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Farmers' perceptions and adoption of agroecological practices in the Central-North region of Burkina Faso

Perceptions des agriculteurs et adoption des pratiques agroécologiques dans la région du Centre-Nord du Burkina Faso

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Abstract

Conventional agricultural systems contribute to the continuous degradation of land, forests and water, ultimately leading to low agricultural yields in most of sub-Saharan Africa, in addition to climate change. The effects vary from one agro-climatic context to another. For a country of the Sahel region such as Burkina Faso, agroecology is an answer to the agro-environmental transition. This paper therefore analyzes the role of perceptions in decisions of farmers to adopt and intensify agro-ecological practices in the North Central region of Burkina Faso. Using a Tobit model with data from 137 farm households, the research shows that perceptions play an important role in the adoption and intensification of agroecology. Perceptions about the coverage of needs and utility favor the practice of agroecology. So do experience, literacy and household size. On the other hand, the perception of risk, the weight of economically inactive people and the size of the area are impediments. These results imply that agricultural policies for the extension of agroecological techniques must take into account the perceptions of farmers. There is also the need to build their capacity through literacy and vocational training.

Keywords: Farmer, perception, agroecological practices, adoption, Burkina Faso

Résumé

En plus du changement climatique, les systèmes agricoles conventionnels contribuent à dégrader continuellement les terres, les forêts et les eaux, et entraînent in fine de faibles rendements agricoles dans la plupart des pays de l'Afrique subsaharienne. Les effets varient d'un contexte agroclimatique à un autre. Pour un pays sahélien comme le Burkina Faso, l'agroécologie est une réponse pour la transition agroenvironnementale. Cet article analyse donc le rôle des perceptions dans les décisions d'adoption et d'intensification des pratiques agroécologiques par les agriculteurs dans la région du Centre-Nord du Burkina Faso. Prenant appui sur un modèle Tobit, avec des données de 137 ménages agricoles, la recherche montre que les perceptions jouent un important rôle dans l'adoption et l'intensification de l'agroécologie. Les perceptions sur la couverture des besoins et de l'utilité favorisent la pratique de l'agroécologie. Il en est de même de l'expérience, l'alphabétisation et la taille du ménage. En revanche, la perception du risque, le poids des inactifs économiques et la superficie sont des freins. Ces résultats impliquent que les politiques agricoles de vulgarisation des techniques agroécologiques doivent tenir compte des perceptions des agriculteurs. Il faut aussi renforcer leur capacité à travers l'alphabétisation et la formation professionnelle.

Mots clés : Agriculteur, perception, pratiques agroécologiques, adoption, Burkina Faso

Introduction

The recurrent food insecurity faced particularly by countries in sub-Saharan Africa (SSA) is partly explained by the low yields of the agricultural sector. In 2020, the average grain yield in SSA was the lowest in the world. Estimated at 1.5 tons (t)/hectare (ha), this yield is well below the world average (4.1 t/ha) (World Bank, 2022). The low agricultural yields can be partly explained by climate change, whose shocks negatively influence agricultural production (Emediegwu et al., 2022). Faced with the persistent adverse effects of climate change in SSA, farmers are trying to adapt by adopting various technologies that can improve their productivity. Among these technologies are agroecological practices that are increasingly preferred over conventional ones. According to Wezel et al. (2011), agroecology is considered to be both a body of scientific knowledge that combines agronomy and ecology, but also a peasant political movement and agricultural practices and techniques. As a farming practice, agroecology reduces dependence on energy-intensive inputs, while improving soil fertility, productivity and biodiversity. It is also based on the principles of optimizing biological interactions, favoring ecological input over external input and valuing farmers' know-how. Agroecology offers important tools to meet food needs, as well as adaptation to climate change.

Given the benefits of agroecological practices, understanding the motivations of farmers in adopting these practices becomes important and necessary for its widespread implementation. Theoretically, the adoption of agroecology is part of the theory of innovation adoption. Based on the paradigms of innovation-diffusion of Rogers, economic constraint of Aikens et al. (1975) and the perception of the adopter of Kivlin and Fliegel (1967), the adoption of agroecological practices is based on both observable and non-observable factors. Several empirical works (Rosário et al., 2022; Benítez-Altun et al., 2021; Akpatcho et al., 2019; Ntshangase et al., 2018; Issoufou et al., 2017) also confirm that agroecology adoption decisions are determined by both observable and unobservable factors. According to this work, taking both categories of factors into account is essential to better understand the explanatory factors of agricultural technology adoption.

