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Determinants of Farmers' Participation in the Agricultural Sector Support Project for the Adoption of Improved Technology in Traditional Poultry Farming: Evidence from Rural Togo

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Abstract: The adoption of improved technologies in agriculture has been shown to improve incomes, reduce poverty and contribute to rural development in many developing nations. In Togo, the Agricultural Sector Support Project (PASA) assists smallholder farmers in the adoption of the Improved Technology in Traditional Poultry Farming (ITTPF) in rural areas as a means of increasing smallholder incomes, enhancing food security and reducing poverty. However, the adoption rate is currently below expectations, especially given the promise it holds not only from an economic perspective but also from a broad environmental sustainability viewpoint since poultry manure can be used as a necessary input in smallholder farms. In this study, we examine the factors associated with the participation of farmers in PASA for the adoption of ITTPF in Togo. Our analysis covers 400 smallholder households in the 23 districts of Togo and employs Logit model with Probit model as robustness check. We find different socio-economic constraints and enablers of participation in PASA. Particularly, level of education, household size, membership in cooperative societies, hatching rate of eggs, farm size, average annual sale of poultry and self-financing capacity were positively and significantly related to the participation of farmers in PASA. The findings are robust to alternative specifications such as Probit model. Based on the findings, we argue that participation in agricultural innovation and development programs depends on the information accessible to farmers. One medium to improve information access could be agricultural cooperatives and extension services since they provide informal education, training, and access to productive inputs for farming and marketing purposes. Our findings suggest the need for agricultural policies which promote farmer organizations such as agricultural cooperatives coupled with effective extension services to enable the adoption of improved agricultural technologies.

Keywords: Traditional poultry farming, Improved technology, Determinants, Adoption, Agricultural cooperative membership, Togo

1. Introduction

Overview of agriculture and livestock sectors

Agriculture plays a vital role in the economy of Sub-Saharan Africa (SSA) as it generates a large share of the Gross Domestic Product (GDP) and employs about two thirds of the active population (OECD/FAO, 2020). Despite this, the issues of poverty, food security and welfare especially in rural areas continue to be an important agenda in SSA and worldwide (Alem, 2015; Sisha, 2020). Several previous scientific research findings support the premise that agricultural production especially crop production and productivity have been significantly declining in recent years due to the adverse effects of climate change, declining cropland fertility, and high population pressure leading to overexploitation of agricultural land and land-use constraints (Afolayan, 2021; Mng'ong'o et al., 2021; Ortiz-Bobea et al., 2021). Thus, poverty alleviation requires adaptation by strengthening farmers' resilience. Therefore, several techniques and strategies for increasing farmer resilience have been documented in the literature (Ali, 2021; Enamul Haque et al., 2022; Haile et al., 2021; Issahaku et al., 2021; Mensah et al., 2021; Roy et al., 2021; Tui et al., 2021).

So far, the literature has examined the barriers to sustainable agricultural production (Hübel and Schaltegger, 2021; Laurett et al., 2021; Liu et al., 2021) but only a few studies have focused on leveraging farmers' inherent know-how in the process of building resilience through the adoption of agricultural technologies. As a means of livelihood, farmers are both into crop and livestock farming (Boote et al., 2021; Gauthier and Langlois, 2010; Giller, 2020). Livestock farming is increasingly regarded as an important sector that could be one of the best options for building farmers' resilience through diversification of income sources, wealth creation, and poverty alleviation (FAO, 2014a). Cattle, pigs, small ruminants, poultry, etc. are among the most common types of livestock production practiced by farmers in rural areas (Devendra and Chantalakhana, 2002; Gauthier and Langlois, 2010). Recent studies have reported that poultry farming is among the most environmentally friendly animal production and the least greenhouse gas emitting compared to other types of animal production such as cattle and other ruminants, which emit significant amounts of greenhouse gases and whose production is highly dependent on vegetation cover (Menghistu et al., 2021; NDC, 2021; Zubir et al., 2021).

Poultry farming in Togo

In Togo, poultry farming enables animal production to contribute 14% to agricultural GDP (Gauthier and Langlois, 2010). Poultry production is essentially characterized by two types of production, namely traditional poultry farming based on the breeding of local birds, and modern poultry farming based on the rearing of imported exotic breeds with different degrees of intensification. The bird species in traditional poultry farming are mainly short-cycle species like chickens, guinea fowls, ducks, turkeys, pigeons, etc. (Dao, 2010). Poultry products and by-products are consumed by most of the population. The purchase price of poultry is affordable for the vast majority of the population. As part of preserving the environment through sustainable agriculture best practices, poultry excreta can be transformed into compost for natural soil fertilization or integrated management of agricultural soil fertility and thus improve crop yields (Tesfaye et al., 2017a; Tesfaye et al., 2017b; Toldrá et al., 2016).

