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MAIZE AND COWPEA YIELDS AS INFLUENCED BY TILLAGE AND CROPPING SYSTEMS WITH ORGANO-MINERAL FERTILIZATION IN BURKINA FASO

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ABSTRACT

The precariousness of agro ecosystems reduces agricultural productivity, necessitating new technologies to ensure sustainability. This study wat set up in 2024 and 2025 to evaluate the effect of tillage and cropping systems with organo-mineral fertilization on maize and cowpea yields, through a completely randomized block with treatments arranged in a split-plot with three replications. Three tillage methods (1) scarifying (TM1) (2) ploughing (TM2), and (3) tied-ridging (TM3) were applied to the main plots, while two cropping systems (1) alternating one row of maize and one row of cowpea (CS1); alternating two rows of maize of two rows of cowpea(CS2) combined with five fertilization levels (1) no fertilization (F1), 200 kg ha^{-1} NPK + 200 kg ha^{-1} urea on maize + 100 kg ha^{-1} NPK on cowpea (F2), 300 kg ha^{-1} NPK + 100 kg ha^{-1} urea on maize + 100 kg ha^{-1} NPK on cowpea (F3), F2 + 2500 kg ha^{-1} compost (F4), and F3 + 2500 kg ha^{-1} compost (F5) were applied to sub-plots. Maize and cowpea grain yields were evaluated. The highest maize grain yields of 921.69 kg ha^{-1} and 862.99 kg ha^{-1} were obtained in the plots receiving TM2-CS2-F4 and TM3-CS2-F4, respectively. The highest cowpea grain yields of 581.97 kg ha^{-1} were obtained with the CS1-F5 combination. Sustainability of production thus relies on the synergy between tillage, cropping system, and organo-mineral fertilization.

Keywords: compost, fertilization, productivity, tied-ridging, tillage.

INTRODUCTION

Burkina Faso is an agricultural country where agriculture contributes significantly to the country's Gross Domestic Product (GDP) and therefore constitutes a key sector for the country's development. In 2024, the primary sector's contribution to GDP was 20%, compared to 17.1% in 2023 (MEFP, 2024). Despite this, food self-sufficiency remains an objective to be achieved (MAAHM, 2021).

In Burkina Faso, low agricultural productivity is partly linked to the natural poverty of the soils (Dabré *et al.*, 2016) particularly organic matter and essential nutrients such as nitrogen (N) and phosphorus (P). Furthermore, Bacyé *et al.*, (2019) have demonstrated the soil's deficiency in organic matter and phosphorus. Furthermore, the continuous degradation of arable land due to its low resistance to water and wind erosion negatively impacts agricultural productivity (Thiombiano, 2000). This low agricultural productivity is also attributable to climatic hazards, particularly droughts and uneven rainfall distribution (Nacro *et al.*, 2010) creating flood or drought in some years. Agricultural production in Burkina Faso is extensive, and does not favor economic development for small rural farmers though it is the primary source of income and livelihood the rural populations, Added to these climatic hazards is the scarcity of arable land caused by population pressure. Therefore, achieving food security remains a challenge under these precarious conditions (Pouya *et al.*, 2020). To optimize agricultural productivity, soil fertility management technologies such as tillage methods and the use of mineral and organic fertilizers that improve soil physical and chemical properties as well as biological activity have been developed to increase crop yields in the Sudanian-sahelian zone of Burkina Faso (Palé *et al.,* 2021) On the other hand, optimal fertilizer application rates using the micro dosing techniques, agro ecological and soil-protective methods such as cereal-cowpea intercropping have been reported as ways to improve productivity (Zongo *et al.,* 2021).

Furthermore, a global meta-analysis of intercropping systems revealed that these systems increased average maize yields by approximately 4.5% to 30% compared to monoculture (Zhang *et al.*, 2024; Xu *et al.*, 2025). Despite the research advances demonstrating the importance of intercropping, several contextual and methodological limitations remain in the literature. Indeed, most studies adopt a single-factor approach, separately analyzing tillage, fertilization, or crop selection, which limits the understanding of the complex interactions between these factors. The aim of the present study is to develop technologies that integrate tillage and cropping systems with organic fertilization to improving soil fertility thus ensuring sustainability of maize and cowpea production Sudanian-sahelian zone of Burkina Faso.