To further understand farmers' motivations in adopting agroecological practices in countries such as SSA, this research chooses Burkina Faso as the study area. As in all countries of the Sahel, the agricultural sector in Burkina Faso is relatively more exposed to climate change and drought. This is compounded by infrastructural constraints, low technical skills, and low levels of education among producers (Institut National de la Statistique et de la Démographie (INSD),

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2021). As a result, cereal deficits are often recorded. For the 2018-2019 agricultural seasons, the majority (more than 50%) of households were not self-sufficient in five regions: Central-East (51%), North (54%), Sahel (56.4%), Central-North (66.6%), Central (69.3%) (Ministry of Agriculture and Hydro-Agricultural Development (MAAH), 2019). As a result, food and nutrition insecurity then remains a worrying situation in this country. The rate of undernourished people in Burkina Faso (20.7%) is one of the four highest rates in the 16 countries of West Africa (Food and Agriculture Organization of the United Nations (FAO) et al., 2015). Rural areas, which rely primarily on agriculture, are particularly affected; 36.5% of households have experienced hunger, compared to 25.3% in urban areas (INSD, 2021).

To mitigate the consequences of climate change and drought, Burkinabe farmers resort to water and soil conservation techniques, and chemical fertilizers that are expensive and not accessible to the poorest (Élie et al., 2021). Fallow land, which was also used as a means of fertilizing the soil, is tending to disappear due to demographic pressure. In this context, in order to strengthen the resilience of rural households, sustainable production means and techniques must be made available to farmers in order to improve agricultural productivity in Burkina Faso.

To our knowledge, in the context of Burkina Faso, among the works that have addressed the explanatory factors of agroecology adoption, very few have taken into account unobservable factors in an economic and econometric approach. The most recent studies, such as those by Zongo et al. (2022) and Coulibaly et al. (2019), even though they have highlighted the factors that determine the adoption of agroecology in Burkina Faso, they have focused solely on observable factors. Moreover, these works simply analyzed the adoption and non-adoption decision, unlike this research, which in addition to the simple adoption decision, also analyzes the intensification of the technology. This research could therefore contribute to a better understanding of adoption and intensification decisions of agroecological practices in a Sahelian country like Burkina Faso.

The overall objective of this research is to analyze the role of perceptions in the adoption and intensification of agroecological practices by farmers in Burkina Faso. To do so, the research postulates that perception is a key factor that conditions agroecological practices in Burkina Faso. The remainder of the paper is structured in four sections. The first section presents the analytical framework. The second section describes the data and variables. The third section discusses the results. The fourth section concludes the paper and draws agricultural policy implications.

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1. Explanatory factors of adoption decisions of agroecological practices: theoretical and empirical review

Theoretically, decisions to adopt agricultural technologies and thus agroecological practices are based on three paradigms: the innovation-diffusion paradigm, the economic constraint paradigm and the adopter's perception paradigm (Adesina and Zinnah, 1993). The innovation diffusion model, which stems from the work of Rogers, argues that access to information about an innovation is the key factor that determines adoption decisions. Also, the problem of technology adoption is then reduced to the communication of information about the technology to potential end users. The economic constraints model advocated by Aikens et al. (1975) argues that economic constraints such as resource endowments are the main determinants of adoption (access to capital, access to credit and access to land). The third paradigm developed by Kivlin and Fliegel (1967) suggests that perceived attributes of innovations condition adoption behavior. These works show that the adoption of agricultural technologies and in particular agroecological practices is based on observable factors, on the one hand, and on unobservable factors on the other.

Among the unobservable factors, theoretically one can retain risk, utility, and social influence. The risk aversion model of Foster and Rosenzweig (2010) argues that risk averse farm households will be more willing to accept the new technology than risk averse households. The technology acceptance model developed by Davis (1989) shows that utility (including perceived ease of use) would significantly influence an individual's attitude through self-efficacy and instrumentality. In the context of Burkina Faso, utility can be extended to the coverage of food needs, which is the ultimate objective of agricultural households. The perceived need to use agroecology in the face of climate change can be considered in this research. Fishbein and Ajzen's (1975) theory of reasoned action emphasizes that an individual's intention to adopt a technology is determined by two basic factors, including self-interest and social influence, notably the people around the individual.

