SOCIO-ECONOMIC DETERMINANTS OF THE ADOPTION OF STONE BARRIERS AND ZAÏ IN NORTH-CENTRAL BURKINA FASO (CASE OF THE COMMUNE OF KORSIMORO)

Abstract

The sustainability of agriculture in sub-Saharan Africa is threatened by climate change and unsustainable traditional agricultural practices. The adoption of sustainable agricultural techniques offers a promising solution to improve agricultural productivity, climate resilience and the conservation of natural resources. This study analyzes the socio-economic factors that influence the adoption of agricultural techniques in the commune of Korsimoro in Burkina Faso. Surveys were conducted among 178 farmers to identify the socio-economic factors that influence the adoption of known sustainable farming techniques. Thus, an econometric analysis using the Multinomial Probit model was carried out to determine the factors influencing the adoption of two specific sustainable agricultural techniques, namely zai and stone barriers. The results indicate that farmers are most familiar with zai and stone barriers and that these practices are among the most widely adopted sustainable farming techniques, with adoption rates of 98.31% and 62.92% respectively. The econometric analysis revealed that several socio-economic factors influence the adoption of these two techniques within the municipality. However, in addition to the results of the literature review, these factors include access to training, subsidies, credit, membership in farmers' organizations, animal ownership, household size, age, and literacy.

Keywords : Korsimoro, agricultural technique, socio-economic factor.

Introduction

This study, conducted in the commune of Korsimoro in Burkina Faso, aims to analyze the socioeconomic factors that influence the adoption of sustainable agricultural techniques. In particular, the study focuses on two specific techniques, namely zai and stone barriers, two ancestral practices that have been brought up to date and which demonstrate a strong potential to improve agricultural productivity and ecosystem resilience in areas facing drought.

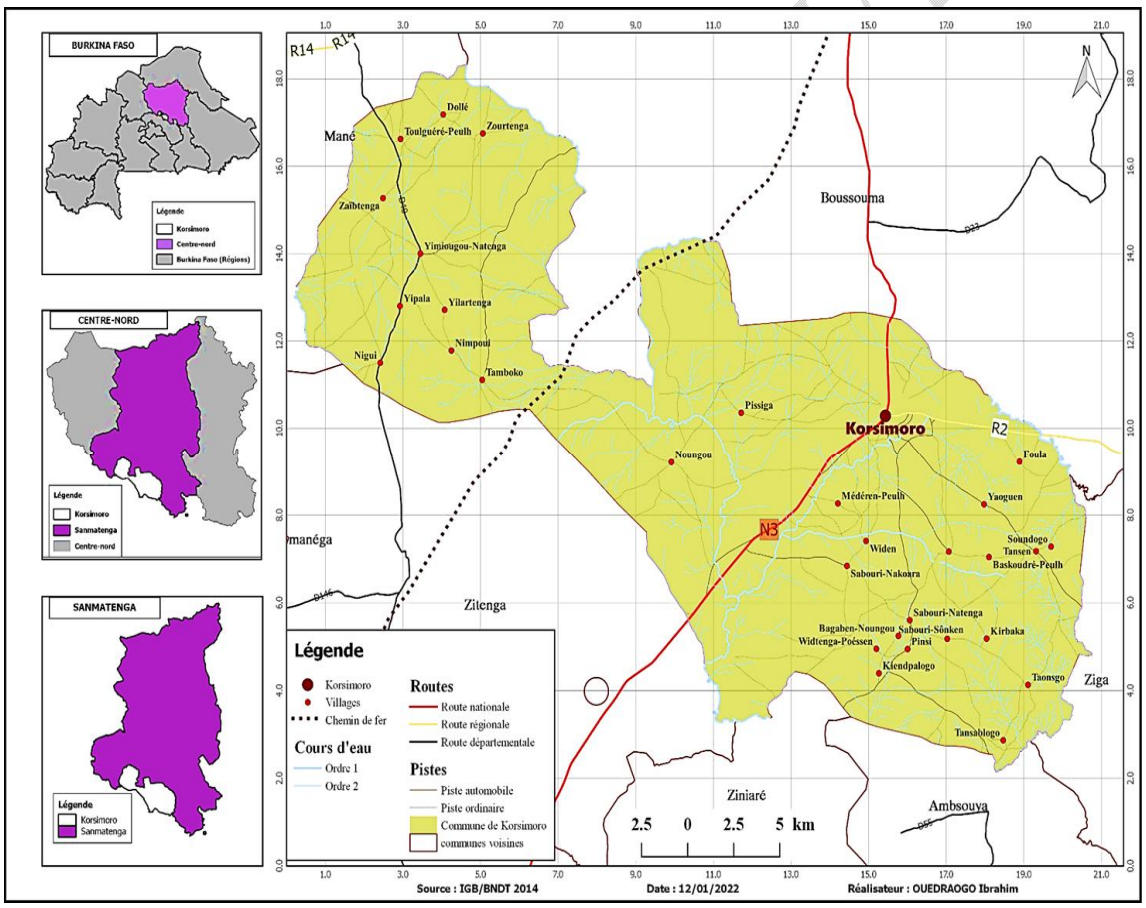
This study makes a significant contribution to the existing literature on the adoption of sustainable agricultural techniques in sub-Saharan Africa. By focusing on two specific techniques, zai and stone barriers, it provides valuable information on the socio-economic factors that influence their adoption by farmers in the commune of Korsimoro. The results of this research will inform policies and programmes to promote sustainable agricultural techniques in the region and remove barriers to their large-scale adoption, thus contributing to the sustainable transformation of African agriculture.

