

Effects of Organic Manure Types on Yield Components of Common Bean (*Phaseolus vulgaris* L.) Varieties in Eastern Zambia

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ABSTRACT

A field study was conducted at Chipata College of Education in Eastern Zambia to evaluate how different types of organic manure influence the performance of four locally cultivated bean varieties: Solwezi Rose, Red Kidney, Pink Speckled, and White Striped. The experiment was carried out over two growing seasons (rainy and winter) using a Randomized Complete Block Design (RCBD) with four replications. Key yield parameters assessed included seed mass, biomass production, number of pods per plant, and number of seeds per pod. The results showed that manure type significantly influenced biomass production and pod number ($p < .05$), with rabbit manure consistently producing the best results. However, no significant differences were observed in seed mass and number of seeds per pod ($p > .05$), suggesting that these traits are largely controlled by genetic factors. Overall, the findings indicate that while organic manure improves certain growth parameters, varietal characteristics play a major role in determining final yield outcomes. The study highlights the importance of matching manure types with suitable crop varieties to enhance productivity and sustainability in smallholder farming systems.

1. Introduction

Common beans (*Phaseolus vulgaris* L.) are among the most important legume crops in Zambia, contributing significantly to household food security, nutrition, and income generation. They are widely grown by smallholder farmers, often intercropped with maize, and serve as an affordable source of protein. Despite their importance, bean yields in Zambia remain below their potential due to declining soil fertility, continuous cropping, and limited access to inorganic fertilizers. Soil nutrient depletion is a major constraint to crop productivity across sub-Saharan Africa (Vanlauwe *et al.*, 2010). The high cost of inorganic fertilizers makes them inaccessible to many farmers, increasing interest in alternative soil fertility management practices such as organic manure use. Organic manures not only supply nutrients but also improve soil structure, enhance microbial activity, and increase water retention (Palm *et al.*, 2001). Although the benefits of organic manure are well established, there is limited information on how different manure types influence specific bean varieties under local conditions. Most previous studies have focused on general crop responses, overlooking varietal differences. This creates a gap in understanding how best to match manure types with specific crop genotypes. Therefore, this study aimed to evaluate the effects of four types of animal manure (kraal, poultry, pig, and rabbit manure) on the yield components of four commonly grown bean varieties in Eastern Zambia.

2. Literature Review

Organic manure is widely recognized for its important role in improving soil fertility and enhancing crop productivity, particularly in leguminous crops such as beans. Previous studies have consistently reported improvements in plant growth and yield following manure application. For example, Shafeek *et al.* (2017) found that cattle manure significantly increased bean yield and growth parameters, while Sitinjak and Purba (2018) reported a 24% increase in green bean production with the use of chicken manure. Similarly, Prabhakar *et al.* (2011) observed that organic manure supplying recommended nitrogen levels enhanced overall crop performance. These findings highlight the effectiveness of organic manure as a sustainable alternative to inorganic fertilizers. The benefits of organic manure extend beyond beans to other legumes. Mahmoud *et al.* (2013) reported improved vegetative growth in pea plants, which was attributed to enhanced soil properties such as increased organic matter content, improved soil structure, and greater microbial activity. These improvements contribute to long-term soil fertility and support sustainable agricultural systems. In sub-Saharan Africa, organic manure plays a particularly important role in low-input farming systems where access to inorganic fertilizers is limited (Ayoola & Makinde, 2009; Mugwe *et al.*, 2009). In Zambia, where agriculture is largely rain-fed, the use of organic inputs is essential for maintaining soil productivity and improving crop resilience. However, crop responses to organic manure are not always consistent and may vary depending on factors such as manure type, application rate, soil conditions, and crop variety. Some studies suggest that differences among manure types may not result in significant yield variations once basic nutrient requirements are met. Under such conditions, environmental factors and plant genetics may exert a stronger influence on crop performance. This observation is consistent with the findings of the present study, where certain yield components were not significantly affected by manure type. This suggests that genetic and environmental factors play a crucial role in determining these traits. Overall, while organic manure improves soil health and supports plant growth, its effects on specific yield components are often context-dependent, highlighting the need for location-specific research.