On the empirical level, Feder and Umali (1993) group observable factors into three categories related to the farmer and his farm: intrinsic characteristics of the innovation, endogenous factors (household size, age and level of education of the farmer, etc.) and exogenous factors (climatic hazards and regulations). Several recent studies have identified these factors as determinants of the adoption of agroecological practices by rural households in developing countries. Kpadenou et al. (2019) showed that in Benin, endogenous factors such as experience, level of education, farm size, number of assets, and land tenure are those that influence the adoption of agroecological practices in Benin. The work of Coulibaly et al. (2019) also showed that training and illiteracy are factors that significantly impact the adoption of agroecology. In the same logic, the systematic review by Tey et al**.** (2017) also showed that gender, age, education level, farm size also determines the adoption of these practices in DCs. Benítez-Altun et al. (2021) showed that gender also influences the adoption of agroecological practices. Regarding exogenous factors, the work of Rabe et al. (2021) showed that in Niger, access to institutions such as extension and credit influence the adoption of agroecology. Benítez-Altun et al. (2021) found the same results for vegetable farmers in Chile, as did the systematic review by Rajendran et al. (2016).

Farmers' perceptions are often discounted in the analysis of agricultural technology adoption (Issoufou et al., 2017; Menapace et al**.**, 2013). However, farmers develop individual perceptions and preferences for innovation, and these are not directly observable. In doing so, work that has examined their effect on the adoption of agroecological practices exists, but remains limited in number, especially in the context of SSA countries. Rosário et al. (2022) showed in a systematic review that the weak capacity highlighted by the models to explain farmers' adoption behavior is due to poor selection of constructs, including the exclusion of unobserved variables that have a determining impact. Overall, Tey et al. (2017) through a review found that farmers' perceived attributes of agroecology (perceptions) significantly impact their technology adoption decisions in DCs. In Chile, Benítez-Altun et al. (2021) showed that risk perception decreases the likelihood of adoption of agroecological practices. Akpatcho et al. (2019) showed that in Benin, producers' preference for a technology depends more on the interest they perceive in its implementation than on the interest they are promised. According to Ntshangase et al. (2018), positive farmer perceptions would significantly increase the likelihood of agroecology adoption in South Africa. Ngondjeb et al. (2011) found that farmer's perception of erosion problems improves agroecology adoption in Cameroon.

2. Material and methods

2.1.Model for analyzing the adoption and intensification of agricultural technologies

This research is part of the theoretical framework of the technology acceptance model, which enriches the models of reasoned action and planned behavior by adding external variables in the modeling of user behavior and by showing how these variables affect the two specific beliefs (usefulness and perceived ease of use) (Venkatesh et al., 2003). This model postulates that the acceptability of using a technological innovation is based on behavioral intention, which is jointly determined by the individual's attitude toward using the innovation and perceived

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usefulness. Perceived usefulness refers to the degree to which an individual believes that using a system will improve their performance.

Generally, the producer bases his decision to adopt a technology on expected profitability or utility (Greene, 2012). He then adopts a given technology only if that profitability is greater than the profitability of not adopting (Raham and Huffman, 1984). Let a producer i be faced with a choice between two alternative technologies $j = 1, 2$ and have a utility Ufunction such as $U = U_{ij}(X_i)$, with X_i The vector representing the set of factors determining the adoption of the technology, which subsequently influences the level of its utility. Let k be the number of these factors, which can be the characteristics of the farm, the characteristics of the technology and the institutional factors (Thornton et al., 2007)

When the producer decides to choose technology 1 (respectively technology 2), he reaches a utility level U_{i1} (U_{i2}). He will then choose the technology that allows him to achieve the highest level of profit. The producer's adoption decision can be represented by an unobserved variable Y_i^* such as:

$$Y_i^* = \beta' X_i + \varepsilon_i, i = 1, \dots, N \quad (1)$$

with β' a vector of k parameters, ε_i A random disturbance. Y_i^* Can take the following values:

$Y_i^* > 0$, if $U_{i1} > U_{i2}$, which means that producer i adopts technology 1;

$Y_i^* \leq 0$, if $U_{i1} \leq U_{i2}$, which means that producer i adopts technology 2.

We can consider Y_i as a dichotomous variable, such as $Y_i = 1$: if producer *i* adopts technology 1 and $Y_i = 0$ if producer *i* adopts technology 2.

If we pose P_i the probability of adoption of technology 1 by producer *i*, we will have:

$$P_i = Prob(Y_i = 1) = Prob(Y_i^* > 0) = Prob(\beta' X_i + \varepsilon_i > 0) = Prob(\varepsilon_i > -\beta' X_i) \quad (2)$$

If the distribution is symmetrical (the case of the normal or logistic distribution), we obtain:

$$Prob(-\varepsilon_i < \beta' X_i) = F(\beta' X_i) \quad (3)$$

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Works on the adoption of agricultural technologies often use Logit, Probit or Tobit models (Greene, 2012). When the dependent variable is binary, the Probit and Logit models are typically used. When the dependent variable is continuous (truncated or censored), then the Tobit model that models both adoption and intensification of technology use is indicated (Adesina and Zinnah, 1993): thus, this model is used for this research.