The predominant method in poultry production in Togo is traditional poultry rearing since it is less expensive compared to modern commercial poultry farming or other types of animal production. Traditional poultry farming is widely established among smallholders in developing countries, especially in pastoral communities; due to low barriers to entry, it is an economic activity easily accessible even to the most vulnerable social strata of the population, including low-income, landless and female farmers. In this regard, traditional poultry farming can be regarded as one of the most reliable sources of income at the level of the poorest social strata (FAO, 2014b). That notwithstanding, it faces enormous constraints that significantly limit its production and profitability (Kondombo et al., 2003) including the high mortality rate of poultry. Despite this, traditional poultry farming seems to serve different purposes including income diversification, food security, employment creation and improved livelihoods (FAO, 2014a). However, the success of poultry farming, like every subsistence farming venture depends to a considerable extent on input availability and accessibility.

To improve smallholder livelihoods, reduce poverty and strengthen the resilience of farmers whose income from crop production has been declining in recent years (IPCC, 2007; Ouédraogo, 2012; UNDP, 2011), the Government of Togo has set up various programs and initiatives as vehicles for meeting the objectives of boosting rural development. In this regard, the Government through the National Program of Agricultural Investment for Food and Nutritional Security (PNIASAN) and the Agricultural Sector Support Project (PASA), offered subsidies to farmers for the adoption of the Improved Technology in Traditional Poultry Farming (ITTPF) in a bid to increase poultry production, create more value added, improve food security and reduce poverty (Gauthier and Langlois, 2010). Suffice to mention that the ITTPF is a semi-intensive type of traditional poultry rearing that differs from free-range traditional poultry farming in terms of the improvement of farm management, farm equipment, poultry housing, poultry feed, and diseases control.

Since the introduction of ITTPF in Togo through the implementation of PNIASAN and PASA, there has been no evaluation of factors contributing to or hindering farmers' participation in this program and project. In this study, we examine the correlates of the participation of famers in PASA for the adoption of ITTPT in Togo with a close look at information access. To the best of our knowledge, we are the first to fill this knowledge gap.

Within the framework of PNIASAN and PASA, the research findings provide leveraging points that will guide policy to reorient the next phases of PASA by capitalizing on the factors that encourage large-scale participation of farmers for the adoption of ITTPF. Finally, the findings contribute enormously to knowledge in technology adoption with a focus on animal technologies.

The rest of this paper is organized as follows. Section 2 describes the National Program of Agricultural Investment for Food and Nutritional Security (PNIASAN) and the Agricultural Sector Support Project (PASA) in Togo. In Section 3, we describe the data collection and develop the empirical specification. Descriptive statistics, econometrics results, as well as a robustness check are presented and discussed in Section 4. Finally, we conclude in section 5.

2. National Program of Agricultural Investment for Food and Nutritional Security (PNIASAN) and Agricultural Sector Support Project (PASA) in Togo

Since the Maputo Commitments in 2003 (Benin and Yu, 2012), the Comprehensive Africa Agriculture Development Program (CAADP) has been at the heart of many African governments' efforts to accelerate growth and reduce poverty and hunger in African countries through the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The Economic Community of West African States' Regional Agricultural Policy (ECOWAS / ECOWAP) was developed as a result of CAADP implementation in 2005 (Kolavalli, 2010; Kolavalli et al., 2012). Togo created the National Program of Agricultural Investment for Food and Nutritional Security (PNIASAN) as part of its 2010-2025 investment plan, with help from the Food and Agriculture Organization of the United Nations (FAO) and the World Bank (Gauthier and Langlois, 2010). The goal of the program was to increase farmers' income and contribute to improving trade balance and rural people's living conditions through sustainable development, with special attention paid to the poorest and most vulnerable groups (ROPPA, 2013).

PNIASAN was divided into five sub-programs, the second of which aimed to improve national livestock product coverage through intensive production of traditional livestock and the promotion of small and medium-sized enterprises in this sub-sector. To achieve the objectives of this second sub-program of the PNIASAN, the Government drew up the Agricultural Sector Support Project (PASA), which had as objective to increase the productivity and/or competitiveness of strategic food crops, export crops and animal production, and to promote an environment conducive for agricultural development. In this regard, a sub-component of PASA was aimed at reviving the livestock sub-sector, the specific objective of which was to provide short-term emergency assistance to rehabilitate poultry and small ruminant production, assist small livestock farmers to develop and improve livestock production in rural areas for wealth creation and poverty reduction (Gauthier and Langlois, 2010; NDP, 2018; World-Bank, 2017).

The Government, through this second component of PASA, has made available to all farmers in rural areas a technical package to facilitate the adoption of ITTPF. This technical package includes the construction of semi-modern poultry houses (improved poultry farms), the provision of technical poultry rearing equipment, training on the composition of balanced and quality feed at lower cost, prophylaxis, vaccination of poultry, cleaning and hygiene of poultry farms, health care, etc. The technical package costs US$ 6,364. Through PASA, the Government, with financial support from the World Bank, subsidized the cost of the acquisition of the technical package at the level of ninety percent (90%). Any farmer interested in this program for improved technology adoption in traditional poultry farming is required to contribute his share of the remaining ten percent (10%), which amounts to US$ 636. This counterpart or individual contribution from farmers interested in the program could be paid in cash or in kind. Most farmers opt for in-kind contribution, through land used as a site for the implementation of semi-intensive or improved poultry farm. Farmers who are aware of the benefits of PASA in terms of wealth creation and poverty alleviation in rural areas, but who lack both financial capacity and land to cover their 10% counterpart, have taken out loans from financial institutions in order to participate in PASA for the adoption of ITTPF.

