African Crop Science Journal, Vol. 32, No. 3, pp. 235 - 250
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pISSN 1021-9730/2024
eISSN 2072-6589/2024

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Based on a work at www.ajol.info/
DOI: https://dx.doi.org/10.4314/acsj.v32i3.4

DETERMINANTS OF SESAME CULTIVATION PRACTICES IN THE EAST REGION OF BURKINA FASO

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(*Received 19 June 2024; accepted 23 August 2024*)

ABSTRACT

Sesame (*Sesamum indicum* L.) is an important oilseed crop, especially in West Africa, contributing to household economies. The demand for sesame has increased remarkably; against low or declining yields. The objective of this study was to identify the major determinants of sesame cultivation in the main agro-climatic zones of the eastern Sudanian region of Burkina Faso, as a strategy for intensifying its production. A survey was carried out involving 300 sesame producers, in the eastern region of Burkina Faso; using a semi-structured. Sesame cultivation was mainly influenced by low level of knowledge of sesame production; lack of improved seed varieties among producers; inadequate soil fertility management and high costs of fertilisers and improved seeds. Factors such as gender, age, education level and land area allocated to sesame cultivation, hitherto believed to be important in sesame production, had no statistically measurable effects on crop cultivation. Allocation of mostly degraded lands to sesame production considerably affected its yield levels.

Key Words: Manure, *Sesamum indicum,* soil fertility

RÉSUMÉ

Le sésame (*Sesamum indicum* L.) est une plante oléagineuse importante, notamment en Afrique de l'Ouest, contribuant à l'économie des ménages. La demande de sésame a augmenté de façon remarquable, malgré des rendements faibles. L'objectif de cette étude était d'identifier les principaux déterminants de la culture du sésame dans les principales zones agro-climatiques de la région soudanienne orientale du Burkina Faso, comme stratégie d'intensification de sa production. Une enquête a été menée auprès de 300 producteurs de sésame, dans la région orientale du Burkina Faso, en utilisant une enquête semi-structurée. La culture du sésame a été principalement influencée par le faible niveau de connaissance de la production de sésame, le manque de variétés de semences améliorées parmi les producteurs, la gestion inadéquate de la fertilité des sols et les coûts élevés des engrais et des semences améliorées. Les facteurs tels que le sexe, l'âge, le niveau d'éducation et la superficie des terres allouées à la culture du sésame, considérés jusqu'ici comme importants dans la culture du sésame, n'ont eu aucun effet statistiquement mesurable sur la culture du sésame. L'affectation de terres, pour la plupart dégradées, à la culture du sésame a considérablement affecté ses niveaux de rendement.

Mots Clés: Fumier, *Sesamum indicum*, fertilité des sols

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop, especially in West Africa, contributing to household economies (Savadogo *et al.,* 2018). The crop commands high local and international demand; and has been at the forefront of factors behind sustaining household economies (Savadogo *et al.,* 2018). Sesame is an aromatic annual crop that is known to grow well mostly in rich, light and deep or low-lying sandy soils.

In Burkina Faso, sesame along with other oilseed crops (shea, cotton and peanuts), represents the scarce export products and brings more than US $ 12.8 million to the country's foreign revenue annually (Rongead, 2013). It also represents the third agricultural export product of the country, after small and large ruminants and cotton (Rongead, 2013).

It is clear, however, that the increase in production of sesame in Burkina Faso is almost exclusively through expansion of land area under cultivation, at the expense of productivity, that is yield per unit area (Adifon *et al.,* 2019). Low productivity could also be attributed to dismal use of improved varieties and underuse of inputs by farmers (Hamissou *et al.,* 2020). All this is exacerbated by deficits in water for production due to climatic variability; in addition to non-innovative cropping practices that affect sesame yield and yield components (Compaoré, 2011). The objective of this study was to identify the major determinants of sesame cultivation practices in the main agro-climatic zones of the east region of Burkina Faso, as a strategy for intensifying production.

MATERIALS AND METHODS

Study area. The study focused on the three agroclimatic zones of the eastern region, specifically the Sahelian, south Sudanian and north Sudanian zones; each of which exhibits distinct agroclimatic characteristics. Precisely, the study was carried out in six municipalities, namely Mani, Diabo, Tibga, Pama and Kompienga, in the east region of Burkina Faso. The areas lie at 12° 152 North and 1° 002 East, in a region covering all the three agro-climatic zones of the country.