The choice of the Tobit model is based on the work of Feder et al. (1985). For these authors, considering the "adoption" and "non-adoption" decision of an agricultural technology cannot provide much information, because the use of this technology can be on 1% or 100% of the cultivated area, for example. The Probit or Logit model is one possibility when the adoption process is dichotomous, but a strictly dichotomous variable is often not sufficient to examine the extent and intensity of adoption (Feder et al., 1985). McWilliams and Zilberman (1995) find that the Tobit model performs better than traditional models that analyze dichotomous variables. Adoption apparently cannot be adequately represented by a dichotomous qualitative variable in many cases (Feder et al., 1985). Indeed, although the results of these tests may suggest a statistically significant effect, it is impossible to know from this type of analysis whether the economic significance of the effect is worth considering.

Expected utility (Y_i^*) is an unobserved latent variable that depends on the two choices $(j = 1, 2)$, socioeconomic characteristics (X_{se}) and producer perceptions (X_p). Based on the work of McDonald and Moffitt (1980), the stochastic form of the Tobit model adapted for this research is represented by equation (1) above. By reconsidering this equation, we define:

$y_i = 1$ si $Y_i^* > 0$ If adoption of agroecological practices

$y_i = 0$ si $Y_i^* \leq$ if non-adoption of agroecological practices

With y_{it} the observed variable β, a vector line of k parameters $\varepsilon_{it} \sim N(0, \sigma^2)$.

Based on Greene (2012), potentially three conditional mean functions are to be taken into account depending on the research objective. For the latent variable, $E(Y_i^*/X_i) = X_i'\beta$. If the data are still censored, this result will generally not be useful. Considering all observations, the expectation of y_{it} becomes (McDonald and Moffitt, 1980):

$$E[y] = X'\beta F(z) + \sigma f(z) \quad (4)$$

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McDonald and Moffitt (1980), specify the expected value of y_i for observations above censoring ($Y_i^* > 0$) as follows:

$$E[y*] = X'\beta + \sigma f(z)/F(z)$$
(5)

With $z = X_i'\beta/\sigma$, (z) , the normal density function and $F(z)$ the normal cumulative function distribution. From this, it is shown that the effect of the explanatory variables in the Tobit model can be decomposed into two parts (McDonald and Moffitt, 1980).

(i). The marginal effect of each explanatory variable on the expected value of the dependent variable is defined as:

$$\frac{\partial E(y)}{\partial X_i} = F(z)(\delta E(y*)/\delta X_i) + E(y*)(\delta F(z)/\delta X_i)$$
(6)

(ii). The change in the probability of adopting the multi-output production system as a result of variation in an explanatory variable is measured by:

$$\frac{\delta F(z)}{\partial X_i} = \frac{\sigma f(z)}{\sigma}\beta_i$$
(7)

(iii). The change in the intensity of adoption of this technology as a result of variation in an explanatory variable is measured by:

$$\frac{\delta E(y*)}{\delta X_i} = \beta_i\left[1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right]$$
(8)

Method of estimation

The estimation of the standard Toby model can generally be done by two methods: the maximum likelihood method (MLM) and the two-step method. Kouassi (2009) points out that using the two-stage method often results in simultaneous adoption decision and intensity of use determination. The maximum likelihood method is therefore adapted for this research, as the adoption decision and the determination of the intensity of use of the technology are generally simultaneous in the African context (Ouédraogo, 2005).

Let us consider the log-likelihood associated with the Tobit model:

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$$Y_L = \begin{cases} Y_i^* si Y_i^* = X_i\theta + \varepsilon_i \geq 0 \\ 0 \qquad\qquad\qquad\qquad sinon \end{cases}$$

The log-likelihood associated with this model is defined by:

$$logL(\theta, \sigma^2) = \sum_{i:Y_i=0} log\left[1 - \Phi\left(\frac{X_i\theta}{\sigma}\right)\right] - N_1 \log\left(\sigma\sqrt{2\pi}\right) - \frac{1}{2\sigma^2}\sum_{i:Y_i>0}(Y_i - X_i\theta)^2$$