1. Materials and method

1.1. Study area

The commune of Korsimoro is located 70 km from Ouagadougou in the province of Sanmatenga, in the Centre-Nord region (Map 1). The municipality of Korsimoro has an area of 667 km2. It is bordered to the north by Boussouma, to the east by Ziga, to the west by Mané and Zitenga and to the south by Absouya and Ziniaré. The agglomeration of Korsimoro is connected to the main centres of its environment by the following national and departmental roads: Korsimoro-Ouagadougou: 70km, Korsimoro-Kaya: 30km, Korsimoro-Boulsa: 60 km and Korsimoro-Ziga: 40 km.

Map 1 : Location of the municipality of Korsimoro



1.2.Methodologicalapproach

For the demographic sampling in this study, the technique used is that of Cochran et al., (1953)[4] readapted by Rea L.M. *et al.*, (1997)[5]. This sampling technique has also been used

by Joski *et al*., (2021) [6], in its work on the analysis of the effects of the adoption of improved maize varieties on food security at the household level in northern Benin. Kay *et al*, (2020)[7], also used this sampling technique to analyze the socioeconomic dynamics of the adoption of cashew nut cultivation in rural Côte d'Ivoire.

It is carried out by determining the sample size by the following formula:

$$\mathbf{n} = \frac{t_p^2 \times P(1-P) \times N}{t_p^2 \times P(1-P) + (N-1) \times y^2}$$

With:

- **n**: sample size that represents the number of households to be surveyed per village (study site);
- N: the size of the target population which is represented by the number of households,
- **P** (constant) : 0.5 ;
- **tp**: Confidence interval which is defined in Table 1. For this study, **tp** = 1.96, i.e. a 95% confidence interval.
- **y**: margin of sampling error which is 5%.

Table 1: TP values associated with confidence intervals

Confidence interval	PQ
90 %	1,65
95 %	1,96
99 %	2,69

Source : Rea L.M. et al., (1997)

This method resulted in a fairly representative sample, which is summarized in Table 2.

Table 2: Selected demographic sample by site

Walking through the villages	Number of households	Ménages selected
Baskoudré-mossi	98	49
Katenga	68	41
Tamsin	97	49

Soundogo	64	39
Total	327	178

Source : RGPH (2019), OUEDRAOGO I.