The municipalities are major sesame producers in the country (MAAHM/DGESS, 2021). The South Sudanian zone, which is relatively small, lies south of the 11°30' parallel, with mean annual rainfall ranging between 900 and 1.200 mm; and a rainy season lasting

approximately six months (Karambiri *et al.,* 2023). This zone corresponds to the southern parts of the Kompienga and Tapoa Provinces, where the dominant soils are Luvisols and Vertisols (Dembele, 2010).

The North Sudanian zone, by contrast, encompasses the southern areas of the Gnagna and Komondjari and Gourma Provinces; and a large part of the Tapoa Province. It is situated at parallels 11°30' and 14°00'N, with mean annual rainfall of 600-900 mm, occurring over four to five months (Karambiri et *al.,* 2023). The predominant soil types in this zone are Luvisols and Regosols, with Vertisols modestly represented (Dembele, 2010).

The Sahelian zone, which is located in the northern part of of our study area, receives mean annual rainfall of between 300 and 600 mm, concentrated over a three-month period (Karambiri *et al.,* 2023). This zone corresponds to the northern parts of the Gnagna and Komondjari Provinces, where the dominant soil types are Regosols, with Cambisols present to a lesser extent (Dembele, 2010).

The survey. A survey was carried out on 300 households that were historically involved in sesame production in the Sahelian and Sudan areas. The sample size was determined using the binomial distribution formula proposed by Dagnelie (1998); which is based on the principle of exhaustive sampling, according to Equation 1:

$$N = (1-p)\ (U_{1-\alpha/2})/d_2 \quad \text{..... Equation 1}$$

Where:

$U_{1-\alpha/2}$ = the value of the normal random variable for the probability value of $1-\alpha/2$;
α = the risk of error.
For α = 5% ($1\% \leq d \leq 15\%$), the probability
$1 - \alpha/2$ = 0.975 and
$U_{1-\alpha/2}$ = 1.96

p is the estimated proportion of people engaged in sesame production in the study area. The error margin of estimation (d), used in this study was 5%.

Data were collected on socio-demographic characteristics of the farmers (Table 1); and cropping systems (Table 2) in each agro-climatical zone, using a semi-structured questionnaire. The questionnaire was digitised for mobile data collection, using the Open Data Kit Collect (ODK) application; and installed in smartphones and Kobotoolbox platform. This method ensured quality data collected; enhanced the reliability of the data, and synchronised and automatically consolidated the data as the survey progress in the field.

Statistical analysis. The data were coded and entered in a database management matrix, using Excel spreadsheet, version 2016. Data analysis employed both descriptive and econometric approaches. SPSS software (Version 25), was used to perform Pearson Correlation Analysis, to determine the significance of relationships among various socio-economic variables.

The XLSTAT 2016 software was used to analyse the determinants of the adoption of soil fertility management practices using logistic regression for the socio-demographic characteristics of producers and cropping systems. The descriptive statistics (frequencies and graphs) were constructed using SPSS software; while means, standard deviations, and Student t-test for quantitative data means comparison were done using Genstat 12 software. Soil fertility management practices data and the use of improved varieties, were analysed using Multiple Component Analysis (MCA).

As part of the econometric approach, a Binary Logistic regression was used to identify the determinants of organo-mineral fertilisers used for sesame production, using XLSTAT 2016 software (Sanon *et al*., 2020). The dependent variable in the logistic regression

TABLE 1. Socio-demographic characteristics of sesame producers regarding in different agro-climatical zones

Variables	Modality	Percentage of farms per agro-climatic zones			
		Sahel	North -Sudan	South -Sudan	Total study area
Sex	Men	16.0	76.0	34.7	51.6
	Women	84.0	24.0	65.3	48.4
Age (years)	[15 ; 35]	39.6	13.0	55.1	35.9
	[36; 50]	38.7	75.0	43.9	52.3
	Age > 50	21.7	12.0	1.0	11.8
Origin	Indigenous	99.1	94.0	89.8	94.4
	Agricultural migrants	0.9	3.0	10.2	4.6
	Wedding migrants	0.0	3.0	0.0	1.0
Marital status	Maried	91.5	92.0	94.9	92.8
	Divorced	0.0	1.0	0.0	0.3
	Single	0.9	2.0	4.1	2.3
	Widow/Widower	7.6	5.0	1.0	4.6
Education level	Primay	4.7	21.0	5.1	10.2
	Junior high school	1.9	10.0	9.2	6.9
	Senior high school	5.7	5.0	6.1	5.6
	Literacy	3.8	1.0	0.0	1.6
	Technical training	0.9	21.0	0.0	0.3
	Illiterate	83.0	42.0	79.6	75.3
Access to land	Donation	3.8	43.0	9.2	18.4
	Heritage	96.2	42.0	90.8	76.6
	Lend	0.0	15.0	0.0	5.0
Land allocated to sesame production (ha)	Fertile soil	98.1	38.0	49.0	62.5
	Unfertile soil/abandoned	1.9.0	62.0	51.0	37.5
Years of of experience in sesame production	[1; 10[	88.7.0	69.0	10.0	85.9
	[10; 20]	7.5.0	28.0	0.0	11.8
	]20; 35]	3.8	3.0	0.0	2.3