2.2.Data choice and description of model variables

2.2.1. Data used

The data used in this research was collected from agricultural households in the Central-North region of Burkina Faso, within the framework of the implementation of a food and nutritional security project, financed by the non-governmental organization "Action de Carême-Suisse." The objective of this project is to carry out actions likely to mitigate the effects of climate change, which is particularly persistent in this region, through the promotion and popularization of agroecological practices. This project covered the Bam province of the Centre-North region, where the relief and climate have made the land quite harsh and arid. Sampling combined random and purposive methods. In the province of Bam, which is the beneficiary of the project, two out of three beneficiary communes (Kongoussi, Sabcé) were selected on the basis of the effectiveness of the implementation of the activities planned by the project. In comparison, two other non-beneficiary communes (Tikaré, Bourzanga) were selected randomly. In each of these communes, one village was randomly selected from among the beneficiary villages. Given the relatively larger size of the commune of Kongoussi, two villages were selected. Subsequently, a total of 137 households were randomly selected to form the study sample. Among these farm households, there were 109 adopters and 28 non-adopters.

2.2.2. Choice and descriptions of the variables

Description of the dependent variable

The dependent variable used in this research is fractional and ranges from 0 to 1. It is calculated by dividing the area of each household plot on which agroecological practices were practiced by the total area of the same household (during the agricultural season); this reflects the intensity of technology use. The adopter therefore represents the household that used the agroecological practices on at least one of its plots during the agricultural season considered. In order to control for as many important factors as possible at various scales (plot, household and locality), the plot is taken as the unit of analysis.

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Choice and description of explanatory variables

In analyzing the explanatory factors of agricultural technology adoption, Thornton et al. (2007), Feder and Umali (1993), Feder et al. (1985), and especially Adesina and Zinnah (1993) recommend taking into account innovation-diffusion paradigms, perception of adoption, and economic constraint. In general, the adoption of an agricultural technology depends on observable socioeconomic factors, the most conventionally used of which are the age and gender of the farmer, human capital (education, literacy, and experience in the activity), social capital (membership in a group), access to institutions (credit), and household size. This adoption would also depend on the farmers' perception vis-à-vis to the characteristics of the new technology compared to the traditional technology (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Negatu and Parikh, 1999) as his attitude towards risks.

Based on the work of Adesina and Zinnah (1993), and taking into account the context of Burkina Faso, the perception variables selected in this research fall into five (5) categories. These are the perception of utility (UTILITY), risk (RISK), necessity (NECESSITY), entourage (ENTOURAGE) and coverage of needs (NEED) that farmers perceive on agroecological practices. Among these variables, only the risk that the farmer perceives on agroecology would negatively influence its adoption. The utility variable represents the benefits that the farmer perceives from the practice of agroecology; it would therefore positively influence the adoption and intensification of this practice. The NEED variable allows us to understand whether or not the farmer finds that agroecological practices contribute to the coverage of food needs. The goal of the farmer in the Burkinabe context is to achieve food self-sufficiency (Sawadogo et al., 2022). So, it is expected that the perception of food needs coverage by the farmer will have a positive effect on the adoption and intensification of agroecology.

Furthermore, given the high level of soil degradation in the North-Central region, which is primarily a Sahelian zone, it is expected that farmers will perceive a need to practice agroecology. Indeed, agroecology contributes to the sustainable restoration of land and the improvement of its fertility. It is also expected that the variable NECESSITY positively influences the adoption and intensification of agroecology. On the one hand, in Burkina Faso, interpersonal relationships are highly developed. The influence that the community has on an individual could guide him or her in these choices. The variable ENTOURAGE allows us to understand the influence of the perception of the farmer's entourage on his or her decision to practice agroecology. It is expected that this variable will have a positive effect on the adoption and intensification of agroecology. The rest of the explanatory variables are control variables.

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For the sake of brevity, Table 1 below, built on the basis of the literature, describes these variables and gives the expected signs.

Table 1: Description of the explanatory variables of the model.

Variables	**Descriptions**	**Expected signs**
Sex	1 if the farmer is a man, 0 if the farmer is a woman	+
Marital Status	1 if the farmer is, 0 if not	+/-
Experience	Number of years of agro-ecological practices by the farmer	+
Education	1 if the farmer is educated, 0 if not	+
Ratio_dpdce	Number of economically inactive people divided by the number of economically active people	+
GPA	1 if the farmer is a member of farmers group, 0 if not	+
Traction	1 if the farmer has and uses animal traction, 0 if not	-/+
Area	Plot area in ha	-
Credit	1 if the farmer has already got a formal credit, 0 if not	+
RISK	1 if the farmer perceives a risk in agroecology, 0 if not	-
UTILITY	1 if the farmer perceives advantages in agroecology, 0 if not	+
NECESSITY	1 if the farmer perceives that agroecology practices are necessary, 0 if not	+
ENTOURAGE	1 if the farmer is influenced by his entourage, 0 if not	+
NEED	1 if the farmer thinks that agroecology practices contribute to the coverage of the household food's needs, 0 if not	+
Zone	1 if the farmer lives in an area covered by the project, 0 if not	+

Source: Survey data, 2019.

