepsilon}$  are statistically different from zero, then the null hypothesis is rejected and ESRM is used (Nonvide, 2018;

Asfaw et al., 2012; Lokshin and Sajaia, 2004). The parameters of the model can be estimated using Full Information Maximum Likelihood estimation technique (Lokshin and Sajaia, 2004). The logarithmic likelihood function using decision equations of being credit unconstrained farmer can be derived as:

$$\ln L_i = \sum_{i=1}^N \vartheta_i \left[ \ln \Phi \left( \frac{\mu_1}{\sigma_{\mu_1}} \right) - \ln \sigma_{\mu_1} + \ln \Phi(\gamma_1) \right] + (1 - \vartheta_i) \left[ \ln \Phi \left( \frac{\mu_0}{\sigma_{\mu_0}} \right) - \ln \sigma_{\mu_0} + \ln(1 - \Phi(\gamma_0)) \right] \tag{11}$$

$$\text{In Eq. (11), } \gamma_1 = \frac{\left( X' \alpha + \frac{\eta_{1e} \mu_1}{\sigma_1} \right)}{\sqrt{1 - \eta_{1e}^2}} \quad \text{and} \quad \gamma_0 = \frac{\left( X' \alpha + \frac{\eta_{0e} \mu_0}{\sigma_0} \right)}{\sqrt{1 - \eta_{0e}^2}}$$

The terms  $\eta_{1e}$  and  $\eta_{0e}$  denote the correlation coefficient between the error terms  $\mu_1$  and  $\mu_0$  and  $\epsilon$ .

$\eta_{1e}$  and  $\eta_{0e}$  having alternate signs implies that having access to full amount of credit is based on farmers' comparative advantage. It means that the credit unconstrained farmers have above average returns from having access to full amount of credit. If  $\eta_{1e}$  and  $\eta_{0e}$  have the same signs, it implies that whether the soybean farmers have the full amount of credit or not have above-average returns. Alternatively, credit constrained farmers have below average returns whether they have access to full amount of credit or not. ESRM can be used to compare the expected revenue of farmers that have access to full amount of credit with respect to farmers that did not (Table 1).

$$E[Y_1/\vartheta_i = 1] = \theta_1 X_i + \sigma_{\mu_1} \lambda_1 \tag{12a}$$

$$E[Y_0/\vartheta_i = 1] = \omega_0 X_i + \sigma_{\mu_0} \lambda_1 \tag{12b}$$

Eqs. (12a) and (12b) are the conditional expectation of soybean revenue of credit unconstrained and credit constrained farmers, respectively. The average treatment effect (ATT) of farmers (Eq. (13)) is derived as the difference between the expected revenue for credit unconstrained farmers conditional on having access to full amount of credit (Eq. (12a)) and the expected revenue for credit unconstrained farmers that have access to full amount of credit conditional on those not having access to full amount of credit (Eq. (12b)).

**Table 1.** Computation of average treatment effects.

	Mean outcome		Treatment effect
	Credit constrained farmers	Credit unconstrained farmers	
Soybean production/revenue	$E[Y_1/\vartheta_i = 1]$	$E[Y_0/\vartheta_i = 1]$	ATT

$$ATT = E((Y_1 - Y_0)\vartheta_i = 1) = X_i(\omega_1 - \omega_0) + (\sigma_{\mu_1} - \sigma_{\mu_0})\psi_1 \quad (13)$$