TABLE 2. Analysis of quantitative data related to different agro-climatical zones in Burkina Faso

Agro climatical zones	Age (years)	Experience in sesame production (years)	Annual land area planted (ha)	Quantity of sesame produced per year (kg)	Proportion of sesame produced and sold per year (%)
Sahel	41 ± 12.6^{a}	6.6 ± 6.2^{b}	0.61 ± 0.3	226.8 ± 64.3^{b}	95.27 ± 12.5^{a}
North sudan	43 ± 7.2^{a}	9 ± 4.6^{a}	1.80 ± 0.9	575 ± 86.4^{a}	89.85 ± 11.9^{b}
South sudan	35 ± 8.3^{b}	5.5 ± 1.8^{b}	1.85 ± 0.4	224 ± 62.8^{b}	86.94 ± 7.7^{c}
Means	40 ± 10.2	7 ± 4.8	1.42 ± 0.5	342 ± 71.9	90.69 ± 11.2
CV%	12.1	16	18.7	77.5	11.3
F Probability	0.001^{***}	0.001^{***}	0.2 ns	0.001^{***}	0.001^{***}

Note: Means with the same alphabetic letters in the same column are not significantly different at the 5% level according to the Student Newman Keul test. *** = ($P<0.001$). ** = ($P<0.01$). * = ($P<0.05$). ns = Not Significant. CV = Coefficient of variation

was binary and noted: "application of organo-mineral fertiliser". It takes the value one (1) if the producer applies both mineral and organic fertiliser; and a value zero (0), if the producer exclusively applies either mineral or organic fertilisers, or does not apply any fertilisers at all. Also, a correlation between the different dependent variables was carried out, in order to establish significance of relationships between the variables.

RESULTS

Socio-economic characteristics. Table 1 presents descriptive statistics of variables relating to the social status of sesame farmers in the different agro-climatical zones of the study. Women contributed significantly to cultivation of sesame (48.4%) in the three agro-ecologicalal zones. This contribution was particularly important in both the Sahelian (84%) and southern Sudan zones (65.3%). Overall, 52% of the sesame producers were between 36 and 50 years old.

There was a highly significant difference in the age ($P < 0.001$) of farmers on the basis of the agro-ecological zones (Table 3), with the highest mean age recorded in the Sudan and North Sahel zones. Sesame production was dominated by indigenous people (94.4%); with the majority (75.3%) having no definite education levels.

The dominant mode for accessing land was by inheritance (76.6%); but there was also by loan which remained low (5%) (Table 1). The majority (62%) of sesame producers in the North Sudan zone South Sudan zone (51%) allocated mostly the less fertile and uncultivated land; and/or abandoned land to sesame production. Generally, farmers had seven years of experience in sesame production (Table 3); which was significantly ($P < 0.001$) higher for farmers in the north Sudan zone.

The majority of population (56.9%) had between 1 and 3 fields (Table 2); in overall farm areas of less than 10 ha. However, the average annual land area allocated for sesame production per household was about 1.42 ha; though this area did not differ significantly between the agro-climatical zones ($P = 0.2$). However, the area planted with sesame was much larger in the north Sudan (1.80 ha) and South Sudan zone (1.85 ha), than in the Sahelian (0.61 ha) (Table 3).

Animal traction was mostly used for plowing in the study area (Table 3). Use of

TABLE 3. Production factor relatiing to different agro-climatical zones in Burkina Faso

Variables	Modality	Percentage (%) of farm per agro-climatical zone			
		Sahel	North-Sudan	South-Sudan	Total study zone
Total number of fields allocated for sesame production	[1; 3]	32.1	42.0	99.0	56.9
	[3; 7]	67.9	58.0	1.0	43.1
	> 7	0.0	0.0	0.0	0.0
Total agricultural land area (ha) per farmer	[0; 10[	100.0	94.0	92.9	95.7
	[10; 20]	0.0	6.0	7.1	4.3
Number of tractors	0.0	100.0	99.0	100.0	99.7
	1.0	0.0	1.00	0.00	0.30
Number of draught animals	0	37.7	29.0	37.8	34.9
	[1; 3]	61.3	54.0	56.1	57.2
	[3; 6]	0.9	16.0	5.1	7.2
	]6; 8]	0.0	1.0	1.0	0.7
Number of cart	0	50.9	46.0	63.3	53.3
	[1; 2]	49.1	54.0	36.7	46.7
Proportion of production processed	Yes	1.0	2.0	0.0	1.0
	No	99.0	98.0	100.0	99.0