MATERIALS AND METHODS

Study Site

This study was conducted at the Saria Environmental and Agricultural Research Station (12° 16’ north latitude; 2° 9’ west longitude). This research station is one of the stations of the Institute of Environment and Agricultural Researches (INERA). It is located 80 km west of Ouagadougou in the Boulkiemdé province and 23 km east of Koudougou being the capital of the province (Figure 1). The study was carried out under rainfed conditions in 2024 and 2025. The site is in the Sudanian-sahelian climatic zone with a rainy season from May

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to October and a dry season from November to April. At the study site, an interseasonal variation in annual rainfall over the last ten years (2016 to 2025) was observed, with an average of 870.29 mm. The total rainfall recorded in 2024 was 910.6 mm over 69 rainy days, compared to 821.5 mm over 71 rainy days in 2025. In 2024, minimum monthly temperatures ranged from 12.63 °C to 27.53 °C, with an annual average of 20.85 °C, and maximum temperatures ranged from 31.01 °C to 41.24 °C, with an average of 35.61 °C. In 2025, minimum temperatures ranged from 14.34 °C to 26.03 °C, with an annual average of 21.21 °C, while maximum temperatures ranged from 30.37 °C to 40.70 °C. The substrate on which the experiment was conducted was a leached, hardened tropical ferruginous soil (CPCS, 1967). The soil has a crust located at more than 50 cm depth, a sandy-loam texture on the surface (78.92% sand, 13.11% silt and 7.96% clay), a low water retention capacity and a pH (water) of 5.18. The substrate is also characterized by a total organic matter of 0.49% with a C/N ratio of 10, a sum of exchangeable bases of 2.14 meq/100g, a cation exchange capacity (CEC) of 3.8525 meq/100g and a degree of saturation (S/T) of 55.5%.

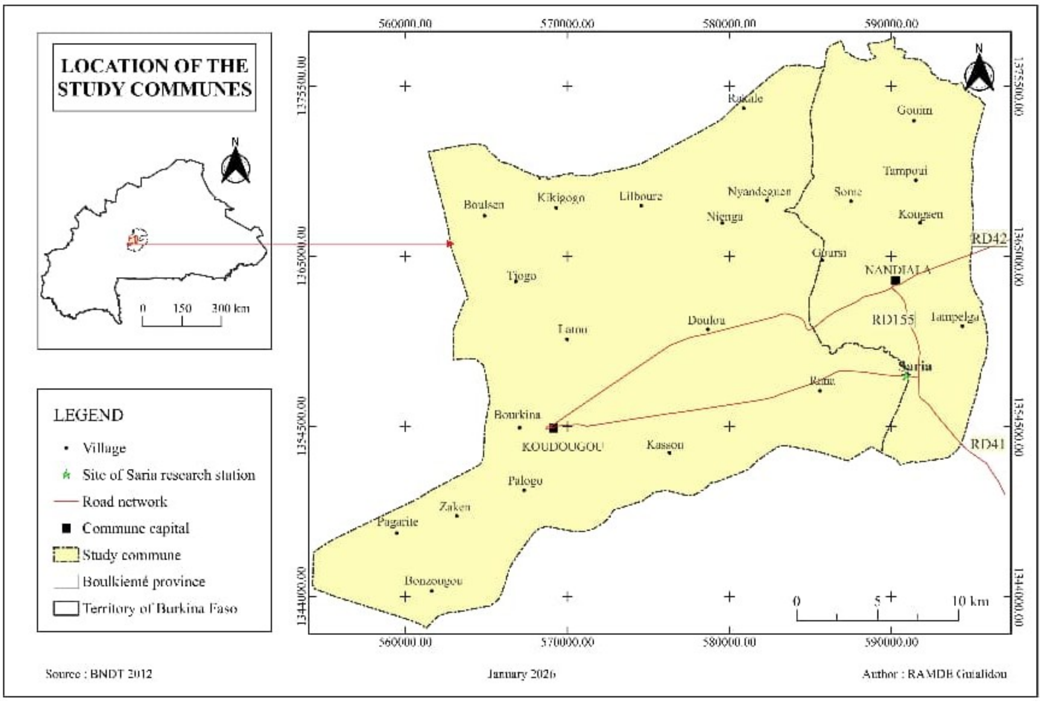


Figure 1. Map showing the location of the study site (Saria Research Station) (map created by G. RAMDE)