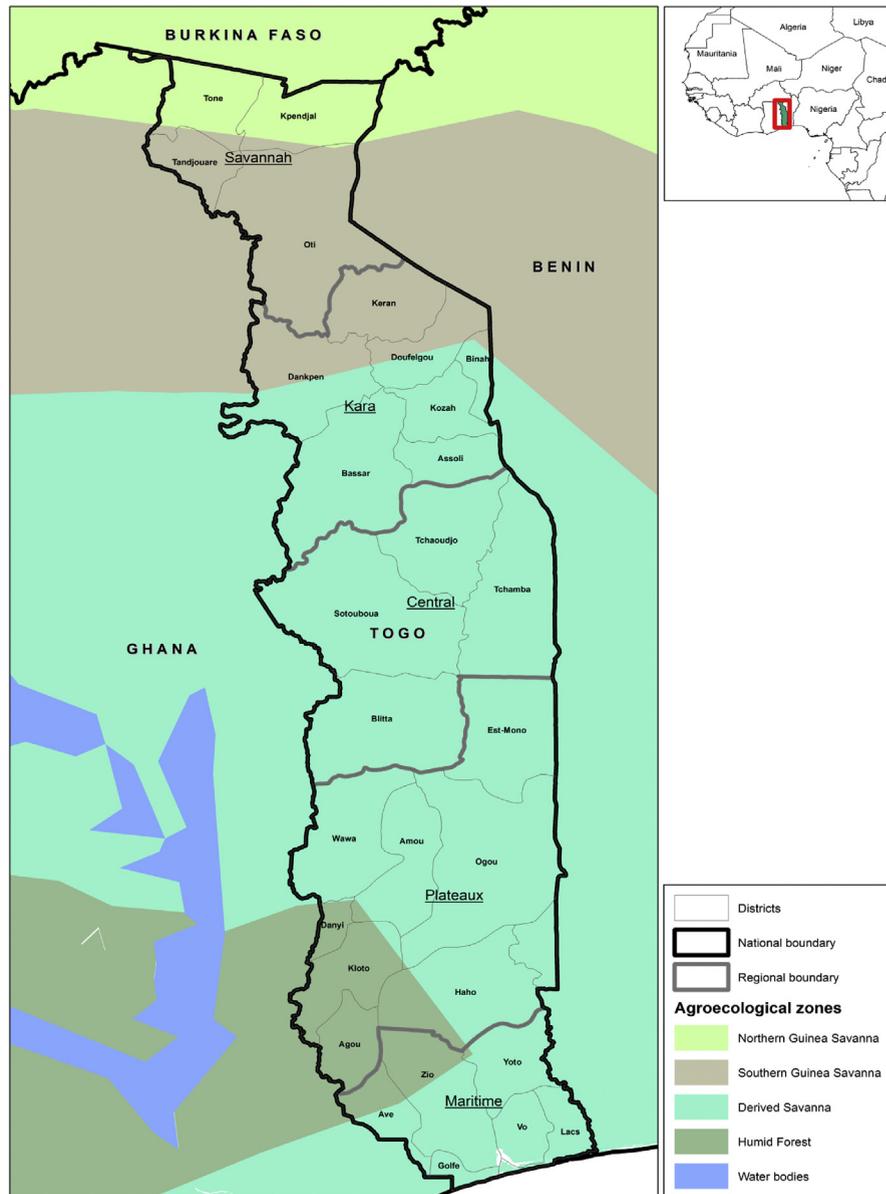
$\psi_1$  is the estimate of the covariance term between having access to full amount of credit and soybean farmer welfare (production and net revenue) and defined as the Inverse Mills Ratio (IMR) that captures the selection bias (Asfaw et al., 2012; Lokshin and Sajaia, 2004). IMR indicates the correlation between access to full amount of credit and production level or net revenue. If ATE is significant and statistically different from zero, then one would conclude that, the credit unconstrained farmers have higher or lower revenue than credit constrained farmers depending on the associated sign.

## 2.2. Data and descriptive results

According to the Ministry of Trade, Industry, Private Sector Promotion and Tourism of Togo (Ministère du Commerce, de l'Industrie, de la Promotion du Secteur Privé et du Tourisme, MCIPSPT, 2016), the Central region remains the area with the highest soybean production compared to other regions in Togo; hence its choice for this study. The Central region belongs to agro-ecological zone with savanna vegetation and it is part of the poorest area of the country, where the incidence of poverty is relatively high and estimated at 77.7%. Three districts (Tchamba, Sotouboua, and Blitta) over the four in the Central region (Fig. 1, annexed) were randomly selected. The data were randomly collected at the farm level under the supervision of the International Institute of Tropical Agriculture (IITA-Ibadan Hubs and headquarter) as part of a capacity building project for graduate students. A structured questionnaire was used to collect data from 500 farmers using the soybean farmers' databased provided by the districts levels administrators and a NGO that often buys soybean grain in the region. The data cover farmers' productivity, their socioeconomic characteristics such as age, sex, education level as well as their accessibility to the agricultural credit (Table 2). The surveyed farmers in the study area are relatively young (37 years old) with 46% being female. Most of soybean farmers in the sample have at least a formal education (75%) which would be determinant when applying for the credit (Saqib et al., 2018).