In the case of this study, the technologies or practices on which the respondents were subjected are those known as techniques/technologies disseminated,[1] which are mainly those that are popularized by the agricultural advisory services of the municipality of Korsimoro. The agricultural extension approaches and tools used by agricultural advisory services are part of the dynamic of increasing agricultural productivity through the improvement of the technical skills of producers. This study focused mainly on stone barriers and zaï.

The practice of a technique can conventionally be modeled as a choice between two alternatives: to practice or not to practice. When considering the adoption or choice of different technologies, the household's goal is to increase its production or maximize its profit by choosing among alternatives. The idea is that the head of household chooses a vector (J, K, L, M, N, etc.) of technologies to maximize its utility.

A head of household who strives to meet the needs of his or her members and to choose from a set of options or technologies (e.g., improved variety, zai, FMN, etc.). If "i" the number of heads of households prefer to choose J, if the perceived benefit of J is greater than the utility of K, then we can write:

$$Uij\ (\beta jXj + \varepsilon i) > Uik\ (\beta kXk + \varepsilon i),\ k \neq J$$

Where Uij and Uik are the perceived utility of the head of household i in the choice of technologies J and K, respectively; Xi is a vector of explanatory variables (e.g., level of education of the head of household, size of the household, land, etc.) that influence the choice of options; βj and βk are parameters to be estimated, εj and εk are the error terms.

We can link the fact that a household adopts a technology for its utility maximization and not adopt as a discrete choice. The result Y is then a dichotomous dependent variable taking the value 1 when the head of household is practising and 0 otherwise (Table 3).

The probability that household i will use technology j, among the set of options, could be defined as follows:

[1]It is a set of knowledge, processes and tools that implement proven scientific discoveries and applications in the agricultural field and provided to producers with the aim of improving their production system.

$$P= (Y=1/X) = P (Uij > Uik/X) = P (\beta'jXi + \varepsilon j - \beta'kXi - \varepsilon k > 0/X)$$

$$= P([\beta'j-\beta'k] Xi + \varepsilon j-\varepsilon k > 0/X) =P (\beta^*Xi + \varepsilon^* > 0/X) = F (\beta^*Xi)$$

When ε* is a random perturbation term, β* is a vector of unknown parameters that can be interpreted as the net influence of the vector of the explanatory variables that determine adoption and F (β*Xi) is the cumulative distribution of ε* to evaluate a β*Xi.

We can then estimate the Probit model based on the assumed distribution that the random term follows, and we can estimate several qualitative choice models such as linear, logit, or probit Probit. In this study, there are several technologies that the head of household practices. Therefore, a multinomial Probit is appropriate for estimating how the socioeconomic and demographic characteristics of respondents determine a household's decision to practice or not to practice a technology/practice, (Greene, 2007;Molua, 2012) [8] [9].

Table 3: Evaluation grid of the determinants of adoption of ICA techniques

Variables	**Definition**
Dependent variable	
Technology/Practice (Y)	Technical package. Takes the value 1 if the technical package is adopted and 0 otherwise.
Explanatory variables	
Age	The CCB Age
Literate	1 = yes oui, 0 yes not
Household size	Number of people
Formation	1 = have received training, 0 if this is not the case
Credit or grant	1 = have received a grant or credit, 0 if no
Member of an organization	Member of a producer organisation (1= yes, 0= no)
Pet ownership	1 = yes oui, 0 yes not

Source: Adapted from MAAHA, (2019); Seydou Zakari, (2017).

3. Results and discussion

3.1. Determinants of adoption of agricultural practices

Barriers such as limited access to education, technological resources and communication infrastructure were highlighted by CHAKER, (2002) [10]. However, a study by Orozco *et al*, (2014)[11], noted that despite these challenges, governmental and non-governmental initiatives to raise awareness and train farmers have contributed to increasing

knowledge in some regions. Knowledge of smart technologies is closely linked to agricultural yields. Research conducted by Ouedraogo *et al.*, (2020)[12], showed a positive correlation between the use of smart technologies and improved agricultural productivity in Burkina Faso.