3. Data collection and empirical specification

Data collection

Togo is a small West African francophone country subdivided into five regions namely, the Maritime Region, the Plateaux Region, the Central Region, the Kara Region and the Savannah Region. Geographically, it lies between 6° and 11° North latitude, and 0° and 2° East longitude. It covers an area of 56,600 km² and has a long and narrow profile, extending over 600 km from north to south, but not exceeding 160 km in width. It is bordered by Burkina Faso, Benin Republic, Ghana and Atlantic Ocean to the North, East, West and South, respectively (UN-DESA-PD, 2019) (see Figure 1). Togo has significant agricultural potential, despite its limited size. Cultivable land is estimated at nearly 3.4 million hectares (64% of the territory), of which 45% is currently cultivated. The country's varied climate divides it into several agroecological zones allowing for the production of a diverse range of agricultural products. Irrigable land is estimated at 86,000 hectares and exploitable lowlands at 175,000 hectares. Despite this important agricultural potential, more and more regions are confronted with the negative effects of climate change and the increase in land pressure caused mainly by anthropogenic actions such as environmental degradation, overexploitation of land, degradation of cultivable soils and their declining fertility (Gauthier and Langlois, 2010).

The analysis of different socio-economic constraints and enablers of participation in PASA for the adoption of ITTPF in Togo in this paper is based on a farm household survey. The survey was conducted between July and October 2020 in the five regions of Togo. Documentation and field visits allowed us to identify the different districts and localities of the five major rural areas involved in this investigation. The target population size represented the total number of farmers in Togo. Following Soviadan et al. (2019), the sample size for this study was determined using Fellegi's (2003) sampling technique with a 95% confidence level. 400 farmers were then selected as the core sample for this study. Baseline data collected from the Ministry of Agriculture, documentation and field visits helped in the identification of 86 farmers who benefited in 2014 from a subsidy for the adoption of improved technology in traditional poultry farming. This grant was awarded to them through the Agricultural Sector Support Project (PASA) of the Ministry of Agriculture in which they voluntarily participated. The total sample of 400 respondents was broken down by region according to the weight of each region in the national agricultural population. The eighty-six farmers exposed to ITTPF were distributed in the five regions of the country and by district. They were therefore considered as the beneficiaries and were part of the overall sample. The non-beneficiaries, randomly selected from the population, constituted the rest of the sample, and were also stratified according to the weight and distribution of farmers subsidized by district. Tables 1 and 2 show the full sample design of the study. Key socioeconomic variables, institutional characteristics, livestock ownership, and income and expenditure were all collected. The main variables in the analysis are described in Tables 3 and 4.

Table 1 – Sample design of the study

Region	Agricultural population by region	Weight of the region	Sample stratified by region
Maritime	776 135	21%	83
Plateaux	1 161 580	31%	124
Central	457 173	12%	49
Kara	601 036	16%	64
Savannah	742 506	20%	80
National Total	3 738 430	100%	400

Table 2 – Full sample design of the study

Region	District Selected	N. of Beneficiaries	Weight of Beneficiaries by district	N. of non-Beneficiaries	Sample by district selected
Savannah	Tandjoare	5	24%	14	19
	Oti	5	24%	14	19
	Tone	6	29%	17	23
	Kpendjal	5	24%	14	19
	Tandjoare	5	24%	14	19
Total Savannah	4	21	100%	59	80
Kara	Binah	6	35%	17	23
	Kozah	6	35%	17	23
	Assoli	5	29%	14	19
Total Kara	3	17	100%	47	64
Central	Tchaoudjo	6	35%	11	17
	Sotouboua	5	29%	9	14
	Blitta	3	18%	6	9
	Tchamba	3	18%	6	9
Total Central	4	17	100%	32	49
Plateaux	Agou	3	17%	18	21
	Amou	1	6%	6	7
	Est-Mono	3	17%	18	21
	Ogou/Anie	5	28%	29	34
	Danyi/Kpele	5	28%	29	34
	Mean-Mono	1	6%	6	7
Total Plateaux	6	18	100%	106	124
Maritime	Golfe	2	15%	11	13
	Lacs	2	15%	11	13
	Zio Sud	4	31%	22	26
	Ave	3	23%	16	19
	Vo	1	8%	5	6
	Yoto	1	8%	5	6
Total Maritime	6	13	100%	70	83
Total	23	86	100%	314	400

Source: Author's computation based on field data, 2014, 2020
Note: N in Table 1 denotes Number