Plant material

The plant material used in this study consists of the maize variety FBC6 and the cowpea variety Teek-songo, both developed by the Institute of Environment and Agricultural Researches (INERA). The FBC6 variety is a dual-purpose composite variety (grain and forage) with a 91-day growing cycle and a maximum height of 2.15 m. It has a potential grain yield of 5.6 t ha^{-1}. The cowpea variety Teek-songo is also a dual-purpose variety with good ground coverage. It has a potential grain yield of 1.5 t ha^{-1} and a stover yield of 4.5 t ha^{-1} with a 70-day growing cycle. Production of these two varieties is recommended in the Sudanian-sahelian zone. Indeed, these two varieties are adapted to the harsh climate and are well-appreciated by the local population.

Fertilizers

The compost used as organic fertilizer was obtained from Bioprotect, a company specialized in the production of biofertilizers and biopesticides. The characteristics of the compost are listed in Table 1. The mineral fertilizers used are NPK (14 N-23 P_2O_5-14 K_2O-6 SO_3-2 B) and urea 30 N (30 N-3 MgO-8 S-0.3 Zn-0.2 B).

Table 1. Chemical composition of the compost used

Total OM	Total C	Total N	C/N	Assimilable P	Total P	Available K	Total K	Total Ca	Total Mg	pH (water)
------------- % -----------				mg/Kg	--------------- g/Kg --------------			------- mg/Kg ------		
28.26	16.39	0.91	18	311.18	5.99	14.1	14.39	654.30	178.96	7.82

***Note*:**C = Carbon, N = Nitrogen, P = Phosphorus, K = Potassium, Ca = Calcium, Mg = Magnesium

Experimental design

The experimental design used is a completely randomized block with treatments arranged in a split-plot with three replications. The main plots are represented by three tillage methods (TM). The subplots are represented by two cropping systems (CS) combined with five (05) levels of soil fertilization (mineral and/or organic fertilization) (F). Plot size was 6 m long by 4 m wide, i.e., 24 m², separated by 1 m wide alleys. The different treatments applied are reported in **Table 2.**

Table 2.Tillage methods (TM), Cropping system (CS), and Fertilization (F), 2024 and 2025, Saria, Burkina Faso.

Tillage methods (TM)

- TM1: Scarifying (shallow scraping) with a cultivator (manga hoe) using ox traction to an average depth of 10 cm.
- TM2: Shallow ploughing with a plow (CH9) using ox traction to an average depth of 15 cm.
- TM3: Tied-ridging. The ridges were made before planting using a tied-ridging plow with ox traction, following the planting row. The ties were made one month after planting.

Cropping system (CS)

- CS1: Intercropping of maize and cowpea in alternating rows: 1 row of maize followed by 1 row of cowpea.
- CS2: Intercropping of maize and cowpea in alternating rows: 2 rows of maize followed by 2 rows of cowpea.

Fertilization (F)

Fertilisation	N	Mg	P_2O_5	Zn	K_2O	S	B	Compost
	-----------------	-----------------	-----------------	kg ha^{-1}	-----------------	-----------------	-----------------	
F1 = Zero fertilizer (control)	0	0	0	0	0	0	0	0
F2 = 200 kg ha^{-1} of NPK + 200 kg ha^{-1} Urea 30 N on maize and 100 kg ha^{-1} of NPK on cowpea	102	6	46	0,6	42	34	6,4	0
F3 = 300 kg ha^{-1} de NPK + 100 kg ha^{-1} Urea 30 N on maize and 100 kg ha^{-1} of NPK on cowpea	86	3	69	0,3	56	32	8,2	0
F4 = F2 + 2500 kg ha^{-1} of Compost	102	6	46	0,6	42	34	6,4	2500
F5 = F3 + 2500 kg ha^{-1} of Compost	86	3	69	0,3	56	32	8,2	2500

Cropping system and fertilization combinations (CS-F)

