

A COMPARATIVE ANALYSIS OF HETEROSIS IN TWO-WAY VERSUS THREE-WAY CROSSBREEDING SYSTEMS FOR GROWTH AND CARCASS TRAITS IN RABBITS UNDER SAVANNAH ZONES OF NIGERIA

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ABSTRACT

This study investigated the comparative analysis of heterosis expression in two-way versus three-way crossbreeding systems for growth and carcass traits in rabbits under the savannah zones of Nigeria. The three-way crossbred rabbits exhibited superior growth performance compared to their two-way counterparts, with significant differences in average daily gain (ADG) and final body weight, suggesting that hybrid vigour enhances growth rates. The carcass traits, revealing that three-way crosses have higher dressing percentages and better meat quality attributes. Reproductive performance metrics suggest that three-way crosses may have a slight edge in litter size and survival rates. Genetic diversity assessment confirms that three-way breeding systems maintain greater genetic variability, which is crucial for resilience against diseases and environmental changes. This study underscores the advantages of three-way crossbreeding systems over two-way systems for optimizing rabbit production in Nigeria's savannah zones.

Keywords: Heterosis, Crossbreeding, Rabbit Production, Growth Performance, Carcass Traits

INTRODUCTION

Heterosis refers to the phenomenon where crossbred individuals exhibit superior traits compared to their purebred counterparts. This concept is particularly significant in livestock production, including rabbit farming, where growth rates and carcass quality are critical for economic viability. In Nigeria's Savannah zones, which are characterized by specific climatic conditions and forage availability, understanding the expression of heterosis in different breeding systems can enhance rabbit production efficiency. Previous studies have shown that both two-way and three-way crossbreeding systems can influence growth and carcass traits; however, a comparative analysis of these systems specifically in the context of Nigerian Savannah is limited (Ogunlade *et al.*, 2020; Akinola *et al.*, 2021). Rabbit farming has gained prominence in Nigeria due to its potential for rapid growth and high reproductive rates. The Savannah zones present unique challenges and opportunities for rabbit production, including variations in temperature, humidity, and feed resources (Ogunbiyi *et al.*, 2019).

In rabbits specifically, research indicates that crossbreeding can significantly enhance growth rates and carcass traits compared to purebreds (Moussa *et al.*, 2018). Two-way crosses involve mating two distinct breeds, while three-way crosses incorporate an additional breed into the mix. The latter is hypothesized to yield greater heterotic effects due to increased genetic diversity (Khalil and El-Sayed, 2007). However, empirical data comparing these two systems within the Nigerian context remains scarce. Despite the recognized benefits of heterosis in livestock production, there is a lack of comprehensive data on how different crossbreeding strategies affect growth and carcass traits specifically in rabbits raised in Nigeria's Savannah zones. Existing literature often focuses on either two-way or three-way crosses independently without direct comparisons under similar environmental conditions. This gap limits farmers' ability to select optimal breeding strategies that could maximize productivity and profitability.

This study is justified by the need for empirical evidence regarding the performance differences between two-way and three-way crossbreeding systems in rabbits within Nigeria's Savannah zones. By providing a comparative analysis of heterosis expression related to growth and carcass traits, this research will contribute valuable insights that can inform breeding decisions among rabbit farmers. This study aims to compare the growth performance of rabbits from two-way versus three-way crossbreeding systems to evaluate carcass traits, assess the expression of heterosis in terms of weight gain and meat quality.

MATERIALS AND METHODS

Site

The research was conducted at Federal college of Forestry, Research unit, Jos.

Experimental design

The study utilized a randomized complete block design (RCBD) to minimize environmental variability.

Rabbit Breeds: The following breeds were included in the study

New Zealand White (NZW), Californian and Local Breed - Indigenous rabbits adapted to local conditions. A control group consisting of purebred NZW was also maintained for comparison purposes.

Crossbreeding Systems

Two-Way Crossbreeding: Combinations of NZW and Californian rabbits. Three-Way Crossbreeding: Combinations involving NZW, Californian, and the local breed. Each breeding system aimed to assess growth performance and carcass traits through various metrics.

Sample Size

A total of 120 rabbits were used in the study, with 40 rabbits allocated to each breeding system (two-way and three-way). Each group consisted of equal numbers of males and females to ensure balanced representation.

Data Collection

Data were collected on growth traits (body weight, daily weight gain) and carcass traits (dressing percentage, carcass weight). Measurements were taken at regular intervals:

Statistical analysis

Data were analysed using Statistical Package for Social Sciences (SPSS) version 25.0. Analysis of variance (ANOVA) was performed to determine the significant differences between groups, followed by Duncan's multiple range test for mean separation at a significance level of $p < 0.05$. Heterosis values for growth traits was calculated using the formula: $\text{Heterosis (\%)} = [(F1 - P_{\text{avg}}) / P_{\text{avg}}] \times 100$, where F1 is the mean performance of the hybrid offspring and P_{avg} is the average performance of the parental lines.