The average land devoted for soybean farming was about 1.3 hectare. The land allocation decision is somewhat decided by male (51% on average). This might influence the production level regarding to the gender. The extension service can be determinant of soybean productivity (Evenson, 2001). The data showed that about 61% of farmers have used an extension service and 32% are member of a soybean farmers' organization.

Being a member of soybean organization facilitates not only access to credit, but also provides agricultural inputs and soybean marketing and negotiation with agribusiness firms. On average, 33% of the surveyed farmers sold their products to private



**Fig. 1.** Study areas with different agro-ecological zones.

organization, while 5% and 47% sold their soybean to recognized non-governmental organization (NGOs) and local market, respectively. The average soybean production of the surveyed farmers reached about 1170.18 kilogram per hectare. Because of soybean characteristics in fixing nitrogen, intercropping would be advisable as conservative agriculture technique. On average, 23% of farmers have adopted for intercropping system, while 37% use mono-cropping systems. Having growing another cash crop like cotton and/or cashews is not only an insurance for a farmer, but also a secure source for a financial institution of repayment of the loans granted to a soybean farmer. Thus, growing cotton/cashews can be determinant of the

**Table 2.** Variables and description.

Variables	Description	Mean	SD
Age	Number of years	37.34	12.61
Experiences in soybean farming	Number of years	8.03	7.70
Gender	Dummy (1 = Female; 0 = Male)	0.46	0.49
Formal education	Dummy (1 = Yes; 0 = No)	0.75	0.43
Primary	(1 = Yes; 0 = No)	0.34	0.47
Junior high school (JHS)	(1 = Yes; 0 = No)	0.26	0.44
Senior high school (SHS)	(1 = Yes; 0 = No)	0.13	0.34
Cultivated soybean Land	Number of hectares	1.3	1.18
Land allocation decision	(1 if the land allocation decision is taken by men; 0 otherwise)	0.51	0.50
Use of extension service	Dummy (1 = Yes; 0 = No)	0.61	0.48
Member of a soybean farmers' organization (SGO)	Dummy (1 = Yes; 0 = No)	0.32	0.46
Soybean production	Number of kg	1170.18	1513.00
Soybean revenue	Local currency (FCFA)	123761.7	211814
Liquid asset	Local currency (FCFA)	308757.9	470711.5
Use of mono-cropping system	Dummy (1 = Yes; 0 = No)	0.37	0.48
Use of intercropping system	Dummy (1 = Yes; 0 = No)	0.23	0.42
Access to credit	Dummy (1 = Yes; 0 = No)	0.6	0.49
Got full amount	Dummy (1 = Yes; 0 = No)	0.52	0.49
Amount of credit	Local currency (FCFA)	65637	241939.3
Cotton or cashew cultivation	Dummy (1 = Yes; 0 = No)	0.31	0.46
Soybean sold to private organization	Dummy (1 = Yes; 0 = No)	0.33	0.47
Soybean sold to a recognized NGO	Dummy (1 = Yes; 0 = No)	0.05	0.22
Soybean sold in the market	Dummy (1 = Yes; 0 = No)	0.47	0.49
Total livestock unit	Number of livestock	6.25	8.60

amount granted to a soybean farmer. On average, 31% of farmers in the sample have grown either cotton or cashews. Having access to credit can also affect soybean farmers' productivity. On average, 60% of farmers in the sample have got at least one agricultural credit, but only 52% on average got the full amount that was requested. A farmer has full access to credit if he got not only a loan from formal or informal lending institution, but also a full amount that was requested. The average amount of credit was about \$131.27 (\$1.00 = 500 FCFA). On average, 40% of surveyed farmers did not request credit and thus, did not have access to credit. Those who got an agricultural credit found their resources from diverse sources (Table 3).

Most of the beneficiaries (47%) are financed by micro-financial institutions followed by the farmers' relatives such as friends and neighbors (9.2%). About 1.8% financed

**Table 3.** Source of agricultural credit.

Sources of credit	Frequency	Percentage of farmers (%)
Did not request for credit	200	40.00
Government	4	0.80
Commercial banks	0	0.00
Agricultural banks	0	0.00
Microfinance	235	47.00
Money lenders	9	1.80
Landlords	1	0.20
Wealthy farmers	5	1.00
Friends and neighbors	46	9.20
Total	500	100

their farming activities from money lenders, while 1% found their resources from the wealthy farmers. Only, 0.8% and 0.2% were financed by the government institution and landlords, respectively. None of farmer got credit from commercial banks or agricultural banks.