- CS1-F1: Maize-Cowpea intercropping in alternating Rows: 1 row of maize followed by 1 row of cowpea with F1
- CS1-F2: Maize-Cowpea intercropping in alternating Rows: 1 row of maize followed by 1 row of cowpea with F2
- CS1-F3: Maize-Cowpea intercropping in alternating Rows: 1 row of maize followed by 1 row of cowpea with F3
- CS1-F4: Maize-Cowpea intercropping in alternating Rows: 1 row of maize followed by 1 row of cowpea with F4
- CS1-F5: Maize-Cowpea intercropping in alternating Rows: 1 row of maize followed by 1 row of cowpea with F5
- CS2-F1: Maize-Cowpea intercropping in alternating Rows: 2 rows of maize followed by 2 rows of cowpea with F1
- CS2-F2: Maize-cowpea intercropping in alternating rows: 2 rows of maize followed by 2 rows of cowpea with F2
- CS2-F3: Maize-cowpea intercropping in alternating rows: 2 rows of maize followed by 2 rows of cowpea with F3
- CS2-F4: Maize-cowpea intercropping in alternating rows: 2 rows of maize followed by 2 rows of cowpea with F4
- CS2-F5: Maize-cowpea intercropping in alternating rows: 2 rows of maize followed by 2 rows of cowpea with F5

Trial management

Before the different tillage methods (scarifying, ploughing, and tied-ridging) were implemented, a dose of 2500 kg ha^{-1} an^{-1} of compost was broadcasted in the plots designated to receive compost prior to planting. Planting (maize and cowpea) took place on July 10 in 2024 and July 11 in 2025. Planting was done in alternating rows. Before planting, the maize and cowpea seeds were coated with the fungicide Calthio. The row spacing was 80 cm, and the hill spacing was 40 cm, for a total of 31,250 hills ha^{-1} for both crops. Thinning to two plants per hill was performed after emergence. Fourteen (14) days after planting (DAP), NPK fertilizer was applied using the micro dosing technique. Urea was applied only to the maize plants, also using the micro dosing technique in two fractions: the first fraction was applied at 30 DAP and the second at 45 DAP. The mineral fertilizer doses for the different treatments are presented in Table II. During the two years, two hoe weeding and one hand weeding were done depending on the weed infestation. To control cowpea aphids (*Aphis craccivora* Koch), insecticide was applied at the bud stage using Pacha 25 EC [Acetamiprid (10 g/L) + Lambda-cyhalothrin (15 g/L)] at a dose of 1 L ha^{-1} mixed with 400 L of water. At pod formation, a second treatment was done using K-Optimal [Lambda-cyhalothrin (15 g/L) + Acetamiprid (20 g/L)] at a dose of 1 L ha^{-1} mixed with 300 L of water. Treatments were realized early in the morning before sunrise.

Data collection

The data collected included grain weights for both maize and cowpea. Crop yields were then determined for each plot.

Statistical analysis of data

The collected data were recorded using Microsoft Excel. Analysis of variance was performed to verify the treatment means. Statistical analyses were carried out using SAS/STAT® software. For the analyses of variance, the critical significance level was set at 0.05.

RESULTS

The results of the analysis of variance indicated an interactive effect of the year and the fertilized cropping system on maize grain yield (P = 0.001). The interaction of the year and tillage affected maize grain yield (P = 0.012) and cowpea stover yield (P = 0.002). The interaction of tillage and the fertilized cropping system affected maize grain yield (P = 0.021) and cowpea stover yield (P = 0.009). The fertilized cropping system had a significant effect on maize stover yield (P < 0.001) and cowpea grain yield (P = 0.019).

