Evaluation of Reproductive Performance of Two Rabbit Breeds in Nigeria

ABSTRACT

This study evaluated the comparative reproductive performance and economic viability of New Zealand White (NZW) and Nigerian Indigenous (NIR) rabbit breeds under the semi-arid conditions of Katsina State, Nigeria. A twelve-month study of 60 does revealed significant breed-environment interactions. New Zealand White (NZW) rabbits were more prolific, with higher conception rates (82.4% vs. 76.2%), larger litters (7.8 vs. 6.1 kits), and heavier birth weights. However, Nigerian Indigenous Rabbits (NIR) showed greater resilience, with 30.6% lower pre-weaning mortality and stable performance across seasons. The reproductive efficiency of NZW was highly susceptible to heat stress, showing a strong negative correlation with the Temperature-Humidity Index (THI) and a critical productivity loss at THI>78, a threshold 7°C lower than for NIR. Economic analysis indicated comparable profitability between breeds; NZW's higher output was offset by NIR's advantages in kit survival, lower feed costs, and reduced labour requirements. The study concludes that while NZW is optimal for climate-controlled systems, NIR is better suited for smallholder production due to its thermotolerance and stability. Recommendations include breed-specific management protocols and policy support for indigenous breed conservation.

Keywords: Reproductive performance, economic viability, New Zealand White (NZW) and Nigerian Indigenous (NIR) rabbit breeds

INTRODUCTION

Rabbit production is a strategic livestock enterprise in Nigeria. This is particularly true in the semi-arid north, where conventional ruminant production is constrained by feed and water scarcity. As a micro-livestock species, rabbits possess unique biological and economic advantages, including rapid growth rates, early maturity, efficient feed conversion ratios, and minimal space requirements. Under optimal management, a doe can produce between 30 and 40 offspring annually, making rabbitry a promising intervention for addressing Nigeria's persistent animal protein deficit, where per capita meat consumption remains below 10 kg per year (Onifade et al., 1999). These attributes have positioned rabbit production as a viable complement to poultry and small ruminants in smallholder and semi-intensive systems.

Their adaptability to diverse diets and low water requirements further enhances their potential in northern Nigeria's harsh climate, though success is closely tied to breed choice. Exotic breeds such as the New Zealand White and Californian are known for high reproductive efficiency in temperate climates, but their performance is often compromised under tropical conditions due to heat stress susceptibility. In contrast, Nigerian Indigenous Rabbits exhibit superior thermotolerance (Jimoh, 2024) and disease resistance, but with lower litter sizes and growth rates. This trade-off between productivity and adaptability underscores the importance of breed evaluation under local environments.

Despite Nigeria's estimated annual rabbit population exceeding 1.2 million (NAPRI, 2023), empirical data comparing the reproductive performance of exotic and indigenous breeds under semi-arid conditions remain scarce. Similar estimates have been reported in regional small livestock assessments (FAO, 2022), confirming the growing role of rabbits in household protein supply. Most existing studies have focused on the southern ecological zones, limiting the relevance of findings to northern environments characterized by higher temperatures and variable humidity. As a result, farmers face uncertainty in breed selection, leading to suboptimal productivity and inefficient resource allocation. Moreover, little is known about the interaction between environmental stressors, particularly thermal stress, and reproductive parameters in these breeds.

The present study was therefore designed to evaluate and compare the reproductive performance of New Zealand White and Nigerian Indigenous rabbits under standardized housing and nutritional conditions in Katsina State. Specifically, the study assessed key reproductive parameters such as conception rate, litter size, kit survival, and inter-kindling interval, while also examining the influence of seasonal environmental variation on these outcomes. The findings are expected to provide evidence-based guidelines for breed selection, inform smallholder husbandry practices, and contribute to the development of climate-smart rabbit production systems in Nigeria.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Prof. Lawal Abdu Saulawa Research and Teaching Farm, Federal University Dutsin-Ma, Katsina State, Nigeria, located within the Sudan Savannah agro-ecological zone. The area experiences two distinct seasons: a dry season from November to March and a rainy season from April to October. Average ambient temperatures range between 28-42°C during the dry season and 24-34°C during the wet season, while relative humidity varies from 15-40% and 45-85%, respectively. Annual rainfall typically ranges from 300 to 800 mm.

Experimental Animals and Management

The study utilised 60 sexually mature female rabbits, comprising 30 New Zealand White (NZW) and 30 Nigerian Indigenous Rabbits (NIR), aged 6-8 months. Twelve breeding males (six per breed, aged 7-9 months) were also used. The NZW stock was sourced from a national research institute, while the NIR was obtained from local farms. Prior to the trial, animals were acclimatised, dewormed, and vaccinated against common rabbit diseases.