3. Results and Discussions

This section builds on the theoretical and empirical approach developed above to identify and analyze the role of perceptions on the adoption and intensification of agroecological practices. To do so, two points are addressed. The first section presents the results of the statistical and econometric analyses, while the second section discusses these results.

3.1. Results presentation

In this part of the research, the analyses are based on the results of the descriptive statistics and those of the econometric estimations. The descriptive statistics focus on means and tests for differences in means. This allows us to characterize the sample in order to ensure the quality of the data used. The difference-in-means tests allow for an initial comparison between adopters and non-adopters.

Descriptive statistics

The data in Table 2 show significant differences in means between adopters and non-adopters of agroecological techniques. These differences are observed in the socioeconomic characteristics of the farmer, particularly in gender, marital status, and experience in practicing agroecology. Based on the analysis of the differences in the average, the risk seems to be the perception that influences the adoption and intensification of agroecological techniques more.

Overall, the survey data show that more than three quarters (85.71%) of the farmers have adopted agroecological techniques in more than half (60%) of the total area of the main plots farmed. Men (84.62%) adopt this practice more than women (15.38%). The data also show that, on average, adopters have more experience (7.75 years) in the practice of these techniques than non-adopters who have barely one year of experience on average (0.68 years). These adopters are also the ones who perceive much more risk, necessity and usefulness in the practice of agroecological techniques. They are also the ones who are most influenced by their environment and those who perceive more of an advantage in terms of covering their needs due to agroecology.

On the other hand, farmer adopters appear to farm a larger total area on average (3.64 ha) than non-adopters (2.75 ha). Each farmer farms an average of 3.45 ha. Finally, we note that the proportion of adopters is higher in the project area, i.e., 69.54%, compared to 64.52% in the non-project area.

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Table 2: Characteristics of farmers according to the adoption of agroecological techniques.

Variables	**Average**			
	Sample	**Non-adopter**	**Adopter**	**Difference**
Agroecology	0.60	0.00	0.73	
Sex (%)	84.62	74.19	87.75	-12.56**
Marital Status (%)	94.51	87.10	96.03	8.93**
Experience	6.54	0.68	7.75	-7.07***
Education (%)	36.26	45.16	34.43	10.72
Ratio_dpdce	0.82	0.83	0.82	0.003
GPA (%)	94.51	90.32	95.36	-5.04
Credit	22.65	40.00	19.21	20.79
Traction (%)	81.87	80.65	82.11	-1.47
Area	3.45	2.75	3.64	-0.89***
RISK (%)	41.21	25.81	44.37	-18.56**
NECESSITY (%)	92.31	90.32	92.71	-2.39
ENTOUR (%)	63.19	51.61	65.56	-13.95
UTILITY (%)	14.83	6.45	16.56	-10.10
NEEDS (%)	25.27	22.58	25.83	-3.25
Zone	68.68	64.52	69.54	-5.02

Source: Calculations from survey data, 2019

Estimation results

The specification of the model is adequate, as the calculated robustness test statistic is above the theoretical value (30.58) at the 1% threshold (Table 3). All the explanatory variables therefore contribute to significantly explain the adoption and intensification of agroecological techniques. Table 3 presents the estimation results of the Tobit model. The marginal effects of the explanatory variables were decomposed using Cong's (2000) program into effects on the probability of adoption and effects on the intensification of the practice of agroecological techniques.

The estimates reveal that three perception variables would significantly influence the adoption and intensification of agroecological techniques. Thinking that agroecology is useful increases the probability of adoption and intensification by 0.24 at the 5% level. Specifically, this probability increases by 0.38 for farmers who are not yet applying agroecological techniques. Farmers who already use the technology intensify its use by an increase in the probability of adoption of 0.19. If the farmer considers that agroecology contributes to the coverage of his needs, the probability that he will adopt and intensify the technology increases by 0.20 at the 1% threshold. However, the increase in this probability is mainly driven by the probability of adoption of non-practicing farmers, which increases by 0.32, compared to only a 0.19 improvement attributable to the intensification of its use by farmers who already use agroecology.