Interactive effect of year and cropping system with fertilization on maize grain yield

The results showed that over two years of experimentation, the application of 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of urea on maize and 100 kg NPK ha^{-1} on cowpea + 2500 kg ha^{-1} of compost with one-row and two-row cropping systems (CS1-F4; CS2-F4) resulted in higher grain yields regardless of the cropping system (Table 3). Specifically, the treatment combining a one-row cropping system with an F4 fertilization dose (CS1-F4) resulted in a grain yield of 981.26 kg ha^{-1} in 2024 compared to 498.33 kg ha^{-1} in 2025, with an average of 739.8 kg ha^{-1}. The CS2-F4 treatment resulted in a grain yield of 1044.6 kg ha^{-1} in 2024, compared to 544.34 kg ha^{-1} in 2025, with an average of 794.47 kg ha^{-1}. Furthermore, CS2-F4 significantly increased corn grain yield by 609.94% compared to the control of the same cropping system without compost and mineral fertilizers (CS2-F1). Similarly, CS1-F4 resulted in a yield increase of 1412.89% compared to the control of the same cropping system without organo-mineral amendments (CS1-F1). However, in 2025, a yield decrease of 48.29% was observed across all cropping systems with fertilization.

Table 3. Year and cropping system with fertilization interaction effect on maize grain yield, Saria, Burkina Faso, 2024 and 2025.

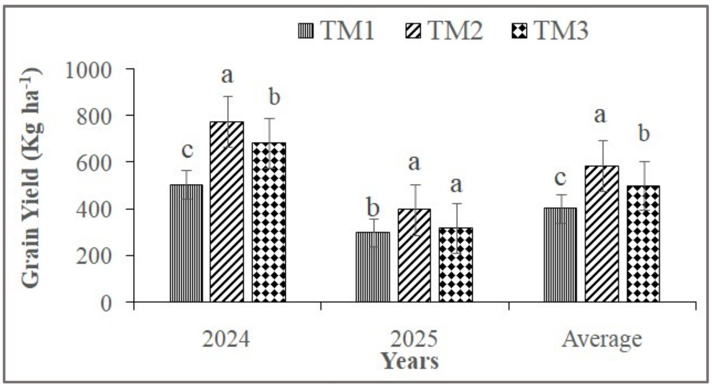
Cropping system (CS) with fertilization (F)	2024	2025	Mean
	------------------- Grain yield (Kg ha^{-1}) --------------------		
CS1-F1	64.86^{dA}	8.61^{cB}	36.74^{d}
CS1-F2	638.76^{cA}	403.16^{abB}	520.96^{c}
CS1-F3	605.63^{cA}	307.36^{bB}	456.50^{c}
CS1-F4	981.26^{abA}	498.33^{aB}	739.8^{ab}
CS1-F5	646.56^{cA}	422.45^{abB}	534.51^{c}
CS2-F1	147.14^{dA}	44.49^{cB}	95.82^{d}
CS2-F2	741^{bcA}	409.8^{abB}	575.4^{bc}
CS2-F3	871.44^{bA}	456.09^{abB}	663.77^{b}
CS2-F4	1044.6^{aA}	544.34^{aB}	794.47^{a}
CS2-F5	817.02^{bA}	296.37^{bB}	556.70^{bc}
Mean	655.827^{A}	339.1^{B}	497.48^{B}

Note: CS1 = 1 row of maize alternated with 1 row of cowpea; CS2 = 2 rows of maize alternated with 2 rows of cowpea; F1 = No fertilization; F2 = 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F3 = 300 kg ha^{-1} of NPK + 100 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F4 = F2 + 2500 kg ha^{-1} of compost; F5 = F3 + 2500 kg ha^{-1} of compost; TM1 = scarifying; TM2 = ploughing; TM3 = tied-ridging.

Values followed by the same lowercase letter in the same column and uppercase letter in the same row are not significantly different at P ≤ 0.05.

Interactive effect of year and tillage on maize grain yields

Statistical analyses indicated that in 2024, ploughing resulted in a higher grain yield (775.26 kg ha^{-1}) compared to ridge tied-ridging (685.41 kg ha^{-1}) and scarifying (507.1 kg ha^{-1}) (Figure 2). In 2025, ploughing also resulted in a higher yield compared to scarifying, but a similar yield to ridge tied-ridging. On average, over the two years, ploughing was more efficient in terms of grain production, with an average yield of 587.03 kg ha^{-1}. Ploughing resulted in an additional gain of 52.88% in 2024 and 33.18% in 2025 compared to scarifying, with an average gain of 43.03%. However, a significant decrease in maize productivity in the second year of Production was observed.



Note: TM1 = scarifying; TM2 = ploughing; TM3 = tied-ridging.