RESULTS AND DISCUSSION

The results and discussion focus on the comparative analysis of heterosis expression in two-way versus three-way crossbreeding systems. Table 1 shows the growth performance of two-way vs. three-way crossbred rabbits.

Table 1: Growth Performance of Two-Way vs. Three-Way Crossbred Rabbits

Trait	Two-Way Cross (Mean $\pm$ SD)	Three-Way Cross (Mean $\pm$ SD)	p-value
Body Weight at Weaning (g)	800 $\pm$ 50	850 $\pm$ 45	0.03*
Average Daily Gain (g/day)	40 $\pm$ 5	45 $\pm$ 4	0.02*
Feed Conversion Ratio	3.0 $\pm$ 0.2	2.8 $\pm$ 0.15	0.04*

The results showed that three-way crossbred rabbits generally exhibit superior growth performance compared to their two-way counterparts. This aligns with previous studies that suggest increased heterosis can lead to enhanced growth rates due to better genetic combinations (Khalil and El-Sayed, 2007). The average weight gain observed in three-way crosses may be attributed to the additive genetic effects and dominance interactions among diverse parental lines as reported by Akinola *et al.* (2021). This can be attributed to the increased genetic diversity present in three-way crosses, which enhances vigour and adaptability under varying environmental conditions typical of the savannah zones in Nigeria (Ogunbiyi *et al.*, 2019).

Carcass traits between two-way and three-way crossbreds is shown on Table 2. The three-way crosses not only had higher Hot carcass weight 0.3kg, dressing percentages 2% higher but also exhibited better muscle-to-fat ratios and 3% higher in three ways than two ways cross breeding. These results

corroborate the findings of Adebambo *et al.* (2015), who noted that hybrid vigour contributes positively to carcass quality traits. Research by Ige *et al.* (2021). supports this observation, noting that the hybrid vigour associated with three-way crosses contributes to improved carcass characteristics.

Table 2: Carcass Traits Comparison Between Breeding Systems

Trait	Two-Way Cross (Mean $\pm$ SD)	Three-Way Cross (Mean $\pm$ SD)	p-value
Hot Carcass Weight (kg)	2.5 $\pm$ 0.3	2.9 $\pm$ 0.25	<0.01*
Dressing Percentage (%)	60 $\pm$ 3	62 $\pm$ 2	<0.05*
Lean Meat Percentage (%)	55 $\pm$ 4	58 $\pm$ 3	<0.05*

Reproductive performance is a key determinant of the sustainability of breeding programs. In three-way crossbreds exhibited higher litter sizes and improved reproductive rates compared to two-way crosses as indicated in table 3. This observation is consistent with previous studies indicating that hybrid vigour can lead to improved reproductive outcomes under optimal management conditions (Ogunbiyi *et al.*, 2019)). This finding supports previous research which suggests that hybrid vigour can enhance reproductive traits through increased fertility and litter viability (Ogunlade *et al.*, 2020). Effective reproduction strategies are crucial for maintaining herd size and ensuring economic viability.

Table 3: Reproductive Performance Metrics

Metric	Two-Way Cross (Mean $\pm$ SD)	Three-Way Cross (Mean $\pm$ SD)	p-value
Litter Size	6 pups	7 pups	<0.05*
Weaning Success Rate (%)	75%	85%	<0.01*

Genetic Diversity Assessment

Genetic diversity is crucial for the adaptability and resilience of livestock populations, three-way crossbreds possess greater genetic variability than two-way crosses, which can lead to improved adaptability under changing environmental conditions typical of the Savannah zones of Nigeria as in table 4. Research has demonstrated that maintaining high levels of genetic diversity enhances population stability against diseases and environmental stressors (Moussa *et al.*, 2018). Research by Adebambo *et al.* (2015) supports this finding, highlighting the importance of maintaining genetic diversity within breeding programs to ensure long-term sustainability.

Table 4: Genetic Diversity Assessment

Heterozygosity	Two-Way Cross (% Heterozygosity)	Three-Way Cross (% Heterozygosity)	P-value
Level	30%	40%	<0.01*

CONCLUSION AND RECOMMENDATION

Implementing a three-way crossbreeding system could optimize growth traits, crucial for meat production efficiency. Hybrid vigour enhance reproductive traits through increased fertility and litter viability. Three-way crossbreeding system are very important for rabbit production systems of Rabbits, aiming at maximizing meat yield, effective reproduction strategies are crucial for maintaining herd size and ensuring economic viability. Further-more, three-way crossbreeding system is importance in maintaining genetic diversity within breeding programs to ensure long-term sustainability.

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