3.2. The determinants of adoption of agricultural technologies and practices

The practices and technologies used to evaluate the level of practice made it possible to take stock of the practices adopted by the agricultural populations in the commune of Korsimoro. Thus, 98.31% of the sample use stone barriers, and 62.92% practice zaï.

3.2.1. Determinants of Zaï adoption

The results of the econometric analysis for the adoption of the technical package (Zaï) are reported in Table 4. These results reveal that access to agricultural training is a very significant factor that increases the probability of adoption of zaï by producers.

Table 4: Estimation result of the Zaï

Variable	Marginal effects dF/dx	Err standard	Z-Value	Pr(>|z|)
Age	-0. 10036	0. 5179	-1. 938	0.05263
Household size	0.10262	0. 07731	1. 327	0. 18436
Subsides	-0. 60957	0. 86349	-0. 706	0. 48023
Ownership of an animal	-1. 08320	1.00008	-1. 083	0. 27876
Literacy	0. 52629	0. 35729	1. 473	0. 14075
Organization	0. 69576	1. 00031	0. 696	0. 48671
Formation	2. 07759	0. 77344	2. 686	0.00723**

Legend: * 1% significance, ** 5% significance, *** 10% significance.
(*) dF/dx corresponds to the discrete change of the dummy variable from 0 to 1
z and P>|z| correspond to the test of the underlying coefficient equal to 0

The adoption of Zai is influenced by various socio-economic determinants. According to Kaboré *et al.*, (2019b)[13], local economic conditions, such as farmers' income levels, play a crucial role in decision-making about the adoption of this agricultural practice. In addition, the TRAORÉ *et al.*, (2019) [14], highlight access to resources, including the availability of materials needed for the construction of Zaïs, as a key factor. On the other hand, the studies of Zongo *et al.*, (2014)[15], emphasize the importance of social factors such as community networks and interpersonal influences in the dissemination of this technique. Regional

disparities, studied by Kinane *et al*., (2008) [16], show that the geography and diversity of local ecosystems also impact the adoption of Zaï. In short, the adoption of Zai is influenced by socioeconomic variables, such as income, access to resources, social factors, and geographical particularities, as highlighted by various authors.

3.2.5. Determinants of the adoption of stone bunds

The objective of the stone barrier technique is to increase soil infiltration and water stock, and to recover and restore the fertility of crusted soils for agronomic and agroforestry use. The econometric analysis shows that producer training, animal ownership and household size are significant factors in the probability of adopting the technique (Table 5).

Table 5: Stone barrier estimation results

Variable	Marginal effectsdF/dx	Err standard	Z-Value	Pr(>|z|)
Age	0. 26345	0. 06454	4. 082	4. 4658
Household size	- 0.28434	0. 09404	- 3. 024	0. 0025**
Subsides	0. 00353	0. 92768	0. 004	0.9970
Ownership of an animal	- 17. 62541	1042. 52156	- 0. 017	0.001865**
Literacy	0. 98465	0. 41585	2. 368	0.0179
Organization	15. 68993	1042. 52156	0. 015	0.9880
Formation	- 0. 48240	0. 84741	- 0. 569	0.001692**

Legend: * 1% significance, ** 5% significance, *** 10% significance.
(*) dF/dx corresponds to the discrete change of the dummy variable from 0 to 1
z and P>|z| correspond to the test of the underlying coefficient equal to 0

The adoption of stone barriers in sub-Saharan Africa is shaped by various socioeconomic determinants. The research of Kouma *et al*., (2018)[17], emphasize that the level of education of farmers is a key factor positively influencing the adoption of stone barriers, highlighting the importance of technical understanding in this process. The work of Raven *et al*., (2017)[18], highlight access to resources, including the availability of stones and other necessary materials, as a crucial determinant in farmers' decision-making. Hardware feasibility appears to play a significant role in the adoption of this practice. As far as economic factors are concerned, the studies of Ngondjeb *et al*., (2009)[19], indicate that the level of knowledge of the impact of erosion on farm units and their impact on agricultural yields are incentives for farmers, thus influencing their adoption.