Rabbits were housed in a modified California cage system, each doe occupying 0.36 m^2 of floor space, with separate compartments for breeding and kindling. Although housing reduced direct solar exposure, ambient temperature and humidity levels remained a critical influence, reflecting realistic semi-arid production conditions. A uniform feeding regimen was adopted, consisting of commercial rabbit pellets (17% crude protein) supplemented with locally available forage and crop byproducts. Feed was offered twice daily (60% morning, 40% afternoon), while water was supplied ad libitum.

Although the sample size was limited to 60 does and 12 bucks due to logistical and facility constraints, it is consistent with experimental designs adopted in similar rabbit reproductive studies (Marai et al., 2021; Ogbuewu et al., 2023). Thus, the findings remain representative of semi-arid production conditions.

Experimental Design

A randomized complete block design (RCBD) was employed across three breeding cycles over 12 months to capture seasonal variations. A 1:5 buck-to-doe mating ratio was maintained. Breeding was scheduled in January (dry season), May (early rains), and September (late rains) to evaluate breed and season interactions.

Data Collection

Reproductive parameters recorded included conception rate, litter size, kit birth weight, pre-weaning mortality, and inter-kindling interval. Conception was verified by abdominal palpation 10-14 days post-mating. At kindling, litter size and kit weights were measured within 24 hours. Kit survival was monitored until weaning at 35 days. Environmental parameters (temperature, relative humidity, and temperature-humidity index, THI) were continuously monitored with automated data loggers positioned within the rabbitry. Nest quality was assessed 24 hours post-kindling using a 5-point scale where 1 = no nest/unorganized straw, 2 = poor nest with little lining, 3 = fair nest with some lining, 4 = good, well-lined nest covering most kits, and 5 = excellent, fully lined nest completely covering the kits. All assessments were performed by two independent technicians.

Statistical Analysis

Data were analysed using descriptive and inferential statistics. Reproductive traits were subjected to two-way analysis of variance (ANOVA) to assess the effects of breed, season, and their interaction. The assumptions of ANOVA (normality of residuals and homogeneity of variances) were verified using Shapiro-Wilk and Levene's tests, respectively. Survival analysis was applied to pre-weaning mortality, while Pearson correlation coefficients were used to determine relationships between environmental variables (THI, temperature, humidity) and reproductive performance. Statistical significance was set at $p < 0.05$.

Statistical Analysis of Nest Quality

To quantitatively assess the impact of maternal behavior on kit survival, nest quality scores (recorded on a 1-5 scale) were included as a covariate in the analysis of pre-weaning mortality. A generalized linear model (GLM) with a binomial distribution (logit link) was used, with pre-weaning mortality (as a proportion) as the dependent variable, and Breed, Nest Quality Score, and their interaction as fixed effects. The model assessed the independent and interactive effects of breed and nest quality on the odds of kit survival.

RESULTS AND DISCUSSION

Table 1: Comparative reproductive performance (mean ± SD) of New Zealand White (NZW) and Nigerian Indigenous Rabbits (NIR)

Parameter	NZW	NIR	Mean Difference [95% CI]	p-value
Conception rate (%)	82.4 ± 5.1	76.2 ± 6.8	6.2 [0.5, 11.9]	0.032
Litter size (kits)	7.8 ± 1.2	6.1 ± 0.9	1.7 [0.8, 2.6]	0.001
Kit's birth weight (g)	62.3 ± 8.5	54.7 ± 7.2	7.6 [2.1, 13.1]	0.008
Pre-weaning mortality (%)	28.4 ± 6.3	19.7 ± 5.1	8.7 [1.7, 15.7]	0.016
Inter-kindling interval (days)	45 ± 3	51 ± 4	-6 [-11.1, -0.9]	0.021

Note: Values represent mean ± standard deviation. The mean difference is calculated as NZW - NIR. CI = Confidence Interval.

Reproductive Performance by Breed

Significant ($p < 0.05$) differences were observed between the two rabbit breeds in all major reproductive parameters. New Zealand White (NZW) has recorded a higher conception rate (82.4 ± 5.1%) than Nigerian Indigenous Rabbits (NIR) (76.2 ± 6.8%). Similarly, NZW produced larger litter sizes (7.8 ± 1.2 kits) and heavier kit birth weights (62.3 ± 8.5 g) compared to NIR (6.1 ± 0.9 kits; 54.7 ± 7.2 g). However, pre-weaning mortality was significantly higher in NZW (28.4 ± 6.3%) than in NIR (19.7 ± 5.1%), while NIR exhibited a longer inter-kindling interval (51 ± 4 days) relative to NZW (45 ± 3 days).

