



Effect of Mixed Bovine and Ovine Stabling on Soil Properties and on Growth and Yield of Okra (*Abelmoschus esculentus* L. Moench.) in the Sudano-Sahelian Zone of Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. Author HO was the principal investigator and participated in all stages of the study and manuscript writing. Authors DG and AI participated in all stages of the study and manuscript writing. Authors AG, KFZ and AC contributed to the manuscript writing. Author EH provided scientific guidance for this work and the correction of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

In Burkina Faso, okra is one of the most important vegetable crops. Low soil fertility is one of the major constraints to okra production. The objective of this study was to evaluate the effect of mixed bovine and ovine stabling on soil properties and on growth and yield of okra in Sudano-Sahelian zone. The study was conducted during the 2023-2024 agricultural season. The experiment design used is a Randomized Complete Block Design with two treatments (with and without stabling) and four replications. The data collected are plant height, collar diameter, number of leaves, number of flowers, soil temperature and soil pH.

Results of the study showed that the stabling treatment (PR) recorded the highest pH (6.27), the highest fruit weight (137.62 g plant⁻¹) and the best fruit yield (2.75 t ha⁻¹), i.e. a yield gain of 17.62% compared to the control (TA). These results highlight that mixed cattle and sheep stabling, a source of organic matter, improves the soil and okra productivity. Thus, the practice of stabling could be an alternative to restore the soil and boost okra production in the Sudano-Sahelian zone of Burkina Faso.

Keywords: Stabling; okra; bovine manure; Boudtenga; soil restoration; Burkina Faso.

1. INTRODUCTION

Burkina Faso's economy is based on the agricultural sector. It contributes 16.3% to GDP formation (INSD, 2024). Market gardening is practiced by a small proportion of households (11.9%) and rural households practice much more than urban households (INSD, 2023). Indeed, 12.6% of households in rural areas practice market gardening compared to 7.2% of households in cities. Okra production is an important part of production with 23632 tons in 2023 (FAOSTAT, 2025) and the 6th place after eggplant in rural areas. Okra (*Abelmoschus esculentus* L.) is a fruit vegetable belonging to Malvaceae family, cultivated for its fruits and leaves in Burkina Faso. Okra is a high-value crop because it is a source of nutrients important to human health, such as vitamins, potassium, calcium, carbohydrates, dietary fiber, and unsaturated fatty acids such as linolenic and oleic acids (Durazzo et al., 2018; Hasan et al., 2025) and is commonly used in different industrial sectors. The fruits, seeds, and leaves of okra have applications due to their composition and properties. This is because the seeds are rich in α -tocopherol and have high levels of minerals, including calcium, potassium, copper, iron, phosphorus, magnesium, zinc and manganese (Dantas et al., 2021). Despite these performances, okra production faces constraints including water insufficiency and low soil fertility.

Water, land degradation and low natural soil fertility had been identified as major constraints to agricultural production in sub-Saharan Africa. This situation is explained by erratic rainfall, water erosion and anthropogenic pressure. In Burkina Faso, irrigation systems have been set up with the aim of contributing to better water management. In addition, many works have indicated that organic amendments increase porosity, improve structure and structural stability, improve water retention capacity, mineralization of soil mineral elements (N'Dayegamiye et al., 2005; Mukalay et al., 2008; Diakit   et al., 2020). Thus, based on the potential of okra in this context of precarious rainfall associated with the continuous degradation of the soil, it is therefore essential to consider an improvement in okra yields. It should consider the restoration of soil capital and smart water management. The present work aims to assess the influence of animal stabling on the soil and the productivity of okra.

2. MATERIALS AND METHODS

2.1 Study Site

The study was conducted on the Henri Christiane farm. This farm is located in the village of Boudtenga, about 35 km east of Ouagadougou, between the parallels of 12.48639   and 12  29' 11" north latitude and the meridians -1.26583  

and 1°16'57" west longitude. Its altitude is 320 m. It is part of the department of Saaba, province of Kadiogo and is located in the North Sudanese phytogeographical domain (Guinko, 1984).

2.2 Plant Material

Okra (*Abelmoschus esculentus* L.) is the plant material used in our study. It is the hybrid variety Rokia F1 with a seed-to-maturity cycle of 40 days.

2.2.1 Experimental design and agronomic management

The experimental device used is a Randomized Complete Block Design with two treatments and four replications. The factor studied is the application of organic manure at two levels of variation: with and without penning of animals. The total surface area of the system is 211.2 m² and consists of elementary plots with an area equal to 42.24 m². The dimension between the elementary plots was 0.5 m. The parking lot left animal faeces on site. The trial was set up after ploughing using a motorized machine. Sowing was carried out on moist soil at the rate of one seed per pocket. Three weedings were carried out 14 days after sowing, 22 days and 36 days followed by ridging at 57 days.