Figure 2. Year and tillage method interaction effect on maize grain yield, Saria, Burkina Faso, 2024 and 2025.

Interactive effect of tillage and cropping system with fertilization on maize grain yield.

The results indicated that with scarifying, the combination of a maize row alternating with a cowpea row + NPK + urea + compost (CS1-F4) produced the highest yield, compared to the two cropping systems that did not receive fertilization (CS1-F1 and CS2-F1) (Table 4). The highest yield was 639.47 kg ha^{-1}, compared to 42.65 kg ha^{-1} for treatment CS1-F1 and 78.08 kg ha^{-1} for treatment CS2-F1. In the ploughed plots, the two-row maize-followed-two-row cowpea system (CS2) with the application of 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of urea on the maize and 100 kg NPK ha^{-1} on the cowpea + 2500 kg ha^{-1} of compost (F4) resulted in a higher yield (921.69 kg ha^{-1}). The yields obtained in the CS2-F4 plots exceeded those observed in the unfertilized plots (F1), regardless of the cropping system, with 36.57 kg ha^{-1} for CS1-F1 and 171.39 kg ha^{-1} for CS2-F1. The results obtained in the ridged plots were similar, with the highest yield obtained with CS2-F4 (921.69 kg ha^{-1}). The rates of variation in this case ranged from 2172.22% to 2675.78% for the same CS1-F1 and CS2-F1 combinations. On average, regardless of the cropping system with fertilization, ploughing was the most productive, with an average yield of 587.03 kg ha^{-1}. Furthermore, considering the SC-F combinations and regardless of the tillage method, the CS2-F4 and CS1-F4 combinations performed best.

Table 4. Tillage method and cropping system with fertilization interaction effect on maize grain yield, Saria, Burkina Faso, 2024 and 2025.

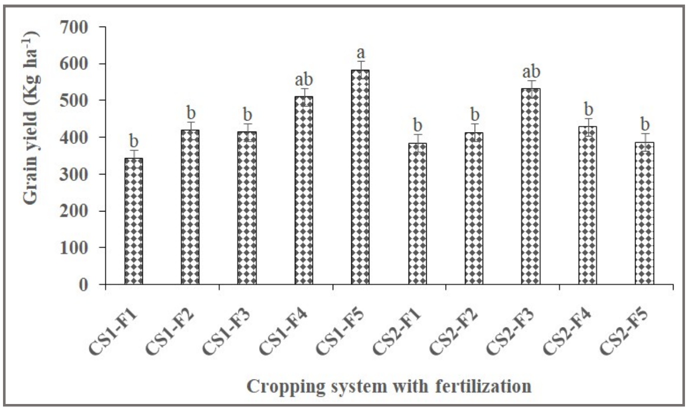
Cropping system (CS) with fertilization (F)	TM1	TM2	TM3	Mean
	--------------------Grain yield (Kg ha^{-1})	-------------------------		
CS1-F1	42.65^{cA}	36.57^{dA}	31.09^{cA}	36.77^{d}
CS1-F2	484.79^{abAB}	677.06^{bA}	401.03^{cB}	520.96^{c}
CS1-F3	537.86^{abA}	450.79^{cA}	380.83^{cA}	456.5^{c}
CS1-F4	639.47^{aA}	800.03^{abA}	779.88^{abA}	739.8^{ab}
CS1-F5	280.42^{bB}	665.58^{bA}	657.52^{bA}	534.5^{c}
CS2-F1	78.08^{cA}	171.39^{dA}	37.98^{cA}	95.81^{d}
CS2-F2	420.37bB	691.21^{bA}	614.63^{bA}	575.4^{bc}
CS2-F3	535.95^{abB}	786.68^{abA}	668.68^{bAB}	663.77^{b}
CS2-F4	600.23^{abB}	921.69^{aA}	862.99^{aA}	794.97^{a}
CS2-F5	412.87^{bB}	669.33^{bA}	587.89^{bcAB}	556.7^{bc}
Mean	403.27^{C}	587.03^{A}	502.25^{B}	

Note: CS1 = 1 row of maize alternated with 1 row of cowpea; CS2 = 2 rows of maize alternated with 2 rows of cowpea; F1 = No fertilization; F2 = 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F3 = 300 kg ha^{-1} of NPK + 100 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F4 = F2 + 2500 kg ha^{-1} of compost; F5 = F3 + 2500 kg ha^{-1} of compost; TM1 = scarifying; TM2 = ploughing; TM3 = tied-ridging.