draught animals remains non-feasible for many sesame producers, whereby 40% of producers did not plow and weed using animal poer. Also, majority of producers (53.3%) did not use animal driven carts for transportation. Table 4 shows that sesame production is primarily for household consumption, with intercropping being common in the Sahel zone. Most farmers ranked sesame as a key crop, and sowing typically occurs in mid-July. In-line sowing techniques are widely used, with limited adoption of plowing methods.

Family labour constituted the primary work force in most (78.3%) of the households. Average annual sesame production, registered was 342.0 ± 311.95 kg ha^{-1} household (Table 3). Figure 1 shows significant yield differences between zones, with the Sahelian zone having the highest yield (379.32 kg ha^{-1}) and South Sudan the lowest (210.19 kg ha^{-1}), confirmed by ANOVA (P = 0.000). The highest production was recorded in the northern Sudanian zone (575 ± 356.43 kg) and the lowest in the other two zones. Most of the sesame produced (99%) had no value added prior to its sale (Table 3); as up to 90.69% of sesame produced was sold in local markets. More than 95% of the sesame produced in the Sahelian zone was sold during the harvest period; against 86.94% in the south Sudanian zone.

Agronomic factors. Figure 2 presents results of a Multiple Correspondence Analysis (MCA), as applied to soil fertility management practices and sesame seed types in relation to the extent of cultivation of sesame in the Sudan climatic zone of Burkina Faso. The two primary axes, F1 and F2, collectively accounted for 88.38% of the total variance, indicating that these axes effectively represented the original variables. The F1 axis, which explained 83.77% of the variance, primarily differentiated practices and agroclimatic zones based on the type of fertiliser (organomineral or otherwise) and the type of seed (improved or traditional) used. Groups with a strong positive correlation with this axis, such as 'AppEngrai-Oi-Eng', 'ZnAgr-3', and 'AppMO-Oi-MO', indicated more intensive practices; whereas negative correlations, including 'ZnAgr-1' and 'AppEngrai-Nn-Eng', are associated with more traditional approaches. The F2 axis, accounting for 4.61% of the variance, further distinguishes specific practices or regions, with positive correlations for 'AppEngrai-Oi-Eng' and 'ZnAgr-3'; and negative correlations for 'AppEngrai-Nn-Eng' and 'ZnAgr-2'.

Fertiliser use in sesame production. The Pearson correlation analysis (PCA) between socio-economic variables and sesame production revealed several significant relationships (Table 5). The agroclimatic zone strongly influenced the adoption of combined agricultural practices ($r = 0.389$, $P < 0.01$); while age ($r = -0.324$, $P < 0.01$) and farmer experience ($r = -0.332$, $p < 0.01$) were negatively correlated with this variable. Education level was positively associated with fertilisation methods ($r = 0.165$, $P < 0.01$); yet experience correlated with higher social status ($r = 0.268$, $P < 0.01$).

Farmers with multiple plots tended to achieve higher sesame yields ($r = 0.435$, $P < 0.01$); whereas a higher social rank was linked to lower yields ($r = -0.497$, $P < 0.01$).

The logistic regression analysis identified key determinants influencing the adoption of organo-mineral fertilisers in sesame production (Table 6). The agroclimatic zone, fertilisation method, sesame variety type, and the number of cultivated plots were found to be significant factors driving fertiliser use. Specifically, the agroclimatic zone ($P < 0.0001$) and fertilisation method ($P = 0.010$) were the most influential to sesame production, and to fertiliser adoption. The type of sesame variety used ($P = 0.004$) and the number of plots ($P = 0.018$) also significantly affected fertiliser use. In contrast, variables such as gender, age, education level, field size and cultivated area were not statistically significant ($P>0.05$).