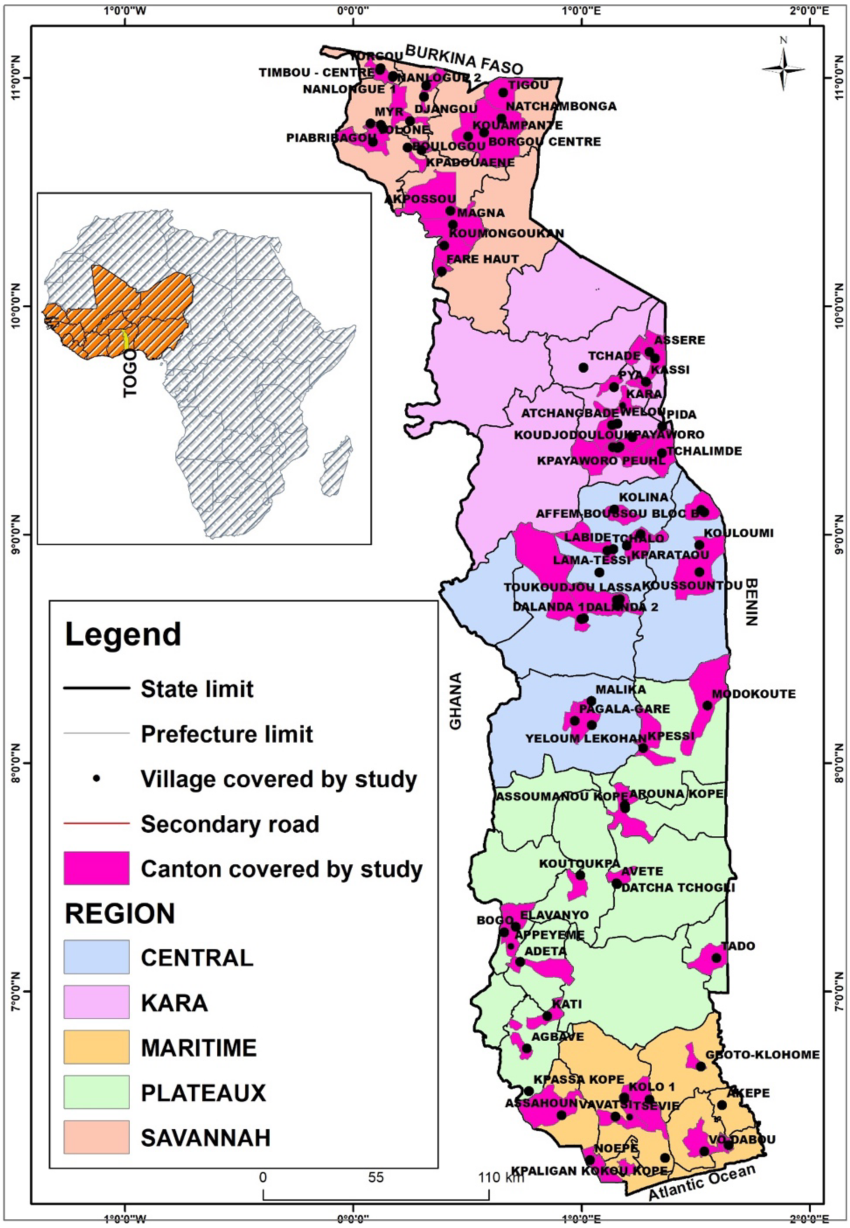

Figure 1 – Map of the study area (Togo). Source: Authors' conceptualization

Empirical specification

Based on the estimated parameters, the expected value of the binary dependent variable (BDV) is the probability that the BDV will take the value 1. Because the probability range is from 0 to 1, it is critical that the Ordinary Least Squares (OLS) predicted values of the dependent variable fall within this range. Unfortunately, it is impossible to guarantee that the predicted values will lie between 0 and 1 in the case of linear probability models (Amemiya, 1977; Heckman and Macurdy, 1985). This is a major shortcoming of linear probability models. Another drawback of linear probability models is that the OLS residuals from such regressions are heteroscedastic and therefore not distributed normally. Recall that although the OLS estimator is unbiased, in the presence of heteroscedasticity, the OLS standard errors are no longer reliable thereby affecting the results of hypotheses tests. In summary, although linear probability models have the advantage of ease of estimation by widely available OLS regression packages, the aforementioned limitations are serious enough to warrant the search for appropriate alternatives to the linear probability model (Aldrich et al., 1984).

There are two widely used alternatives to the linear probability model which guarantee that the predicted values (which are interpreted as probabilities) lie within the 0 to 1 feasible range. The two alternatives are the Probit model and Logit models. Both are such that the probabilities are non-linear functions of the relevant independent variables (in contrast, the linear probability model gives probabilities that are linear functions of the relevant independent variable(s)). There is no doubt that Probit and Logit models are better than the linear probability model. The Logit model is based on the cumulative probability of the logistic distribution, whereas the Probit model is based on the cumulative probabilities of the standard normal distribution. Since the cumulative probabilities of bonafide probability distributions lie within the 0 to 1 range, the estimated probabilities will always lie within the 0 to 1 range (Greene, 2012; Wooldridge, 2005).