Values followed by the same lowercase letter in the same column and uppercase letter in the same row are not significantly different at P ≤ 0.05.

Effect of cropping system with fertilization on cowpea grain yield

The results revealed a variation in cowpea grain yield (Figure 3). Clearly, the rotation of a maize row followed by a cowpea row + 300 kg ha^{-1} of NPK + 100 kg ha^{-1} of 30N Urea on the maize + 100 kg NPK ha^{-1} on the cowpea (CS1-F5) was the most promising, with the highest yield of 581.97 kg ha^{-1} compared to the other combinations.



Note: CS1 = 1 row of maize alternated with 1 row of cowpea; CS2 = 2 rows of maize alternated with 2 rows of cowpea; F1 = No fertilization; F2 = 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F3 = 300 kg ha^{-1} of NPK + 100 kg ha^{-1} of 30N urea on maize; 100 kg ha^{-1} of NPK on cowpea; F4 = F2 + 2500 kg ha^{-1} of compost; F5 = F3 + 2500 kg ha^{-1} of compost.

Figure 3. Effect of cropping system with fertilization on cowpea grain yield, Saria, Burkina Faso, 2024 to 2025.

DISCUSSION

Effect of the tested factors on the agronomic performance of maize intercropped with cowpea.

After analysis, the results indicated that in maize-cowpea intercropping systems with organo-mineral fertilization, tillage methods positively influenced maize productivity. This improvement can be explained by the positive effects these agricultural production techniques had on soil water management and the chlorophyll content of maize leaves. Indeed, several studies have shown that judicious soil water management significantly improves leaf water status, chlorophyll index, and photosynthetic capacity of maize, promoting better chlorophyll assimilation and, consequently, increased yield (Long *et al.*, 2024).

The results of the present study revealed that ploughing was the most effective, followed by tied-ridging. Previous authors have shown that ploughing and tied-ridging have the advantage of improving soil moisture and leaf chlorophyll, which undoubtedly has a positive impact on crop, yields (Palé *et al.*, 2021; Koumbem*et al.,* 2022; Koumbem *et al.*, 2023). It has also been reported that ploughing improves soil aeration and microorganism activity, with good nutrient release for the benefit of plants (N'Dayegamiye, 2007). The effect is even more remarkable when ploughing was combined with an organo-mineral amendment. Ploughing and tied-ridging are thought to improve the physical properties of soils, specifically soil structure and particularly porosity (Traoré, 2012) thus allowing for additional gains in crop production.

The results also showed a significant decrease in corn grain yields in the second year of the study regardless of tillage method, which could be explained by continuous soil depletion over the years of cultivation. Indeed, prior to the trials, the plot was left fallow, which would have created a residual organic matter (OM) effect. This OM was beneficial to the first-year crops, thus improving yields. Previous investigations have shown that under corn production, soil OM decreases significantly, thus affecting long-term productivity (Balík *et al.*, 2020). The successive daily rainfalls during July and August in 2025 would have negatively impacted plant growth and productivity. Furthermore, the sandy surface texture of the soil at the study site, exacerbated by heavy rainfall during July and August, have favored vertical leaching of mineral elements applied through organo-mineral fertilization. Consequently, this phenomenon would have limited the effectiveness of the organo-mineral fertilization by carrying the minerals beyond the rhizosphere.