TABLE 4. Cropping practices of sesame producers related to different the agro-climatical zones

Variables	Modality	Percentage (%) of farm per agro-climatical zone			
		Sahel	North-sudan	South-sudan	Total study zone
Characteristic of the production	Seed production	0.0	2.0	24.5	7.9
	Production for the household consumption	100.0	96.0	73.5	90.1
	Seed production and household consumption	0.0	2.0	2.0	2.0
Cropping system	Sole cropping	55.0	99.0	89.0	80.9
	Intercropping	45.0	1.0	11.0	19.1
Ranking of the importance of sesame production	1st	2.8	2.0	40.8	14.8
	[2; 4[	88.7	76.0	59.2	75.0
	[4; 7]	8.5	22.0	0.0	10.2
Variation in the sowing dates from one year to an other	Yes	85.0	2.0	97.0	61.0
	No	15.0	98.0	3.0	39.0
Sowing period	Early june	0.0	0.0	1.0	0.3
	Mid-june	0.0	1.0	3.1	1.3
	End june	0.0	1.0	8.2	3.0
	Early july	1.9	12.0	31.6	14.8
	Mid-july	98.1	16.0	43.9	53.6
	End july	0.0	33.0	8.2	13.5
	Early August	0.0	28.0	4.1	10.5
	Mid- August	0.0	8.0	0.0	2.6
	End August	0.0	1.0	0.0	0.3
Sowing technics	In line	100.0	91.0	82.7	91.4
	With the flap	0.0	9.0	17.3	8.6

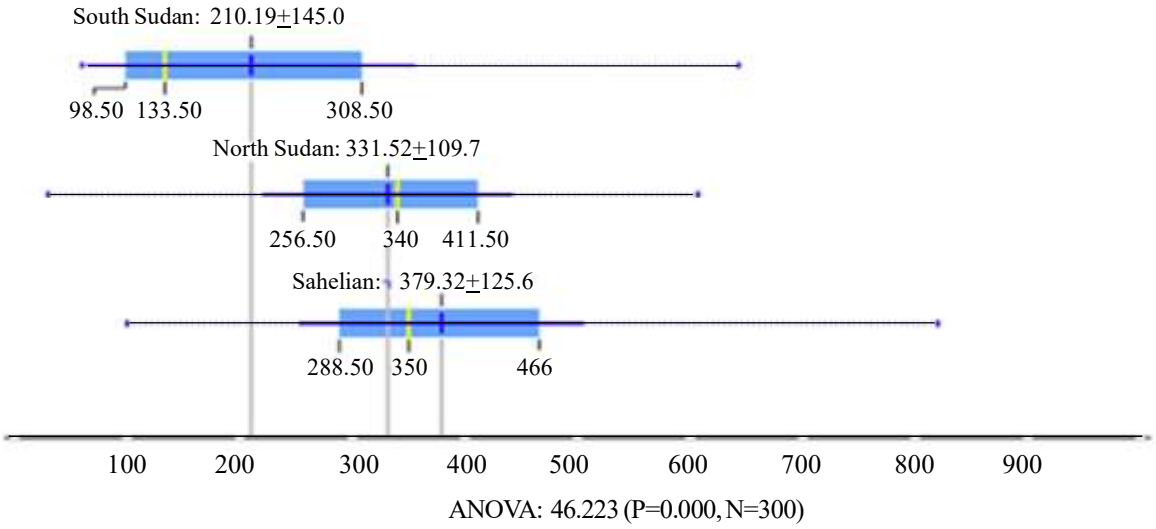

Figure 1. Average sesame yields (kg.ha^{-1}) n relation to the agro-climatical zones in Burkina Faso.