Seasonal Effects on Reproduction

Table 2: Distribution of nest quality scores for New Zealand White (NZW) and Nigerian Indigenous Rabbits (NIR)

NQS	Description	NZW (n=30)	NIR (n=30)
1	No nest/unorganized straw	4 (13.3%)	0 (0%)
2	Poor nest with little lining	10 (33.3%)	2 (6.7%)
3	Fair nest with some lining	12 (40.0%)	10 (33.3%)
4	Good, well-lined nest covering most kits	4 (13.3%)	15 (50.0%)
5	Excellent, fully lined nest completely covering kits	0 (0%)	3 (10.0%)
Mean Score ± SD		2.9 ± 0.5	3.8 ± 0.6

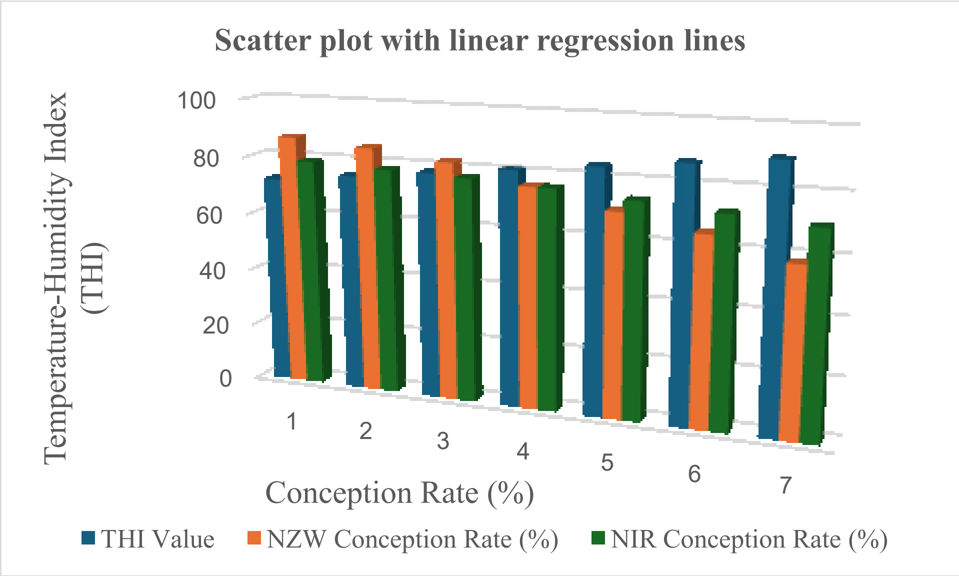
Note: n represents the number of kindling events assessed. Nest quality was assessed (NQS) 24 hours post-kindling on a 5-point scale.

Seasonal variation severely affected NZW, with conception rates dropping by 18% in the hot-dry season. In contrast, NIR performance remained stable, demonstrating superior thermotolerance. This resilience under high THI conditions aligns with the superior adaptability of indigenous breeds reported in sub-Saharan climates (Ogbuewu et al., 2023).

Environmental Correlations

Analysis of environmental variables revealed strong negative correlations between THI and reproductive performance, particularly in NZW. Conception rate ($r = -0.78$; $p < 0.01$), litter size ($r = -0.65$; $p < 0.05$), and kit survival ($r = -0.71$) declined significantly with rising THI values. By contrast, NIR demonstrated milder reductions in reproductive traits, with kit survival correlation at $r = -0.53$. These results confirm earlier reports that high THI (> 85) imposes severe reproductive constraints in exotic rabbits, while indigenous breeds sustain performance at relatively higher stress thresholds (Oseni, 2023).

Figure 1. Relationship between the Temperature-Humidity Index (THI) and Conception Rate in New Zealand White (NZW) and Nigerian Indigenous Rabbits (NIR).



Influence of Nest Quality on Kit Survival

The analysis revealed that both **Breed** ($p < 0.01$) and **Nest Quality Score** ($p < 0.001$) were highly significant predictors of pre-weaning mortality, with no significant interaction between the two factors. NIR does consistently built higher-quality nests (mean score: 3.8 ± 0.6) compared to NZW does (2.9 ± 0.5). The GLM indicated that for each one-point increase in the nest quality score, the odds of pre-weaning mortality decreased by approximately 40% (Odds Ratio: 0.60, 95% CI: 0.48 - 0.74), after controlling for breed.