### 3. Results and discussion

#### 3.1. Gender and socioeconomic characteristics

Disparities could be found among gender in the sample. Men earn more than women from the soybean business. This can be explained by the amount that women produced (on average 1566.25 kg for men in contrast to women with 705.23 kg) and the land area devoted to soybean cultivation which is lower for women compared to men (Table 4).

The discrimination against women in accessing to land resources is evident in developing countries (Doss et al., 2018). Moreover, the difference of average amount of credit received among men and women is positive and significant at 5% level. It implies that women are more constrained compared to men in terms of amount of credit received. This could affect women in the inputs purchase for soybean farming, hence the low level of productivity and revenue. The experience and education level among gender could be also determinants. The data show that men are more experienced in soybean production compared to women. Also, the average proportion of men that have at least a formal education is higher than that of women. At 1% significant level, our results confirm that men have higher education compared to women. The rate of women attending the primary level is higher than men, but the difference is not significant. The results show that women still have a low participation rate in terms of access to extension services and enrollment to a membership

**Table 4.** Gender and respondents' socioeconomic characteristics.

Variables	Men	Women	Difference in mean
Production	1566.25	705.23	861.01***
Net revenue	168361.70	71405.15	96956.59***
Age	36.98	37.75	-0.76
Experience	9.22	6.64	2.57***
Formal education	0.90	0.57	0.32***
Harvested land	1.72	0.80	0.91***
Use of extension services	0.66	0.54	0.12***
Intercropping	0.29	0.16	0.13***
Mono-cropping	0.45	0.27	0.17***
Amount of credit	87983.33	39404.35	48578.99**
Primary	0.27	0.42	-0.14
Junior high school	0.38	0.13	0.25***
Senior high school	0.24	0.01	0.22***
Member of a soybean group organization	0.39	0.23	0.15***
Cotton/cashews	0.43	0.17	0.25***
Livestock unit	6.51	5.95	0.56

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.10$ .

of a soybean organization (MSGO). The data show that apart from soybean cultivation, men cultivate more cotton and cashew as an alternative cash crop (Table 4).

### 3.2. Credit constraint and farmers socioeconomic characteristics

Access to the full amount of credit is somewhat related to farmers' socioeconomic characteristics (Table 5).

At 1% significant level, our results confirm that there is a difference between farmers that have at least a formal education and those who did not in terms of getting the full amount credit received (Table 5). It indicates that credit unconstrained farmers have mostly a formal education compared to credit constrained farmers. This is consistent with Saqib et al. (2018), but inconsistent with Rojas et al. (2016) who finds that there are no credit constraints based on education in the Chilean case study. Moreover, the credit constrained farmers often sell their products at the local market instead of selling through soybean member organization or to a recognized NGOs or a private organization. A farmer selling at the local market or at the farm gate faces price uncertainty compared to a farmer who sells his production to a recognized NGO or private organization. The predictability of price volatility can be seen as a key indicator for the lending institutions and therefore the amount of credit awarded could be dependent.

**Table 5.** Credit constraint and farmers' socioeconomic characteristics.

Variables	Credit constrained farmers	Credit unconstrained farmers	Mean Diff
Production	1247.51	1099.93	147.57
Net revenue	134124.20	114348.50	19775.71
Age	34.74	39.69	-4.95
Formal education	0.68	0.82	-0.14***
Harvested land	1.32	1.27	0.04
Primary school	0.38	0.31	0.06*
Junior high school	0.27	0.25	0.02
Senior high school	0.16	0.11	0.04*
Member of a soybean group organization	0.24	0.39	-0.15
Soybean sold to private organization	0.31	0.35	-0.03
Soybean sold to NGO	0.01	0.08	-0.07
Soybean sold in the market	0.53	0.41	0.11***
Cotton/cashews	0.28	0.34	-0.06
Livestock unit	5.7	6.72	-0.98

\*\*\* $p < 0.01$ ; \* $p < 0.10$ .