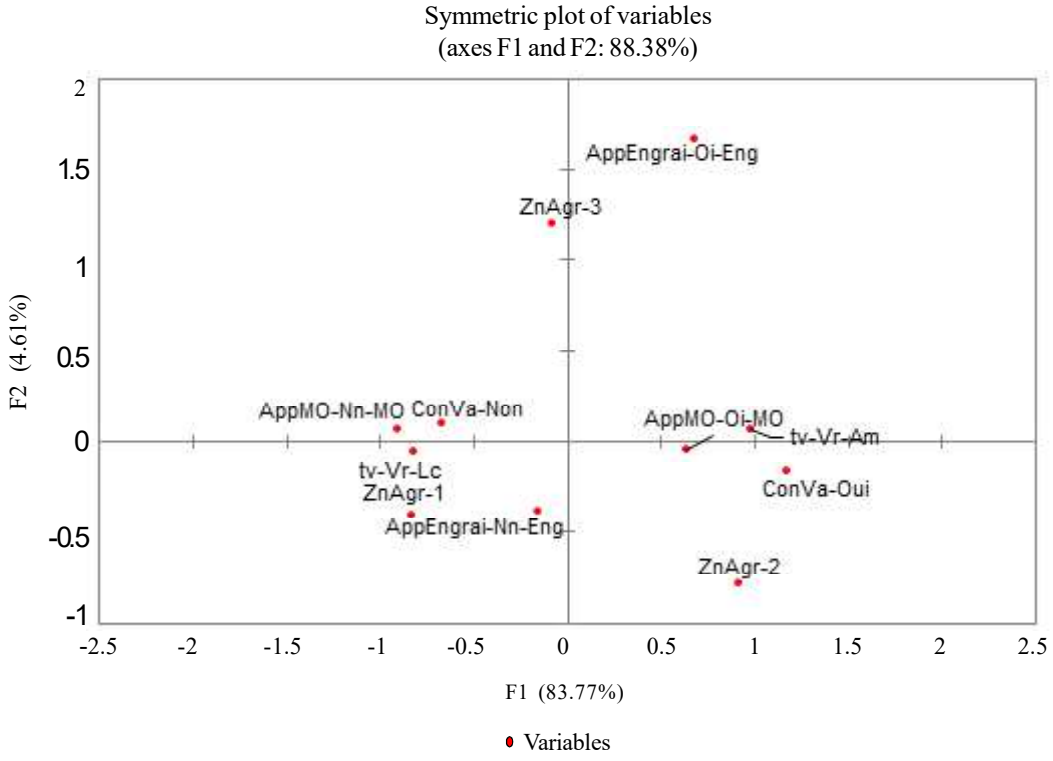

Figure 2. Results of the Multiple Component Analysis (MCA) of soil fertility management practices and type of sesame seed used in different agroclimatic zones in Burkina Faso.

ZnAgr-1: North Sudan agro-climatic zone; ZnAgr-2: Sahel agro-climatic zone; ZnAgr-3: South Sudan agro-climatic zone; ConVa-No: No knowledge of improved seed variety; ConVa-Yes: Knowledge of improved seed variety; Tv-Am : Use of improved seed variety; Tv-Lc: Use of local seed variety; AppEngrai-Nn-Eng: No application of mineral fertilizer; AppEngrai-Oi-Eng: Apply of mineral fertilizer; AppMO- Nn-MO: No apply of organic manure; AppMO- Oi-MO: Apply of organic manure.

TABLE 5. Pearson Correlation Analysis results for sesame cultivation in Burkina Faso

Correlation	Agro zone	ApCombi	Sexe	AGE	NivSco	Exp	ModTer	LdProd	Rank	TypCul	TvarUt	NbWd	LA	Yd
Agro zone	1													
ApCombi	0.389**	1												
Sex	0.090	0.026	1											
AGE	-0.324**	-0.100	-0.067	1										
NivSco	-0.122*	-0.064	-0.201**	-0.200**	1									
Exp	-0.332**	-0.116*	-0.096	0.371**	-0.032	1								
ModTer	-0.269**	-0.056	-0.159**	0.165**	0.030	0.194**	1							
LdProd	-0.101	-0.290**	-0.285**	-0.041	0.032	0.062	0.200**	1						
Rank	-0.553**	-0.216**	-0.155**	0.383**	0.092	0.268**	0.191**	0.016	1					
TypCul	0.104	-0.108	0.215**	0.080	-0.123*	-0.002	-0.106	-0.222**	-0.007	1				
TvarUt	0.189**	0.383**	0.298**	-0.033	-0.061	-0.079	-0.072	-0.566**	0.017	0.068	1			
NbWd	-0.034	0.251**	0.227**	0.025	0.015	-0.038	-0.048	-0.521**	0.085	0.116*	0.408**	1		
LA	0.004	-0.023	-0.082	-0.042	-0.017	0.001	0.038	0.109	-0.055	-0.080	-0.076	-0.094	1	
Yd	-0.332**	0.124*	0.125*	0.153**	0.066	0.036	0.033	-0.497**	0.224**	0.133*	0.406**	0.435**	-0.085	1

** : Correlation is significant at the 0.01 level (two-tailed), * ;Correlation is significant at the 0.05 level (two-tailed).

Legend: Agro zone: agro-climatic zone; ApCombi: application of NPK and organic manure; Sex: gender; AGE: age; NivSco: level of education; Exp: level of experience of the farmer in sesame cultivation; ModTer: mode of access to land; LdProd: type of land allocated to sesame cultivation; Rank: Rank of importance of sesame among the other crops grown by the producer; TypCul: Sole Sesame cultivation or intercropping; UtVar: Use of seed of improved variety; NbWd: Number of weeding practiced; LA: land area (ha); Yd grain yield (kg. ha)