The results obtained also indicate that the association of maize and cowpea with an organo-mineral amendment had a significant impact on grain and stover yields of maize. This increase in production could be explained by the synergistic effect of the legume (cowpea), which ensures biological nitrogen fixation, and the organo-mineral amendment, which promoted nutrient availability and improved the soil's physical and chemical properties. In general, the results obtained are consistent with those of previous investigators who reported that cereal-legume intercropping improves soil fertility and water status, which in turn boosted productivity through better yields (Koumbem *et al.*, 2022). In the present study, it appears that alternating one or two rows of maize and cowpea with the addition of 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of urea on maize + 100 kg NPK ha^{-1} on cowpea + 2500 kg ha^{-1} of compost resulted in the highest grain yields. Cowpea, as a cover crop, helps retain soil moisture for several days, which benefits the associated maize plants (Koumbem *et al.*, 2022). It also improves nitrogen nutrition in maize through symbiotic nitrogen fixation. The results obtained in this study are consistent with other more recent studies. Indeed, Yizhe *et al.,*(2024) showed that intercropping maize with legumes increased the rate of denitrification in the rhizospheres, releasing nitrogen that supplements the needs of maize grown on nutrient-deficient soils in the Sudanian-sahelian zone. It is therefore important to improve soil fertility through optimal and efficient fertilization. Applying mineral fertilizers using the microdosing technique helps limit soil acidification (due to excess fertilizer) observed by (Hien, 2004). The fertilization level consisting of 200 kg ha^{-1} of NPK + 200 kg ha^{-1} of urea on maize + 100 kg NPK ha^{-1} on cowpea with 2500 kg ha^{-1} of compost (F4) resulted in higher yields. OM has so improved the physical and chemical properties and biological activity of soils.

Effect of the tested factors on cowpea productivity in association with maize.

Cowpea grain yields were significantly affected by the application of combined cropping systems and fertilization. Results showed that the alternation of one row of maize and one row of cowpea with application of 300 kg ha^{-1} of NPK + 100 kg ha^{-1} of 30N urea to maize and 100 kg NPK ha^{-1} to cowpea and addition of 2500 kg ha^{-1} of compost resulted in the highest yields of cowpea. These results can be explained by the positive synergistic effect offered by this cropping system with organo-mineral amendment. Indeed, the addition of compost leads to an improvement in soil physical, chemical, and biological properties, thus increasing structural stability and soil water retention capacity (Palé *et al.*, 2021). Furthermore, Sanou *et al.,*(2016) have shown that the use of compost, in addition to improving soil structure and soil water retention capacity, increases soil nutrient status. Combined with NPK fertilizer, compost helps increase agricultural production, particularly in low-fertility agro-ecosystems such as those in the Sudanian-sahelian zone. Also, according to Otieno *et al.,*(2024), the combined application of mineral and organic fertilizers improves microbial biomass, mineralization and the efficient use of nitrogen by crops. The soil thus benefits from a gradual source of nutrients for plant growth. In addition, the joint application of NPK and urea on maize and the application of NPK on cowpea allows for a targeted and balanced supply of nitrogen and phosphorus for better plant growth and good cowpea productivity in the Sudanian-sahelian zone (Balah *et al.*, 2024).

This availability of nutrients promotes good plant growth, resulting in better cowpea grain yields (Zhang *et al.*, 2025). Furthermore, intercropping maize and cowpea results in a balanced, more efficient use of nitrogen by the entire cropping system, therefore favoring more efficient use of soil resources.

CONCLUSION

This study was set up at the Saria Environmental and Agricultural Research Station to evaluate the effects of tillage and cropping systems with organo-mineral fertilization on maize and cowpea yields. The results showed that the tested factors influenced the productivity of both maize and cowpea. The use of alternated maize and cowpea rows (one or two) with mineral fertilizers on both crops in ploughed plots resulted in higher grain yields for maize compared to scarifying (control). In tied-ridging plots the alternation of two rows of maize and two rows of cowpea showed increased maize grain yield. Cowpea grain yields were only affected by cropping systems with soil amendments with higher cowpea grain yields occurring in plots where one row of maize alternated with one row of cowpea and fertilized with mineral fertilizers and compost which was applied before planting.

Based on these results, the following production practices can be recommended to ensure agricultural productivity in the Sudanian-sahelian zone of Burkina Faso:

- two-row or one-row alternating cropping systems with an application mineral fertilizers and compost and the use of ploughing or tied-ridging as tillage methods for maize production;
- one-row alternating cropping system with mineral fertilization and compost for cowpea production.

CONFLICT OF INTEREST

All authors who participated in this study declare that they have no conflicts of interest.

CONTRIBUTION OF AUTHORS

From the development of the research protocol to the fieldwork and the writing of the manuscript, all authors demonstrated their unwavering commitment and participation.

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