### 3.3. Credit constraints and soybean productivity in Togo

The results of the full information maximum likelihood estimators of the endogenous switching regression model are indicated in Table 6. The likelihood ratio test (LR test) for joint independence equation is statistically significant at the 1% level (Table 6). We therefore conclude that the three models as indicated in Table 6 are jointly dependent and should not be estimated separately. We also observed that the both covariance ( $\sigma_0$  and  $\sigma_1$ ) are different from zero, showing an existence of the endogeneity (Maddala, 1986); hence the justification of the use of the ESRM. Age and age square are both significant at 1% level with alternative signs in the selection equation. It implies that the probability of getting the full amount of credit increases with the unit increase of soybean farmer's age up to 37 years, beyond which, an increase of a unit of age of farmers will decrease the probability of getting full amount. This could lead to the low adoption of new technology in soybean production process and therefore low production level. The evidence is that older credit constrained farmers produce less soybean compared to those older credit unconstrained farmers (Table 6).

The results indicate that, being a group member of a soybean organization would increase farmers' probability of getting full amount of credit. This implies that the being a group member may be a guarantee and therefore reduce the probability of non-payment. This will increase the chance of having access to credit that is requested

**Table 6.** Estimates of the impact of access to credit on soybean production.

Variables	Getting full amount (1/0)	Std. Error	Soybean Production			
			Credit constrained farmers	Std. Error	Credit unconstrained farmers	Std. Error
Constant	-2.047***	0.526	5.001***	0.359	4.962***	0.612
Gender	0.069	0.136	0.685	0.682	-2.420***	0.618
Age	0.070***	0.019	-0.009***	0.003	0.006**	0.002
Age*Age	-0.0005***	0.0002				
Primary	-0.043	0.122				
JHS	0.008	0.127				
Member of SGO	0.375***	0.114				
Sold to NGO	1.068***	0.295				
Sold at the local market	-0.044	0.096				
Cotton/cashew	0.191*	0.104				
ln(Land)	-0.095	0.087	0.702***	0.076	0.726***	0.078
ln(Asset)	0.012	0.033	0.039**	0.019	-0.006	0.024
Experience			0.007*	0.004	0.010***	0.003
Formal education			0.059	0.084	0.062	0.067
Labor(Log)			0.263***	0.081	0.009	0.079
Extension			0.159***	0.061	0.017	0.059
Intercropping			-0.012	0.067	0.133**	0.062
Mono-cropping			0.113*	0.068	0.073	0.060
ln(Amount)			-0.002	0.007	0.083**	0.039
Gender*labor			0.019	0.143	0.416***	0.114
Gender*ln(Asset)			-0.075**	0.031	0.072**	0.035
Total Livestock unit			0.012**	0.003	0.0042	0.003
Gender*ln(Land)			0.088	0.125	0.007	0.111
sigma0; sigma1			0.533***	0.051	0.519***	0.043
rho0; rho1			-0.795***	0.100	0.840***	0.075
Number of observation	500		238		262	
Wald chi <sup>2</sup> (15)			675.30***			
Log likelihood			573.54985			
LR test of indep. Eqns chi <sup>2</sup> (2)			17.54***			

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.10$ .

from lenders. Selling the soybean to a recognized NGO or growing cotton or cashew can increase the probability on getting full amount of credit. This can be justified by the fact that the probability of soybean price volatility could be reduced by selling the product to NGO rather than the local market or at the farm gate. Also, growing cotton or cashew can be an alternative of loan repayment in the case of bad harvests.

Cashew and cotton in that case constitute insurance in the occurrence of adverse weather or extreme price volatility.

The results show that an increase of cultivated land and farming experience will increase soybean production in both regimes (Table 6). The average farm size of the selected sample was only 1.3 hectares and increasing the soybean cultivated land could increase the productivity as suggests the agricultural growth theory (Rada and Fuglie, 2018; Barrett et al., 2010). This result is similar to Rada and Fuglie (2018) and Sheng and Chancellor (2018), but in contrast with Carletto et al. (2015) and Barrett et al. (2010) who found the inverse relationship between farm size and productivity. Also, the regular visit of an extension services and using more labor could increase the productivity of credit constrained farmers (Table 6). The adopted agricultural techniques influence farmers' productivity in both regimes. For instance, using mono-cropping techniques will increase productivity of credit constrained farmers. Probably the intercropping that is seen as conservation agriculture technique is more costly for the credit constrained farmers compared to credit unconstrained farmers. Mixing soybean production with other crops is encouraged in agricultural systems, since it helps fixate nitrogen while increasing nitrogen availability for the associated plants (van Vugt et al., 2018; Khojely et al., 2018; Manda et al., 2017; Sinclair et al., 2014). The results show that the soybean productivity of the surveyed women increase if the full amount of credit that is requested is awarded. The correlation coefficients are significant at 1% level with alternative sign. The correlation between getting full amount of credit and soybean production is positive, while soybean production and the group of credit constrained farmers are negatively correlated. It implies that the soybean farmers that have the full amount of credit have above average returns and not better-off if they do not have full amount of credit. Alternatively, those who do not have the full amount of credit have below-average returns, but they are still worse by not having access to credit than a random farmer in the sample would have gained.