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However, the perception of risk in the practice of agroecology by the farmer reduces the probability of adoption and intensification of the technology by 0.26 at the 1% threshold. Non-practicing farmers contribute the most with a reduction in the probability of adoption of 0.41, compared to only 0.20 related to the decrease in intensification of farmers' already practicing agroecology. Among the control variables, the experience of the farmer and the dependency ratio of his or her household would contribute to significantly increase the probability of adoption and intensification of agroecology at the 1% and 5% threshold respectively. Specifically, an additional year of experience increases this probability by 0.04. An increase in the dependency ratio of one additional unit increases the probability of adoption and intensification of agroecology by 0.07. In contrast, the total area farmed by the household would reduce this same probability. Thus, one additional ha cultivated reduces the probability of adoption and intensification of the technology by 0.03.

Table 3: Explanatory factors for adoption and intensification of agroecological practices

Variables	**Marginal effects**	**Effects on**		**Coefficients**	**Standard errors**
		Adoption probability	***Intensification of the use***		
Sex	0 .09	0.15	0.07	0.24	0.19
Marital_status	0.08	0.12	0.06	0.21	0.33
Experience	0.04***	0.06***	0.03***	0.09***	0.01
Education	-0.09	-0.13	-0.06	-0.21	0.13
Ratio_dpdce	0.07**	0.11**	0.06**	0.18**	0.09
GPA	0.04	0.07	0.03	0.11	0.27
Credit	0.01	0.02	0.01	0.03	0.16
Traction	-0.10	-0.16	-0.08	-0.25	0.18
Area	-0.03**	-0.06**	-0.02**	-0.07**	0.04
RISK	-0.26***	-0.41***	-0.20***	-0.66***	0.17
NECESSITY	0.06	0.10	0.05	0.16	0.24
ENTOURAGE	0.06	0.09	0.04	0.15	0.15
UTILITY	0.24**	0.38**	0.19**	0.62**	0.24
NEEDS	0.20***	0.32***	0.16***	0.52***	0.19
Project Zone	0.02	0.03	0.01	0.05	0.13
Constant				0.11	0.51
Log-likelihood					-136.76
Pseudo R^2					0.27
LR test					102.74***
Number of observations					181
Proportion of adoption of agroecology techniques					82.97%

(***), (**), (*): Significance at the 1%, 5%, and 10% thresholds, respectively.

Source: Estimation on STATA 17

From these results, two major conclusions can be drawn. First, we find those socioeconomic and demographic factors, as well as the perception variables that are significant, have a greater

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effect on the adoption decision of farmers who are not yet practicing agroecological techniques. Second, the effects of farmers' perceptions on the adoption of agroecological techniques seem to be more significant. This reflects the importance of considering unobservable factors in the analysis of agricultural technology adoption.

3.2.Discussions

Perceptions and adoption of agroecological practices. This research shows that agroecology is seen by farmers to improve food self-sufficiency. The econometric analysis showed that the perceived usefulness and contribution of agroecology to meeting food needs would drive farmers to adopt and scale up the technology. In the context of Burkina Faso, meeting food needs remains the ultimate goal of farm households (Sawadogo et al., 2022). They therefore use all means to avoid risks that could lead to a catastrophic harvest. In general, in the Sahelian zone of the country such as the North Central region covered by the study, this objective is difficult to achieve by many farming households. This is due to poverty, which limits their access to the necessary means to acquire chemical inputs to mitigate low soil fertility. For the 2018-2019 agricultural season, more than 60% of households in the Sahelian zone did not cover their cereal needs from their agricultural production alone (MAAH, 2019). Under these conditions, any techniques that would allow them to achieve this goal are an option taken very seriously and can therefore be adopted. These results corroborate those found by Mounirou (2015) in the case of Benin. Adesina and Zinnah (1993) showed, for example, that the perceived relative advantage of technology use by farmers promotes its adoption and intensification.

On the other hand, the perception of risk would be a brake on the adoption of agroecology by farmers. The results show that when the farmer perceives a risk in the use of the technology, he is less inclined to adopt it. This result can be explained by the fact that farmers have limited knowledge about the importance of these technologies in agricultural production, especially in a context of climate change and low soil fertility. In the context of Burkina Faso, the lack of information on the positive socioeconomic impacts of the integral adoption of agricultural technical innovations would also explain this result. Indeed, the majority of farmers have low levels of education and technical skills. On the other hand, farmers' habit of using chemicals and their aversion to risk makes them prefer to stay with what they know rather than move into the unknown. These results were also found by Ntshangase et al. (2018), who showed that risk perception reduces the likelihood of conservation agriculture adoption. Mounirou (2015) showed that risk perception seems to be one of the important factors limiting the adoption of agricultural technologies in the Banikoara cotton basin in Benin.