One problem with the Logit and Probit models is that they cannot be conveniently estimated by OLS. Such a model is often estimated by non-linear least squares or maximum likelihood procedure, which are relatively more demanding (Dubin and Rivers, 1989). Although such procedures have now been incorporated in many widely available regression software packages, the problem with these procedures is that convergence to the right solution is not guaranteed. It is not uncommon to find that for certain data sets, it may not be possible to get the solutions without changing the starting values of the algorithms involved or relaxing the desirable convergence criteria (Wooldridge, 2003, 2005; Brooks, 2008; Gujarati and Porter, 2009; Greene, 2012).

Linear Probability Model (LPM)

To fix ideas, let's consider the case of understanding the various enablers and constraints farmers are facing in participating in PASA. Following Carrasco and Ortuzar (2002) and Heckman and Macurdy (1985), the linear probability model for the participation in PASA can be specified as:

$$\begin{cases} Y_i = \beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i \\ P_i = \beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i \end{cases} \tag{1}$$

Where Y_i or P_i is a binary variable taking the value one for farmers that participate in PASA and zero otherwise. X_i is a vector of explanatory variables expected to be related to the participation of farmers in PASA. These set of covariates are based on both theoretical and empirical literature on technology adoption in smallholder farming systems (Curry et al., 2021; Konja, 2021; Mogaka et al., 2021; Omara et al., 2021; Peles and Kerret, 2021; Qi et al., 2021; Tey and Brindal, 2012; Xie and Huang, 2021). These include household socio-economic characteristics such as household head's sex, age, marital status, educational level, household size, membership in cooperative societies, self-financing capacity in cash or kind, farm size, average annual sale of poultry, hatching rate of eggs and poultry loss rate. $\boldsymbol{\beta}$ is the vector of the parameter estimates corresponding to the various explanatory variables and ε_i is the stochastic error term.

Marginal effect for the linear probability model $((dP_i)/(dX_i))$

The marginal effect of factors in the model on the participation in PASA is determined by taking the derivative $(dP_i/d\boldsymbol{X_i})$

$dP_i/d\boldsymbol{X_i} = \boldsymbol{\beta}$

The marginal effect $(dP_i/d\boldsymbol{X_i})$ in the case of the linear probability model is equal to **β.** The problems related to the linear probability model are the heteroscedasticity and the probability outside range.

Logit model

Following Cramer (2004) and Stoltzfus (2011), the logistic regression model corresponding to the linear probability model above for the participation of farmers in PASA for the adoption of improved technology in traditional poultry farming is given by:

$$\begin{cases} Y_i = exp(\beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i)/[exp(\beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i) + 1] \\ P_i = exp(\beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i)/[exp(\beta_0 + \boldsymbol{\beta X_i} + \varepsilon_i) + 1] \end{cases} \quad (2)$$

Where P_i is the probability that $Y_i = 1$ if a farmer (i) participates in the project and 0 otherwise. By applying the logarithmic transformation, the logistic regression model above can be rewritten as follows:

$$\boldsymbol{ln[P_i/(1 - P_i)] = exp(\beta_0 + \beta X_i + \varepsilon_i)} \quad (\mathbf{3})$$

Where $P_i/(1 - P_i)$ is called the odds-ratio, that is the ratio of the probability of participation in PASA for the adoption of improved technology in traditional poultry farming (P_i) over the probability of non-participation $(1 - P_i)$.

Marginal effect for Logit model (dP_i/dX_i)

The marginal effect of factors in the logistic regression model on the participation in PASA is determined by taking the derivative $(dP_i/d\boldsymbol{X_i})$

$$(dP_i/d\boldsymbol{X_i}) = \boldsymbol{\beta} P_i(1 - P_i)$$

Probit model

Following Carrasco and Ortuzar (2002) and Heckman and Macurdy (1985), the Probit model corresponding to the linear probability model above for the participation of farmers in PASA for the adoption of improved technology in traditional poultry farming is given by:

$$P_i = \Phi\ (\beta_0 + \boldsymbol{\beta X_i} + \mu_i) \quad (4)$$

Where $\Phi(\cdot)$ is the cumulative probability from Standard of Normal Distribution (SND) (Bliss and Fisher, 1935; Greene, 2012; Wooldridge, 2005).

Marginal effect for Probit model (dP_i/dX_i)

The marginal effect of factors in the Probit model on the participation in PASA is determined by taking the derivative $(dP_i/d\boldsymbol{X_i})$

$(dP_i/d\boldsymbol{X_i}) = \boldsymbol{\beta} f(\beta_0 + \boldsymbol{\beta X_i} + \mu_i)$ with $f(\cdot)$ a density function

Assessing goodness of fit in Logit and Probit models

The Pseudo-R squared is used instead of the conventional R squared to assess goodness-of-fit in Probit and Logit models. The term "pseudo" is used to distinguish it from traditional R-squared because it cannot be used to make statements like "X percent of the variation in the dependent variable is explained by variation in the independent variable(s) included in a regression model". In general, a bigger pseudo-R-squared value is indicative of a better fit (Wooldridge, 2005; Greene, 2012).