### 3.4. Credit constraints and soybean revenue in Togo

The results show that having access to full amount of credit will affect more women's revenue compared to men (Table 7). Maybe, women undertake small business using loans obtained and the return could be reinvested in the soybean farming activities. This result is consistent with Pitt and Khandker (1998) who find that access to credit has a larger effect on women than men in the case of Bangladesh. However, increasing land area and accessing extension services will increase the revenue of the two groups of farmers. Participating in extension programs enhances technology adoption and productivity and therefore the households' revenue as found in previous studies (Wossen et al., 2017; Abdulai, 2016; Läßle et al., 2013; Becerril and Abdulai, 2010).

**Table 7.** Estimates of the impact of access to credit on soybean revenue.

Variables	Getting full amount	Std. Error	Soybean Revenue			
			Credit constrained farmers	Std. Error	Credit unconstrained farmers	Std. Error
Constant	−2.094***	0.429	9.483***	0.444	6.133***	1.514
Gender	0.147	0.139	0.833	0.765	5.393***	2.091
Age	0.077***	0.019	−0.0008	0.009	0.016***	0.005
Age*Age	−0.0006***	0.0002				
Primary	−0.170	0.133				
JSH	0.033	0.161				
Member of SGO	0.427***	0.162				
Sold to NGO	1.633***	0.318				
Sold through SGO	8.615***	0.633				
Cotton/Cashew	0.231*	0.136				
Total livestock unit	−0.006	0.008				
ln(Land)	−0.086	0.089	1.079***	0.125	0.534***	0.158
Experience			0.016*	0.008	0.006	0.011
Formal education			0.362*	0.215	0.058	0.170
Extension			0.366**	0.159	0.401**	0.160
Intercropping			−0.475**	0.197	0.361	0.238
Mono-cropping			0.336*	0.196	0.220	0.207
Gender*Intercropping			0.921***	0.333	−0.306	0.339
Gender*Mono-cropping			0.160	0.321	−0.335	0.304
ln(Amount)			−0.007	0.023	0.333**	0.130
ln(Asset)			0.069**	0.030	−0.058	0.047
Gender*ln(Asset)			−0.106*	0.064	0.164*	0.093
Gender*ln(Land)			0.167	0.235	1.425***	0.252
Gender*ln(Amount)			0.019	0.042	−0.614***	0.193
Money lenders			0.430	0.454	−0.455**	0.233
Sold to private			0.492***	0.127	0.324**	0.148
Sigma0; Sigma1			0.998	0.058	1.128***	0.068
Rho; Rho1			−0.019	0.383	0.528***	0.108
Number of obs			238		262	
Wald chi <sup>2</sup> (17)				320.26***		
Log pseudo likelihood				−1028.9065		
Wald test of indep. eqns.: chi <sup>2</sup> (2)				16.54***		

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.10$ .

Moreover, increasing the land area for women and women's asset would increase soybean revenue compared to men. Creating the business environment through the soybean value chain could help increase women asset. This can be a portal that helps women to reinvest in soybean farming activities. The money lenders as source of credit and the soybean net return are negatively correlated. This result is consistent with [Muravyev et al. \(2009\)](#) and can be explained by the variation of interest rate across credit sources ([Poulton et al., 2006](#)).