3. Data Analysis and Results

Data were analyzed using Two-Way ANOVA in IBM SPSS (Version 20) at a 95% confidence level.

3.1 Pods per Plant

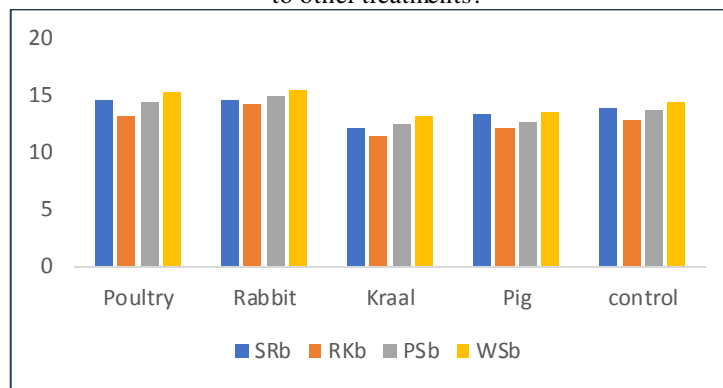
The ANOVA results (Table 1) showed that manure type (p = .011) and bean variety (p = .023) significantly affected pod number.

Table 1: ANOVA results for pods per plant

Source	SS	Df	MS	F	P
Variety	10.23	3	3.41	4.53	.023
Fertilizer	15.67	4	3.92	5.21	.011
Error	12.05	12	1.00		

Rabbit manure produced the highest pod numbers across most varieties.

Figure 1. Pods per Plant by Manure Type: A bar chart illustrating higher pod numbers under rabbit and poultry manure compared to other treatments.



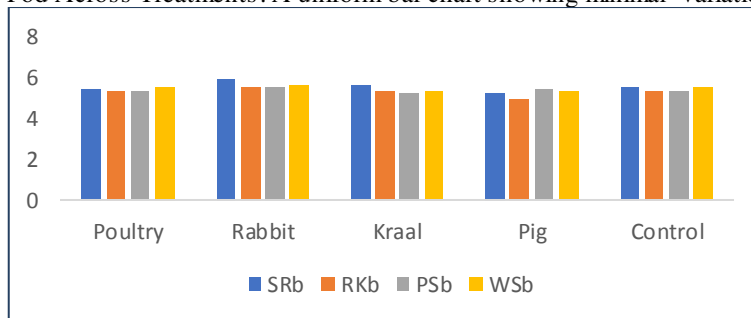
3.2 Seeds per Pod

No significant differences were observed for seeds per pod (Table 2).

Table 2: ANOVA results for seeds per pod

Source	SS	df	MS	F	P
Variety	0.24	3	0.08	1.53	.254
Fertilizer	0.42	4	0.105	2.01	.157
Error	0.63	12	0.052		

Figure 2. Seeds per Pod Across Treatments: A uniform bar chart showing minimal variation among treatments.



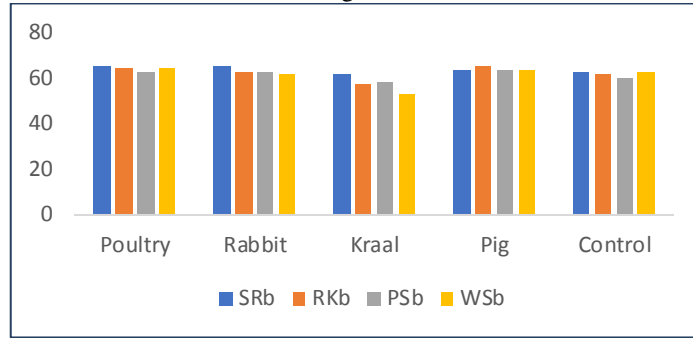
3.3 Seed Mass

Seed mass showed no statistically significant differences (Table 3), although manure effects approached significance.

Table 3: ANOVA results for seed mass

Source	SS	df	MS	F	P
Variety	24.19	3	8.06	0.65	.597
Fertilizer	154.19	4	38.55	3.12	.056
Error	148.21	12	12.35		

Figure 3. Seed Mass Variation Across Treatments: A bar chart showing small differences, with poultry and pig manure slightly higher.