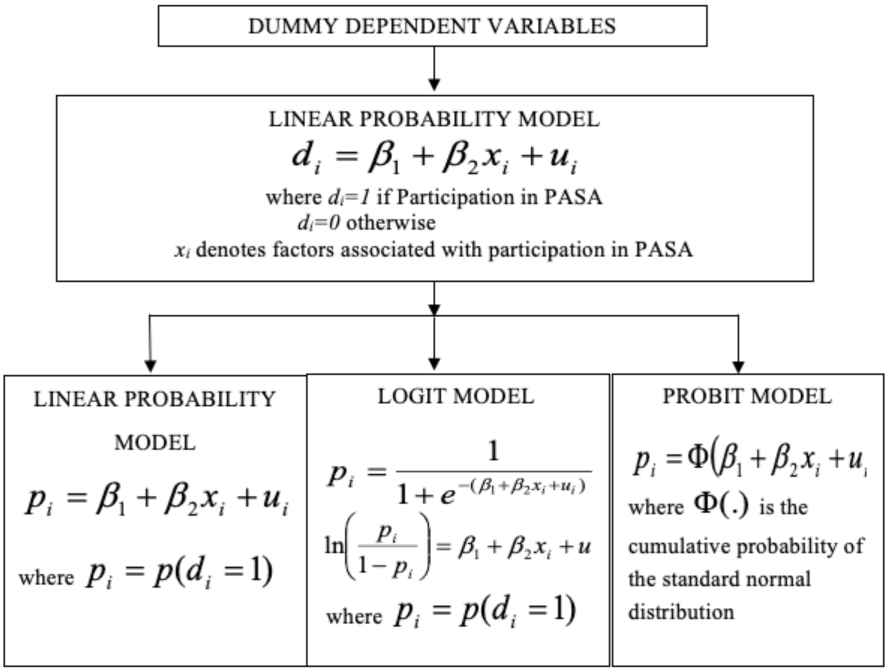

Figure 2 – Dummy dependent variables. Source: Authors' conceptualization

Given that our outcome variable is a binary variable, we employ binary dependent models. The most commonly used approaches to estimate such dummy dependent variable regression models are (1) the Logit model, and (2) the Probit model (Wooldridge, 2003; Gujarati and Porter, 2009; Brooks, 2008). The Logit and Probit models are quite similar in most applications. The main difference between the two is their distribution, which is captured by the Cumulative Distribution Function (CDF). Probit has a normal distribution while Logit has a logistic (slightly flatter tails) distribution and therefore, the choice of Probit versus Logit regression depends largely on the distribution assumption one makes. Due to its comparative mathematical simplicity, the Logit regression model is more commonly used. Gujarati and Porter (2009) argue that logistic regression is powerful, convenient and flexible and is often chosen if the dependent variables are categorical and/or are not normally distributed. For brevity, we would only discuss the Logit model with Probit model as robustness check.

4. Results and discussion

Descriptive statistics

Table 3 compares the socioeconomic characteristics of the project beneficiaries and non-beneficiaries before the implementation of PASA. Prior to the introduction of PASA, both groups of farmers (beneficiaries and non-beneficiaries) have similar socio-economic characteristics such as gender where men are more represented, age on average 46 years old, marital status where almost all respondents are married, as well as hatching rate of eggs which is 75% on average in most traditional poultry farms. Consequently, these variables might or might not be associated with farmers' participation in PASA, and they might also be used as control variables in the project's impact assessment study. However, prior to the implementation of PASA, both groups of farmers differed significantly in terms of socio-economic characteristics such as level of education, household size, farm size, average annual sales of poultry, poultry loss rate, hatching rate of eggs, agricultural cooperative membership, and self-financing capacity. Hence, these variables could be related to farmers' participation in PASA (Soviadan et al., 2021).

Econometric results

The logistic regression model presents the marginal effects showing farmers' likelihood of participating in PASA for the adoption of ITTPF. The farmers' socio-economic characteristics namely sex, age and marital status are not statistically significant as shown in Table 4. In contrast, the hatching rate of eggs is only significant at 10% threshold and positively related to the participation of farmers in the project (PASA). The loss rate of poultry is also significant at 10% threshold but negatively associated with the participation of farmers in the project. The farm size and the average annual sale of poultry are significant at 5% thresholds and positively associated with the participation of farmers in the project while the level of education, the membership of agricultural cooperative societies, the household size and the self-financing capacity are all significant at 1% thresholds and positively related with the participation of farmers in the project.

Table 3 – Descriptive statistics

	Project Participants	Non Participants	t / (χ2)	Statistical Significance
Sex	1	1	-0.01	
	(0.04)	(0.02)		
Age	48	44	-3.57	
	(0.95)	(0.55)		
Marital status	2	2	0.26	
	(0.04)	(0.02)		
Level of education	2	1	-6.24	***
	(0.09)	(0.05)		
Household size	10	7	-4.91	***
	(0.58)	(0.18)		
Farm size	72	33	-12.57	***
	(4.32)	(1.10)		
Average annual sale of poultry	49	24	-12.33	***
	(2.67)	(0.72)		
Poultry loss rate	0.42	0.55	6.46	***
	(0.03)	(0.01)		
Hatching rate of Eggs	0.76	0.74	-1.46	
	(0.02)	(0.00)		
Membership of cooperative	1	2	41.48	***
	(0.02)	(0.01)		
Self-financing capacity	1	2	60.07	***
	(0.02)	(0.01)		