2.2.2 Collected parameters

To assess okra productivity and soil fertility dynamics, the following data were collected: plant height, diameter at the collar, number of leaves, number of flowers, soil temperature, and soil pH.

- ✓ **The height of the plants:** this was measured using a tape measure.
- ✓ **The number of leaves:** it was evaluated by counting the number of leaves produced per plant as they appeared.
- ✓ **The number of flowers:** it was evaluated by counting the number of flowers produced per plant as they appeared.

- ✓ **The number of fruits:** this was obtained by counting the number of viable fruits per plant.
- ✓ **The diameter at the collar of the plants:** it was measured using a digital caliper.
- ✓ **The pH and temperature of the soil:** these were taken using an electronic pH meter with a probe (Soil tester).

2.2.3 Data processing and statistical analysis

The different means and standard deviations are calculated using the EXCEL version 2019 software and the analysis of variance (ANOVA) is performed using R software version 3.5.2. The significant differences between the means were highlighted using the Student-Newman-Keuls (SNK) test at the 5% probability threshold.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Effects of treatments on plants height, number of leaves, number of flowers, number of fruits, diameter at the collar and temperature of soil

The analysis results showed that the treatments had no significant effect on height ($P=0.0547$), collar diameter ($P=0.0522$), number of leaves ($P=0.811$), number of flowers ($P=0.134$), and number of fruits ($P=0.477$). Also, there was no statistically significant difference between the effects of the treatments on soil temperature (Table 1).

3.1.2 Effects of treatments on soil pH

Analysis of the results revealed that the pH of the soils studied ranged from 5.96 ± 0.24 to 6.27 ± 0.15 . The soil under the PR treatment was less acidic than that under the TA treatment ($P=0.0162$). The application of animal manure led to a significant increase in soil pH from 5.96 (TA) to 6.27 (PR).

Table 1. Plant growth parameters and soil temperature under treatments

Treatment	Height (cm)	Diameter at collar (mm)	Number of leaves per plant	Temperature (°C)	Number of flowers per plant	Number of fruits per plant
TA	46.08 ± 2.12^a	14.50 ± 1.43^a	33.64 ± 2.62^a	30.56 ± 0.48^a	1.82 ± 0.58^a	4.18 ± 0.77^a
PR	41.58 ± 1.89^a	11.90 ± 1.61^a	34.41 ± 2.28^a	30.65 ± 0.31^a	1.25 ± 0.29^a	4.56 ± 0.63^a
P-Value	0.0547	0.0522	0.811	0.409	0.134	0.477

TA: Control; PR: Mixed bovine and ovine stabling. Means with the same letters were not significantly different at $p \leq 0.05$

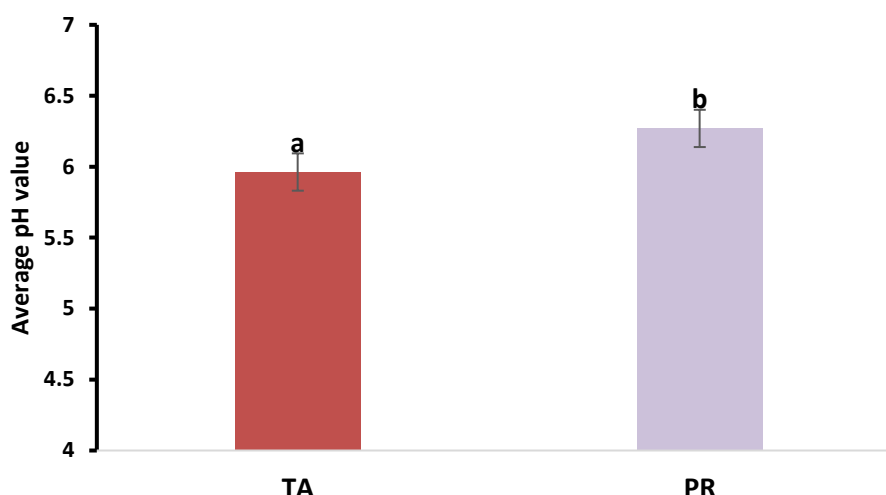


Fig. 1. Effects of treatments on soil pH

PR: stabling and TA: Absolute control

3.1.3 Effects of treatments on okra fruit yield

The results obtained for okra fruit yield show a statistically significant difference ($P = 0.00419$). Treatments have an influence on fruit productivity. The highest weights were recorded in okra in plots under penning. Okra cultivation has better performance on the ground under the pen. The penning has led to an increase in the weight of the fruit by 17.62% compared to the TA.