Conclusion

Sub-Saharan Africa faces major challenges in terms of food security, poverty and environmental degradation. In this context, the promotion of sustainable agriculture is a top priority to ensure food production, improve the livelihoods of rural people and preserve natural resources. The adoption of sustainable farming techniques is a promising approach to addressing these challenges. This study, conducted in the commune of Korsimoro in Burkina Faso, makes a valuable contribution to understanding the socio-economic factors that influence the adoption of sustainable agricultural techniques. By analysing the adoption of two specific techniques, zai and stone barriers, the study highlights farmers' knowledge, resources and capacities as key determinants of adoption.

The findings of this study have important implications for policymakers, development practitioners, and agricultural extension services, particularly in the context of Burkina Faso and other sub-Saharan African countries. The study highlights the importance of promoting the adoption of sustainable agricultural techniques in agricultural policies and strategies, given their potential to improve productivity, resilience and conservation of natural resources.

References

[1] C. Daniel *et al.*, "Associations of perennial and annual crops in marginal areas of oil palm and coconut cultivation", CIRAD-SAR, 1996. Accessed on: November 12, 2023. [Online]. Available on: https://agritrop.cirad.fr/464422

[2] E. Pelzer, L. Bedoussac, G. Corre-Hellou, M.-H. Jeuffroy, T. Métivier, and C. Naudin, "Association of annual crops combining a legume and a cereal: farmers' feedback and analysis", *Innov. Agron.*, vol. 40, pp. 73-91, 2014, Accessed November 12, 2023. [Online]. Available on: https://hal.science/hal-01173338/

[3] J.-M. K. Ambouta and I. B. Moussa, "Experiments in the recovery of degraded Sahelian soils through the incorporation of variable doses of manure and a fertilizing water retainer", *Sci. Chang. PlanetaryDrought*, vol. 15, no. 1, p. 49-55, 2004, Accessed: November 11, 2023. [Online]. Available on: https://www.jle.com/e-docs/00/04/00/81/

[4] W. G. Cochran, F. Mosteller, and J. W. Tukey, "Statistical Problems of the Kinsey Report," *J. Am. Stat. Assoc.*, vol. 48, no. 264, pp. 673-716, 1953.

[5] L. Rea L.M. et al. et Parker, R. A, « Ad-Aware SecureSearch ».

[6] Y. A. Joski, A. A. Servais, and Y. A. Jacob, "Analysis of the effects of the adoption of improved maize varieties on the food security of the adoptive parent's household in northern Benin," 2021.

[7] K. M. Kouassi and L. S. Kouakou, "Socio-Economic Dynamics of the Adoption of Cashew Nut Cultivation in Ivorian Rural Areas, Case of the Sub-Prefecture of Languibonou", *Int. J. Progress. Sci. Technol.*, Vol. 21, No. 2, pp. 141-152, 2020.

[8] W. Greene, "Functional Form and Heterogeneity in Models for Counting Data," *Found. Trends Econom*®., vol. 1, n° 2, p. 113-218, 2007.

[9] E. L. Molua, "Gendered Response and Capacity to Adapt to Risks to Climate Variability for Sustainable Food Security in Northern Cameroon", *Int. J. Clim. Change your strategist. Manag.*, vol. 4, n° 3, p. 277-307, 2012.

[10] S. CHAKER, "For a strategy in favour of new information and communication technologies in the least developed countries of Africa". ITU-November, 2002. Accessed November 12, 2023. [Online]. Available on https://duddal.org/files/original/cd43b6727fed023b1e508180938472bda8cebf55.pdf

[11] F. A. Orozco and D. C. Cole, "Addressing Challenges to Farmers' Health and Agro-Ecosystem Sustainability in the Highlands of Ecuador," in *Ecohealth Research in Practice*, D. F. Charron, Éd., New York, Springer New York, 2014, p. 53-66. DOI : 10.1007/978-1-4614-5281-2_4.