3.4 Biomass Production

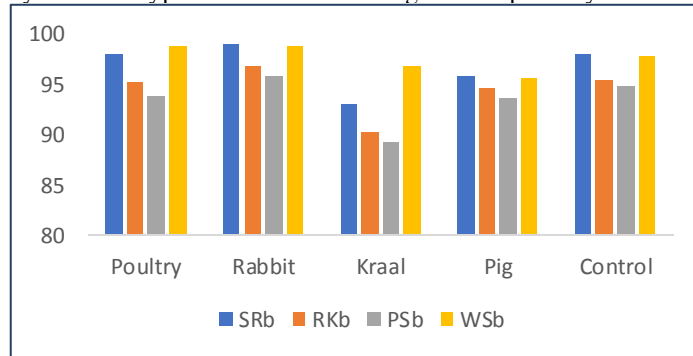
Biomass was significantly influenced by manure type (p = .007) and variety (p = .029)

Table 4: ANOVA results for biomass

Source	SS	df	MS	F	P
Variety	24.19	3	8.06	4.21	.029
Fertilizer	44.59	4	11.15	5.82	.007
Error	23.01	12	1.92		

Rabbit manure produced the highest biomass across all varieties.

Figure 4. Biomass Production by Manure Type: A bar chart showing clear superiority of rabbit manure in biomass production.



4.5 Discussion

The results of this study show that organic manure had a significant effect on biomass production and pod formation, suggesting that these aspects of growth are highly responsive to nutrient availability. Among the treatments, rabbit manure produced the best results, which may be attributed to its relatively fast nutrient release and balanced nutrient composition (Palm *et al.*, 2001). This supports previous findings that organic manures enhance plant growth and yield by improving nutrient supply and overall soil conditions.

In contrast, seed mass and the number of seeds per pod were not significantly influenced by manure type. This indicates that these traits are largely controlled by genetic factors rather than soil nutrient inputs. Similar observations have been reported in other leguminous crops, where reproductive traits tend to remain stable across different fertility conditions (Giller, 2001). This suggests that once the basic nutrient requirements of the crop are met, additional nutrient inputs may not lead to noticeable changes in certain yield components, reflecting the principle of diminishing returns.

Overall, these findings are consistent with existing literature, which shows that while organic manure improves soil fertility and supports plant growth, its effects on specific yield components can vary depending on the context. The results highlight the importance of combining effective soil fertility management with appropriate varietal selection to optimize both vegetative growth and reproductive performance in bean production systems.

4. Conclusion and Recommendations

4.1 Conclusion

Based on the findings of this study, it can be concluded that both manure type and bean variety significantly influenced biomass production and the number of pods per plant, with rabbit and poultry manure showing the best performance. However, the number of seeds per pod and seed mass were not significantly affected by manure type, indicating that these yield components are largely determined by genetic factors rather than nutrient inputs.

These results demonstrate that different yield traits respond differently to soil fertility management. While vegetative growth and pod formation are highly sensitive to nutrient availability, reproductive traits tend to remain stable across treatments. Furthermore, although the overall effect of manure type on some yield components may be limited, the combined nutrients in organic manures play an important role in promoting plant growth, particularly in biomass accumulation.

This study contributes to a better understanding of how different organic manure types influence common bean productivity under local conditions. It also provides useful insights for improving soil fertility management practices. However, the findings are limited to the specific conditions of the study area, and further research is needed to assess long-term effects, nutrient interactions, and performance across different agroecological zones.

4.2 Recommendations

Based on the results, all the tested organic manures can be used to achieve comparable pod and seed production. However, rabbit manure, followed by poultry manure, is recommended for maximizing biomass production and overall plant performance. Farmers are encouraged to combine suitable manure types with appropriate bean varieties and adopt sustainable farming practices such as crop rotation, residue management, and soil conservation.

Future research should focus on increasing sample sizes, testing under different environmental conditions, and evaluating additional manure types to develop more reliable and location-specific recommendations. Long-term studies will also be important in guiding farmers and policymakers toward informed decisions that improve productivity, sustainability, and soil health in common bean production systems.

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