3.1.4 Relationship between pH, temperature and plant parameters

Fig. 3 shows the interactions between pH and the parameters of the plants studied. Principal component analysis (PCA) revealed that pH and temperature are positively correlated with the number of leaves, flowers and fruits and yield. Also, the number of leaves, flowers and fruits are positively correlated with diameter and height. However, a negative relationship was observed between pH, temperature, and yield with diameter and height.

3.2 Discussion

3.2.1 Effects of treatments on soil pH

The pH of the soil under mixed animals waste is less acidic than that of the control soil. The stabling of the animals led to an increase in the pH units of the soil and therefore reduced the

acidity of the soil. The mixture of cattle and sheep manure exerted a significant influence on soil chemistry. These results are in line with those obtained by Naramabuye & Haynes, (2006) who found that the pH of the soil treated with cattle manure was higher than the control soil. Also, similar results were found by Cairo-Cairo et al., (2023) and Citak & Sonmez, (2011) which have shown that manure increases the pH of the soil. Also, Ano & Ubochi, (2007) had reported a steady increase in soil pH following the application of cow manure. The increase in pH recorded is attributable to the organic matter content. The penning of animals is a source of organic matter. The corrective effect of soil pH by organic matter had been widely demonstrated (Hien, 2004; Koull, 2007; Adamou et al., 2009). In addition, the increase in pH can be attributed to calcium carbonate and bicarbonate in manure (Whalen et al., 2000; Eghball et al., 1996). The addition of cations such as Ca and Mg (L'Herroux et al., 1997) and the presence of organic anions in manure can neutralize H^+ ions (Butterly et al., 2013). Other authors had found that sheep manure significantly reduced soil acidification and increased soil pH (De Souza et al., 2023; Traoré et al., 2021). Thus, animal excrement from penning could be an alternative for regulating the pH of the soil.

3.2.2 Effects of treatments on okra fruit weight and yield

The analysis of variance shows that the treatments significantly influenced the fresh weight of okra. Animal stabling recorded the highest number of fruits per plant and the highest fruit weight. The heaviest fruits were observed in the plots under stabling. Indeed, the mixture of bovine and sheep manure made it possible to note a 17.62% gain in fruit weight compared to the control. Our results corroborate those of Moyin-Jesu, (2007) which had shown that the

application of 6 t ha⁻¹ of plant residues increased okra fruit yield. Also, Abdou et al., (2022) found that cattle manure allowed for higher weights of okra fruit than absolute control. This influence on the weight of the fruit is explained by the addition of excrement from the penning (Ncuuri et al., 2023). Adding compost to the soil led to improve soil health and okra growth (Nengi-Benwari & Abah, 2025). These droppings