TABLE 6. Logistic regression model setting

Parameters	Estimated values	Standard deviations	Khi²	Pr. > Khi²
Constante	-21.254	5.388	15.558	< 0.0001***
Agro-zone	3.278	0.678	23.391	< 0.0001***
Sex	0.022	0.563	0.002	0.969ns
AGE	-0.441	0.427	1.065	0.302ns
NivSco	-0.131	0.251	0.272	0.602ns
Exp	0.951	0.836	1.294	0.255ns
ModTer	3.276	1.265	6.709	0.010*
TdProd	-0.576	1.172	0.242	0.623ns
Rang	-0.119	0.250	0.228	0.633ns
TypCul	-0.564	0.670	0.710	0.399ns
TvarUt	2.351	0.821	8.202	0.004**
NbWd	2.679	1.128	5.641	0.018*
LArea	0.016	0.047	0.115	0.735ns
Yd	0.002	0.002	1.292	0.256ns

Agro-zone: Agroclimatic zone; ApCombi: Application of NPK and organic manure; Sex: Gender; AGE: Age; NivSco: Level of education; Exp: Producer's level of experience in sesame cultivation; ModTer: Mode of access to land; TdProd: Type of land allocated to sesame cultivation; Rank: Rank of importance of sesame among the other crops grown by the producer; TypCul: Sole Sesame cultivation or intercropping; UtVar: Use of seed of improved variety; NbWd: Number of weeding practiced; Sup: area (ha); Yd: grain yield (kg ha^{-1})

DISCUSSION

Socio-economic characteristics. The analysis of descriptive statistics related to the social status of sesame producers across different agro-climatic zones, revealed significant disparities in terms of women's contribution, producers' age, and land access modes (Table 1). The contribution of women to sesame cultivation, particularly in the Sahelian (84%) and South Sudanian (65.3%) zones, was a crucial. These findings are consistent with those of Njuki *et al*. (2011), who demonstrated that women play a central role in agricultural production in semi-arid regions due to their involvement in cash crops such as sesame. Similarly, the work of Saïdou *et al*. (2007) in central Benin indicated that men's investment in certain crops compared to women was influenced by customary rules that often restricted women's land ownership rights. Therefore, gender is an important factor to consider in the planning of development strategies involving sesame production in Burkina Faso.

The age distribution of producers, with a concentration between 36 and 50 years and a significant difference across agro-ecological zones ($P < 0.001$) (Table 1), reflects similar dynamics observed by Amadu *et al*. (2022), who highlighted that the average age of producers can influence productivity and the adoption of new agricultural technologies, with older producers often being more hesitant to adopt new innovations. Additionally, the predominance of indigenous producers (94.4%) and the access to land primarily through inheritance (76.6%), confirm the importance of traditional social structures in resource management. This finding is supported by Turner *et al.* (2021) on the impact of land access rules on agricultural productivity in West Africa. These findings imply that average age of households, their

indigenous status and form of access to land for cultivation of sesame are primary factors that should be considered while designing strategies geared to promoting production of sesame in Burkina Faso.

Although animal traction was a predominant mode of land preparation for sesame fields, a notable proportion of producers (40%) lacked the necessary tools for effective plowing and weeding (Table 3). This lack of the requisite equipment limit the feasibility of use of the agricultural practices, thus impairing efficient production of the crop. Side *et al*. (2015), who noted that limited access to animal traction hindered agricultural intensification in semi-arid regions. The lack of easy access to animal traction, and the restricted use of manual labour for to accomplish field activities will remain a major bottleneck to accelerated sesame production, unless when considered proactively in planning and designing of development strategies.

The marketing of sesame, with the majority of products sold in local markets without value addition (Table 3), highlights a missed opportunity to improve producers' incomes. This point was emphasised by Kassie *et al*. (2023) in their study on sesame value chains in sub-Saharan Africa. These results underscore the need for targeted interventions to improve access to agricultural technologies, strengthen producers' capacities, particularly women, and optimise land use in different agro-climatic zones to maximise sesame productivity and economic benefits for rural communities.

The fact that the majority of sesame producers had low levels of formal education or literacy (Table 1) appears to have accounted for the weak adoption of fertiliser technology to improve sesame yield. According to Yabi *et al*. (2016), the more educated the more the farmers are open to new knowledge. According to Teno *et al*. (2018), farmers with a high level of education have good understanding of new technology, and therefore are more willing to judge its usefulness and effect adoption. Education is, therefore, a key issue to consider when facilitating adoption of new agricultural technologies for improved sesame production in Burkina Faso.