Source: Author's computation based on field data, 2020
*Note: Asterisks *** indicate that mean values are significantly different at 1% threshold and no significant difference otherwise, (t-test for continuous variables and chi-square (χ2) test for non-continuous variables). Mean values are shown with standard errors in parentheses.*

The loss rate of poultry is significant and negatively related to the participation of farmers in PASA for the adoption of ITTPF. The higher the loss rate of poultry in the farmers' poultry farms, the lower the participation of farmers in PASA. This can be explained by the fact that poultry losses through mortality, predation, theft and accidents lead to revenue shortfalls and reduced profit margins. According to some farmers, traditional poultry farming is not very beneficial for them because of the huge losses they incur. This could arguably be due to non-membership in agricultural cooperatives which are beneficial to their members through the provision of essential training on reducing such structural losses along the production chain. In addition, farmers who are not members of agricultural cooperative societies are likely not aware of the relevance of PASA. Perhaps, if the majority of farmers realized the benefits of PASA, those facing high poultry loss rates in their traditional poultry farms would have been much more motivated to participate in PASA in order to significantly reduce these poultry loss rates and improve their poultry productivity and production through the adoption of the improved technology that PASA offers to beneficiaries.

The level of education is significant and positively associated with the participation of farmers in PASA for the adoption of ITTPF. The more educated a farmer is, the more he or she understands the importance of innovations and is willing to take advantage of available opportunities to improve their traditional poultry farm and make it more profitable. A similar study in Tanzania by Albert et al. (2020) assessing factors influencing youth involvement in horticulture agribusiness found that level of education is positively correlated with participation. Zhang et al. (2011) report a significant correlation between education level and willingness to support the conversion of cultivated land to wetlands. Individuals with higher education levels, according to the authors, are more likely to depict favorable attitudes toward the conversion of cultivated land to wetland than those with lower education.

Table 4 – Logistic regression predicting factors related with participation of farmers in the agricultural sector support project (PASA) for the improvement of traditional poultry farming

Variable	Coefficient	Standard error	z
Sex (Male=1, Female=0)	−1.508	1.234	−1.222
Age (Years)	0.011	0.137	0.080
Marital status	−1.128	2.189	−0.515
Level of education (Categorical)	0.830***	0.190	4.368
Household size (Number of members)	0.038***	0.042	0.904
Membership of cooperative (Yes=1, No=0)	19.176***	2.221	8.633
Self-financing capacity (US $)	3.401***	0.775	4.388
Farm size (Number of poultry)	0.006**	0.005	1.200
Average annual sale of poultry (NPS)	0.001**	0.001	1.000
Hatching rate of eggs (%)	10.778*	6.957	1.549
Loss rate of poultry (%)	−1.606*	6.485	−0.247
Diagnostic statistics			
Number of observations	400		
LR Chi^2 (11)	420.158		
Prob > Chi^2	0.0000		
% Correctly Predicted	99.5%		
Pseudo R^2	96.88%		

*Source: Author's computation based on field data, 2020. Note: * Significant at 10% threshold; ** Significant at 5% threshold; *** Significant at 1% threshold. NPS= Number of Poultry Sold*

Enete and Amusa (2010) argued that women's level of education is positively and significantly related to their level of contribution to household farming decisions. Specifically, well-educated women are more likely to be involved in farming decisions than their less-educated counterparts. Thus, education appears to be a critical factor in the decision-making process of farmers in particular, and all populations in general, for participation in development programs and projects.

Household size is positively associated with the participation of farmers in PASA for the adoption of ITTPF. Given the nature of most rural agricultural production systems where family labour is usually utilised for different farm purposes, household size could be a source of labour for semi-intensive poultry farming. Therefore, the higher the number of working family members, the more likely is the farmer to participate in the project for the adoption of improved technology in traditional poultry farming. Selejio and Lasway (2019) also found the household size to be positively related to the adoption of inorganic fertilizers and a blanket of other technologies. According to the authors, when household size increases, the propensity to adopt inorganic fertilizers and the package of technologies increases. Akudugu et al. (2012) argued that households with a high number of family members have an easier time participating in agricultural technology adoption by having numerous active members committed to agricultural activities. These results are also in line with those of Neupane et al. (2002), Akpaden et al. (2014), Coulibaly-Lingani et al. (2011), Tobogbonse et al. (2013), and Tamimie and Goldsmith (2019) who arrived at the same conclusion that the availability of family labour is a factor in motivating farmers to participate in major agricultural intensification projects.

Membership in cooperatives and producer organizations is positively associated with the participation of farmers in PASA for the adoption of ITTPF. Farmers who belong to agricultural cooperatives are much more likely to join the project. This could be because these cooperative members may be better organized, and hence benefit from technical training, advice and support from experts in the agricultural sector. They may also be aware and well informed about the advantages of participating in the agricultural development programs and projects offered to them. These findings are in line with the new institutional economics theories (Ajates, 2020; Ortmann and King, 2007; Williamson, 2000; Zhang et al., 2019) and some empirical analyses (Awotide et al., 2016; Zhang et al., 2019; Manda et al., 2020).