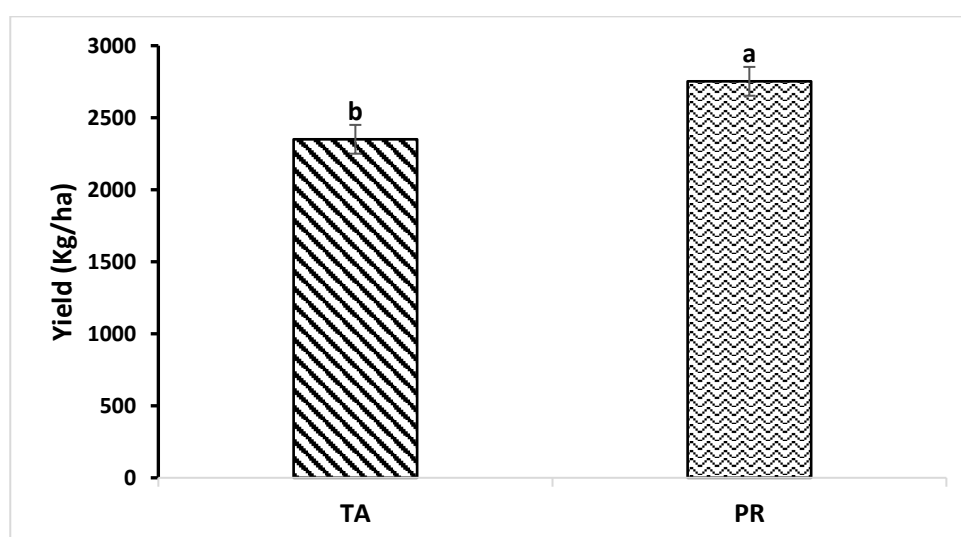


Fig. 2. Effects of treatments on okra yield

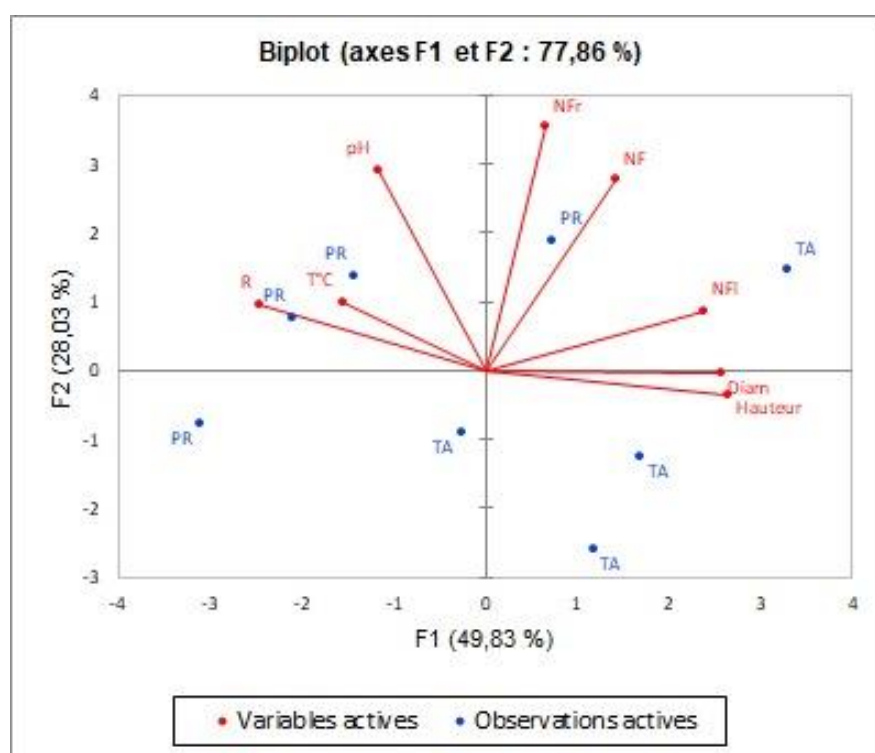


Fig. 3. Principal Component Analyses (PCAs) between pH, temperature and agronomic parameters of okra

increase the organic matter content (Adekiya et al., 2020) and improves soil pH. Yet, organic matter has multiple benefits due to the balanced supply of nutrients, including micronutrients, increased availability of soil nutrients due to increased soil microbial activity, decomposition of harmful elements, improvements in soil structure and root development, and increased availability of soil water (Han et al., 2016). Furthermore Maheshbabu et al., (2008) had indicated that the addition of manure helped boost crop yields. Also, the analysis of the main component showed a strong and positive correlation between pH and fruit weight. Indeed, the more the pH value tends towards neutrality, the more heavy fruits are formed. Thus, this improvement in pH promotes the assimilation of nutrients by the plants (Genot et al., 2009) of okra. This improvement in pH also leads to an improvement in nitrogen and carbon content. Indeed, authors had mentioned a very positive correlation between the increase in the pH value and the increase in the carbon and mineralizable nitrogen content of the soil (Andersson et al., 2000; Curtin et al., 1998; Neina, 2019). The weight of okra fruit under the penning is high compared to the control. This increase in weight is explained by the improvement in pH due to the dissolution of organic matter resulting from the decomposition of bovine and sheep manure. The consequence of dissolved organic matter is the increase in mineralizable C and N and stimulates phosphorus uptake. Thus, nitrogen is used by the plant to strengthen fruiting and fresh weight (Yang et al., 2023) as it is essential for the growth and development of fruit trees and is therefore a key factor in determining productivity (Zhao et al., 2008). Moreover, phosphorus fertilization significantly improves vegetative growth parameters and yield performance of okra (Hasan et al., 2025) and farmyard manure increased okra yields by more than 50% (Thakur, 2025). In addition, an analysis of the carbon and nitrogen and assimilable phosphorus contents should be carried out to confirm this dependence. Mixing cattle and sheep manure is an alternative to regulate pH and increase soil organic matter content for increased okra productivity in Burkina Faso.

4. CONCLUSION

The study consisted of evaluating the influence of mixed cattle and sheep pens on the soil and

okra productivity in the Sudanian zone of Burkina Faso. The results revealed that penning positively affects soil chemistry ($P=0.0162$) and okra yield ($P = 0.00419$). The highest pH values and fruit weight are recorded under the mixed cattle and sheep penning treatment. Thus, these results highlight that it is possible to improve okra productivity through the practice of penning. Therefore, the adoption of penning could be a good alternative to restore soils, improve the availability of organic matter and increase okra productivity in the Sudano-Sahelian zone of Burkina Faso.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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