[12] J. Ouedraogo, I. Serme, M. B. Pouya, S. B. Sanon, K. Ouattara, and F. Lompo, "Improving sorghum productivity through the introduction of technological options for integrated soil fertility management in the northern Sudanian zone of Burkina Faso", *Int J Biol Chem Sci*, vol. 14, no. 9, pp. 3262-3274, 2020, Accessed November 12, 2023. [Online]. Available on https://www.academia.edu/download/82826207/193417.pdf

[13] P. N. Kabore, B. Barbier, P. Ouoba, A. Kiema, L. Some, and A. Ouedraogo, "Perceptions of climate change, environmental impacts and endogenous adaptation strategies by producers in north-central Burkina Faso", *Dizziness*, Vol. 19, No. 1, 2019, Accessed November 12, 2023. [Online]. Available on https://www.erudit.org/en/journals/vertigo/1900-v1-n1-vertigo04936/1065432ar/abstract/

[14] O. M. TRAORE and D. KOURA, "Effect of endogenous innovative practices of sustainable land management on the technical and economic performance of the network of producers in the commune of Mani in Burkina Faso", *Afr. Sci.*, vol. 15, no. 1, p. 432-447, 2019, Accessed November 12, 2023. [Online]. Available on https://www.researchgate.net/profile/Adededji-Labiyi/publication/334204374_Effet_des_pratiques_innovantes_endogenes_de_gestion_durable_des_terres_sur_la_performance_technico-economique_du_reseau_de_producteurs_dans_la_commune_de_Mani_au_Burkina_Faso/links/5d1cbf58299bf1547c93c784/Effet-des-pratiques-innovantes-endogenes-de-gestion-durable-des-terres-sur-la-performance-technico-economique-du-reseau-de-producteurs-dans-la-commune-de-Mani-au-Burkina-Faso.pdf

[15] B. Zongo, A. Diarra, B. Barbier, H. Yacouba, and T. Dogot, "Does Supplementary Irrigation Enable Sahelian Farmers to Adapt to Climate Change? Contribution of bioeconomic simulation, Burkina Faso", in *Doctorate 2014*, 2014. Accessed November 12, 2023. [Online]. Available on https://orbi.uliege.be/bitstream/2268/190525/1/Communication%20orale_L%E2%80%99irrigation%20de%20compl%C3%A9ment.pdf

[16] M. L. Kinane, M. Kone, and A. Sidibe, "Perception of Land Degradation and Adoption of Water and Soil Conservation Technologies in Northern Burkina Faso, the Case of Zaï and Cordon Pierreux", 2008. Accessed on, November 12, 2023. [Online]. Available on, https://ageconsearch.umn.edu/record/52192/

[17] B. Kouma *et al.*, "Factors influencing the adoption of water and soil conservation techniques, Case of stone barriers and zai in the farms of the Bankass circle in Mali", in *Proceedings of the Malian Symposium on Applied Sciences (MSAS)*, 2018, p. 548-556. Accessed on, November 12, 2023. [Online]. Available on, https://duddal.org/files/original/38ace920a090e20dd7fbb9b0f3205eedf333defc.pdf

[18] M. M. Rabe *et al.*, "The socio-economic determinants of the adoption of improved cowpea production technologies disseminated by farmer field schools in the Maradi and

Zinder regions of Niger", *Int. J. Biol. Chem. Sci.*, Vol. 11, No. 2, pp. 744-756, 2017, Accessed November 12, 2023. [Online]. Available on https://www.ajol.info/index.php/ijbcs/article/view/158802

[19] Y. Ngondjeb, P. Nje, and M. Havard, "The determinants of the adoption of techniques to combat water erosion of soils in the cotton-growing zone of Cameroon", CIRAD-ES, 2009. Accessed November 12, 2023. [Online]. Available on https://agritrop.cirad.fr/554302/1/document_554302.pdf