The crossing effect of gender and the amount of credit is negative and statistically significant at 1% level. This result indicates the gender discrimination in accessing the full amount of credit from lenders leading to the negative impact on soybean net returns. A similar result was found by the previous studies ([Nwosu and Orji, 2017](#); [Fletschner and Kenney, 2014](#); [Asiedu et al., 2013](#); [Barber and Odean, 2001](#)). Moreover, the results show that adopting mono-cropping system in soybean farming increase the revenue of farmers that did not have access to full amount. If female soybean farmers had access to the full amount of loan and did use intercropping strategies, they had higher revenues compared to male ones. This result is similar to the case study of [Abdulai \(2016\)](#) in Zambia and to the one by [Ares et al. \(2016\)](#) who found that intercropping systems increase crop yield by 23% and farm revenue by \$172 per hectare in the case study of Africa. Probably women who often do not have access to land prefer to mix soybean production with other crops in order to earn more. The correlation coefficients (Rho and Rho1, [Table 7](#)) have negative and positive sign, respectively and significant at 1% level only for soybean revenue of the group of farmers that have access to full amount of credit (credit unconstrained farmers) implying that farmers who have access to full amount of credit have above average revenues compared to a random individual in the sample.

### 3.5. Credit constraint and soybean farmers' welfare

The estimation of the average treatment effect (ATT) that describes the impact of credit constraint on soybean farmers' economic utility is presented in [Table 8](#).

**Table 8.** Impact of credit constraint on soybean farmers' welfare.

	Mean outcome <sup>a</sup>		ATT	t-value
	Credit unconstrained farmers	Credit constrained farmers		
Soybean production (log)	6.52	5.16	1.35***	18.74
Soybean revenue (log)	10.60	9.28	1.32***	6.17

\*\*\* $p < 0.01$ .

<sup>a</sup>The mean outcome is estimated after ESRM in which the outcome equations are the logs of production and revenue, hence the prediction are in the form of log.

The results show that having access to the full amount of credit has positive and significant effect on soybean farmers' welfare in terms of economic utility. The average treatments effect (ATT) is positive and statistically different from zero at 1% level for the production and the net returns (Table 8). This result implies that the credit unconstrained farmers have higher production level and net return than credit constrained farmers. The soybean farmers that are credit unconstrained have a 1.35% higher production level than credit constrained farmers. Having access to full amount of credit leads soybean farmers earn 1.32% more than credit constrained farmers.

#### 4. Conclusion

The role of agricultural credit on farmers' welfare needs to be investigated. This study assesses the impact of having access to full amount of farm credit on soybean farmers' welfare in subsistence agriculture in Togo. The farmers' welfare (in terms of economic utility) was measured by the soybean production level and net return. The endogenous switching regression approach was used to account for selection bias and to assess the impact of access to the full amount of credit on soybean production and revenue. A random sampling technique and data collected from 500 soybean farmers were used for the purpose. A simple mean test showed a significant difference among gender and discrimination regarding to the amount of credit. Regarding to the status of having access to full amount of credit, only formal education and education levels were significant. The results revealed that farmers' age, the membership of the soybean organization and growing the cotton or cashew as well as selling soybean through a member group, a recognized NGO or private organization are key indicators for accessing the full amount of credit. However, the land, the amount of credit obtained education and regular visits of extension services appear to increase soybean farmers' welfare. Also, using intercropping system as a conservation agriculture technique and increasing the land devoted to soybean production could improve farmers' welfare. The average treatment effect of having access to full amount of credit would lead to an increase by 1.35% and 1.32% higher of production and net revenue, respectively compared to credit constrained farmers. The affordability of farm credit will help in covering the production costs and potentially increase productivity. Encouraging the farm based organizations will reduce the probability of non-payment since group members constitute a form of guarantee that increases the chance of having access to farm credit from financial institutions. The access to farm credit would help in engagement of soybean transformation and commercialization. The rethinking of the role of agricultural credit in subsistence agriculture should be reconsidered in order to increase farmers' welfare and a specific attention should be given to the gender dimension.

## Declarations

### Author contribution statement

E. Ali: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

N.E. Awade: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

### Funding statement

This work was supported by the Alliance for Green Revolution in Africa (AGRA), the International Development Research Centre (IDRC), the West and Central Africa Council for Agricultural Research and Development (CORAF/WECARD) and the International Institute of Tropical Agriculture (IITA) through the grant for thesis writing. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of AGRA, IDRC, the CORAF/WECARD and the IITA.

### Competing interest statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

### Acknowledgements

The authors would like to thank Prof. Abdoulaye Tahirou from IITA, Ibadan (Nigeria), Mr Bamba Zoumana and the capacity building office of IITA for their supports and comments.

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