The size of the landholding and the average annual sale of poultry are significant and positively related to the participation of farmers in PASA for the adoption of ITTPF. Although these farmers are involved in other agricultural production such as crop production, they are convinced of the importance of improved traditional poultry farming not only as a source of additional income generation but also in building resilience.

Moving ahead, self-financing capacity is significant and positively associated with the participation of farmers in PASA for the adoption of ITTPF. Recall that the Government, through the second component of PASA made available to all farmers in rural areas a technical package to facilitate the adoption of ITTPF. This package includes the construction of semi-modern poultry houses (improved poultry farms), the provision of technical poultry rearing equipment, training on the composition of balanced and quality feed at lower cost, prophylaxis, vaccination of poultry, cleaning and hygiene of poultry farms, health care, etc. Farmers on their part are requested to contribute a share of about 10% which could be paid in cash as well as in kind. The contribution in kind, through the development of the land used as the site of the semi-intensive or improved poultry farm, was the option of most of the subsidized farmers (Soviadan et al., 2021). Thus, the more a farmer can cover 10% of the technical package cost, the more motivated he or she is to participate in the project.

Note that some farmers who did not have the financial capacity or real estate (rural land) to cover their 10% counterpart, and who were interested in the project, took out financial credits with financial institutions to cover their financing capacity to benefit fully from the project's technical package. Suffice to mention here that it was much easier for farmers who are members of the agricultural cooperatives to obtain credit from financial institutions than for non-member farmers. These findings are consistent with a broad literature that has shown that access to financial credit appears to be positively and strongly associated with the adoption of agricultural technologies (e.g. Alem and Broussard, 2018; Conley and Udry, 2010; Duflo et al., 2011; Dupas, 2014; Giné et al., 2008; Grimm et al., 2017).

Robustness check

Now that we have established the various factors associated with the participation of households in PASA for the adoption of ITTPF using logistic regression model, we performed a robustness check on the estimates from the Probit model to assess the robustness of the results. The results of the Probit model are presented in Table 5.

Table 5 – Probit regression predicting factors related with participation of farmers in the agricultural sector support project (PASA) for the improvement of traditional poultry farming

Variable	Coefficient	Standard error	z
Sex (Male=1, Female=0)	0.062	0.568	0.109
Age (Years)	0.015	0.047	0.319
Marital status	−0.621	0.490	−1.267
Level of education (Categorical)	0.414***	0.120	3.450
Household size (Number of members)	0.005**	0.030	0.166
Membership of cooperative (Yes=1, No=0)	6.769***	0.692	9.781
Self-financing capacity (US $)	0.903***	0.677	1.333
Farm size (Number of poultry)	0.003**	0.002	1.500
Average annual sale of poultry (NPS)	0.002*	0.015	0.133
Hatching rate of eggs (%)	3.741*	7.382	0.506
Loss rate of poultry (%)	−0.779*	1.765	−0.441
Diagnostic statistics			
Number of observations	400		
LR Chi2 (11)	401.645		
Prob > Chi2	0.0000		
% Correctly Predicted	99.2%		
Pseudo R2	97.06%		

*Source: Author's computation based on field data, 2020. Note: * Significant at 10% threshold; ** Significant at 5% threshold; *** Significant at 1% threshold. NPS= Number of Poultry Sold*

5. Conclusion

In this study, we examined the various determinants associated with the participation of farmers in the agricultural sector support project (PASA) for the adoption of improved technology in traditional poultry farming (ITTPF). Employing Logit model on a cross-sectional data set of 400 smallholder farm households in Togo, we show that different socio-economic and contextual factors matter in the participation of farmers in this project. Key among these are level of education, membership of cooperatives societies, household size, farm size and self-financing capacity which showed a positive and significant relationship with participation in PASA for the adoption of ITTPF.

The results suggest the need for agricultural policies that promote farmer organizations such as agricultural cooperatives coupled with effective extension services for faster and greater adoption of emerging agricultural practices and improved agricultural technologies indispensable for agricultural development. To be able to participate without any constraint in innovation programs for the improvement of agricultural production, it is very indispensable for farmers to adhere to agricultural cooperatives to benefit from the services that these cooperatives provide to their members such as information and awareness, education, literacy, training, access to inputs and financial credits, creation of value chains through agricultural cooperatives networking and access to markets for the valorization of agricultural commodities.

Like every other study, we end by mentioning a limitation of the study. Firstly, we guide the understanding of this analysis from a correlation viewpoint with no implication for causality. Given that we used cross-sectional data and could not control for many confounding in the way of identifying participation in PNIASAN and PASA, we do not make any causal claims. Future research may want to credibly identify participation in such program and project through the use of longitudinal data sets or in a more controlled experimental setting.

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Compliance with ethical standards

Conflict of interests

The authors declare no conflict of interest.

Statement of human and animal rights

This study did not collect any confidential or private information about the farmers. All individual participants in the study provided informed consent. This article does not include any animal studies conducted by any of the authors.

Data availability statement

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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