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Observable factors and adoption of agroecological practices. Among the observable factors selected, the farmer's experience and the weight of economic inactivity are favorable to the adoption and intensification of agroecology. As the farmer gains experience in agriculture, he or she increases his or her knowledge and discovers more and more the net benefits of agroecological practices. Furthermore, the farmer also learns by doing (through the process of learning by doing), which allows him to develop skills under real conditions. All of this strengthens the farmer's mastery and technicality, which can lead to good agricultural results, and pushes him or her to intensify the technology. Asare-Nuamah et al. (2022) showed that farmer experience and age positively influence the adoption of agricultural technical innovations by mango farmers in Ghana. This same result was found among farm households in Burkina Faso in the work of Zongo et al. (2022). For Mounirou (2015), the experience of the farmer represented by his or her age positively influences the adoption of agricultural technical innovations in Benin.

Regarding the weight of economically inactive members, it should be noted that a high dependency ratio would generally lead to a detour of resources intended for production to, for example, education, health, and food for economically inactive members. This implies greater needs, less productive capacity and sometimes liquidity constraints. The goal of rural households is food self-sufficiency, so they will adopt technologies that allow them to avoid catastrophic production in particular, and this is precisely the role that agroecology would play. Yifru and Miheretu (2022) found similar results among farm households in Ethiopia.

The total area farmed by the household on the other hand is a hindrance to the adoption of agroecology. Farmers who farmed the largest areas were the ones who adopted and intensified agroecological technologies less. In general, given the limited means of production associated with rural household poverty, farms are small. Large farms do not necessarily imply that the household is relatively wealthy, as in Burkina Faso's Sahelian zone, increasing agricultural production to meet household food needs is done by expanding the area under cultivation. The practice of some of the agro-ecological technologies (zaï, half-moons) analyzed in this research is relatively labor intensive, which could be a hindrance for households that lack assets, or that do not have the means to employ outside labor. Moreover, the agricultural sector still faces labor market constraints. In addition, some of the technologies also require a minimum investment, which is inaccessible to the poorest, and this can also be a barrier to adoption, especially for large areas. In Burkina Faso, Zongo et al. (2022) showed that households that farmed large areas were less likely to adopt certain agroecological practices such as soil and water conservation techniques.

Conclusion and policy implications

The issue of agroecology is part of a broader debate that invites attention to the sustainability of the current dominant farming systems. In general, the use of these systems, combined with climate change, is continuously degrading land, forests, and water, ultimately leading to low agricultural yields in most SSA countries. The effects vary from one agro-climatic context to another. For a Sahelian country such as Burkina Faso, agroecology is an answer to the agro-environmental transition, hence the importance of questioning its adoption and intensification by farmers. The objective of this research was therefore to analyze the explanatory factors of the adoption and intensification of agroecological techniques based on a Tobit model. The results showed that mainly, the perceptions of the farmers, in particular the utility and the coverage of the food needs favor the adoption and the intensive practice of agroecological techniques, but the perception of the risk constitutes a brake. The experience of the farmer and the weight of the economically inactive in the household also reinforce the practice of agroecology. On the other hand, large cultivated areas would negatively influence the adoption and intensification of the technology. Based on these results, the main obstacles to the adoption and intensification of agroecological practices by farmers are therefore the perception of risk and the use of large areas.

Like other climate change adaptation techniques, agroecological techniques allow for sustainable land management. To improve the adoption of these techniques, in the design of agricultural policies, a large-scale consultation of farmers is necessary to facilitate the dissemination and extension of technology packages.

In practice, this research suggests that in a comprehensive way, the promotion of agroecology must necessarily consider farmers' perceptions. Three actions are suggested to strengthen the resilience of farmers in Burkina Faso. (i) In strategies to promote agroecology, emphasis should be placed on its usefulness and its contribution to meeting food needs, which remains the goal of farm households in Burkina Faso. These two perceptions seem to be the ones that would most encourage the practice of agroecology. (ii) Since farmers' experience reinforces the intensive practice of agroecology, emphasis should also be placed on professional agricultural training. This can be done through field schools, which can be a means of extension of agricultural innovations and can also leverage the experience of working people in agroecological practices. (iii) By combining these two actions, this can help to minimize the effect of the perception of risk that would be a brake on the practice of agroecology according to the research. Farmers must therefore discover the scope of the benefits of agroecology.

The analyses conducted in this research, while considering observable and unobservable factors, are limited to a single region of Burkina Faso. A nationwide survey can contribute to a better understanding of the motivations of Burkina Faso farmers.

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