Indeed, the study reveals low productivity of sesame in all agro-climatical zones. Yields component vary between 210.13 ± 145 and 379.32 ± 125.6 kg ha^{-1} (Fig. 1). Similar results were also registered by Rongead (2013). This study revealed low productivity level of sesame in Burkina Faso. However, the author, found yield levels ranging between 300 and 350 kg ha^{-1}. These results reflect the characteristics of sesame cropping practices in the study area, dominated by no compliance with cropping calendar, low supply of fertiliser and low use of improved varieties. We also noticed variability in the sowing periods from one year to another among sesame producers (Table 4). This is due to the weak importance given by farmers to this crop. Thus, farmers of the study area give much more importance to the staple food crops and the cash crops compared to sesame cultivation. Therefore, these crops are sown firstly before sesame. Such situation is often observed in the study area (Boureima and Diouf, 2011; Diatta and Diouf, 2022). Sesame is sensitive crop; the sowing period determine yield potential. Late sowing negatively affects the yield (Olowe, 2007; Abdel-Latief *et al*., 2022).

Agronomic factors. The marked distinction between intensive and traditional practices on axis F1, which explained the significant portion of the variance (83.77%) (Fig. 2), aligns with recent research highlighting the impact of organo-mineral inputs and improved seeds on agricultural yield increases in semi-arid regions (Fayama *et al*., 2020). Similarly, the study conducted by Sileshi *et al*. (2019) on conservation agriculture in West Africa demonstrated that combined use of organic and mineral fertilisers, alongside improved seeds, can substantially increase crop productivity in semi-arid zones. Furthermore,

the emphasis on differentiating agricultural practices by agro-climatic zones, aligns with Bienfait *et al*. (2019), who showed that adapting soil fertility management techniques to local climatic specifics is essential for optimising agricultural yields under variable climatic conditions.

Although PCA Axis F2 explained a lesser portion of the variance (4.61%) related to sesame production practices, it provided additional granularity by distinguishing specific practices or regions, an observation that aligns with MacCarthy *et al*. (2021) on the influence of specific agricultural practices on the sustainability of production systems in West Africa. Moreover, PCA highlighted the significant influence of agro-climatic zones on the adoption of combined agricultural practices ($r = 0.389$, $P < 0.01$). This result is consistent with the observation by Demongeot (2023) that local climatic and environmental conditions critically shape farmers' choices of cultivation techniques, particularly in semi-arid regions. Additionally, the negative correlation between age ($r = -0.324$, $P < 0.01$) and farmers' experience ($r = -0.332$, $P < 0.01$) with the adoption of combined agricultural practices, suggests that older and more experienced farmers are less inclined to adopt new or combined techniques, a trend observed in Castle *et al*. (2016). The positive relationship between education level and fertilisation methods ($r = 0.165$, $P < 0.01$), underscores the importance of education in modernising agricultural practices on farm; a point that conforms to the conclusion by Bouda (2023), that access to education enhances farmers' ability to adopt advanced agricultural technologies. The association between higher social status and lower yields ($r = -0.497$, $P < 0.01$), may indicate that higher social rank farmers adopt less intensive practices, a similar dynamic to that observed by Yabi *et al*. (2016).

The results of the logistic regression analysis on the adoption of organo-mineral fertilisers in sesame production (Table 6), provide valuable insights into the determinants influencing agricultural practices. The significance of agro-climatic conditions ($P < 0.0001$) and fertilisation methods ($P = 0.010$); is consistent by Golla (2021), who demonstrated that adapting fertilisation techniques to agro-climatic specifics was crucial for maximising yields, particularly in semi-arid regions.

The significant role of sesame varieties ($P = 0.004$) and the number of plots ($P = 0.018$) in the adoption of organo-mineral fertilisers (Table 6), conforms to the results of Fayama *et al*. (2020), thus highlighting the importance of improved seeds for encouraging the use of modern agricultural techniques. The results suggest that to improve the adoption of fertiliser use, interventions should target specific agro-climatic zones, promote appropriate fertilisation techniques, and facilitate access to improved seed varieties; while also supporting farmers with multiple plots, thus contributing to a sustainable increase in sesame yields in the relevant regions.

CONCLUSION

The most influential determinants of sesame cultivation in the Sudan climatic zones of Burkina Faso, in descending order, included limited use of organominal fertiliser, improved seeds, and noncompliance with technical guidelines provided by agricultural extension and advisory services. Other influential factors include unfavourable mode of access to land and inadequate of weeding practices, both of which moderately influence production of the crop.

Factors such as gender, age, education level and land area allocated to sesame cultivation, hitherto believed to be important in sesame production, had no statistically measurable effects on crop cultivation. Allocation of mostly degraded lands to sesame production considerably affected its yield levels.

ACKNOWLEDGEMENT

This study was part of the PhD research by the first author, at Abomey-Calavi University, Benin. The Fond National de la Recherche et de l'Innovation pour le Développement (FONRID) funded this study under the Projet d'Amélioration et d'Intensification de la Production du Sésame dans la région de l'Est.

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