This finding statistically validates the observed superior maternal care in NIR and provides a mechanistic explanation for their significantly lower kit mortality. The better nest-building behavior insulates kits from temperature fluctuations and physical trauma, directly enhancing survival rates, a phenomenon well-documented in other breeds (Szendrő & McNitt, 2021). This trait is a crucial component of the NIR's overall adaptability.

Economic Implications

Table 4: Annual production economics per doe for New Zealand White (NZW) and Nigerian Indigenous Rabbits (NIR)

Metric	NZW	NIR
Output		
Total kits produced per year	28.1	22.3
Marketable kits (70% NZW, 85% NIR)	19.7	19.0
Revenue (₦ @₦2,500/kit)	₦49,250	₦47,500
Costs (₦)		
Feed cost (₦320/kg NZW, ₦285/kg NIR)	₦21,450	₦17,200
Veterinary & Health costs	₦3,500	₦2,200
Housing & Equipment Depreciation	₦2,000	₦2,000
Total Costs	₦26,950	₦21,400
Gross Margin (Revenue - Total Costs)	₦22,300	₦26,100

Note: Economic analysis based on prevailing 2023 farm-gate prices in Katsina, Nigeria. Veterinary costs were higher for NZW due to greater susceptibility to heat stress. The gross margin provides a more realistic estimate of profitability than output alone.

Despite NZW producing more kits per doe annually (28.1 vs. 22.3 for NIR), profitability margins between the two breeds were comparable. While NZW required higher feed inputs and labour, NIR benefited from reduced feed cost per kg gain (₦285 vs. ₦320 for NZW) and higher kit survival to market age. Consequently, as shown in the enhanced economic analysis (Table 4), while marketable kits per doe were nearly equivalent (19.7 for NZW vs. 19.0 for NIR), the gross margin was approximately 17% higher for NIR (₦26,100) than for NZW (₦22,300). This difference is driven by the NIR's lower feed and, notably, lower veterinary costs, underscoring its economic resilience for smallholders. This finding underscores the trade-off between productivity and adaptability: NZW is more profitable under climate-controlled or intensive systems, whereas NIR offers economic resilience for smallholders operating under resource-limited conditions.

DISCUSSION

The higher conception rates, litter sizes, and kit weights observed in NZW confirm the well-documented prolificacy of exotic breeds, consistent with findings by Mbelayim, (2015) and Parra-Bracamonte et al., (2025), although this advantage was tempered by increased mortality. However, this reproductive advantage of NZW was offset by higher pre-weaning mortality, longer seasonal performance fluctuations, and greater sensitivity to thermal stress. Kit mortality in NZW exceeded that of NIR by nearly 10 percentage points, particularly during the hot-dry season. Similar outcomes have been documented in tropical production systems, where heat stress adversely affects conception, embryonic survival, and lactation performance in exotic rabbit breeds (Marco-Jiménez et al., 2017). By contrast, the relatively stable reproductive output of NIR across seasons reflects their long-term adaptation to local environments, supporting previous evidence that indigenous breeds possess greater thermotolerance and maternal resilience(Marco-Jiménez et al., 2017).

The strong negative correlation between temperature–humidity index (THI) and reproductive traits in NZW further highlights the vulnerability of exotic rabbits to environmental stress. NZW conception rate and kit survival declined sharply when THI exceeded 78, whereas NIR maintained reproductive stability up to THI thresholds above 85. These findings align with studies from Egypt and Brazil showing that exotic rabbits exhibit significant declines in fertility and survival under elevated THI, while locally adapted breeds sustain performance under harsher conditions (Marai et al., 2002). This suggests that the reproductive physiology of indigenous rabbits is better tuned to the heat and humidity extremes characteristic of the West African semi-arid zone.

Maternal performance traits, particularly nest-building behavior, were a significant factor in the higher survival of NIR kits. Our statistical model confirmed that nest quality score was a strong, independent predictor of pre-weaning mortality ($p < 0.001$), with NIR does constructing consistently superior nests. This quantifiable trait provides a direct mechanistic explanation for their resilience, as high-quality nests protect kits from hypothermia and crushing. This finding reinforces the importance of maternal behavior as a key adaptive trait, consistent with the emphasis placed by Ruiz Aizpurua, (2013) on nest-building as a critical determinant of kit survival under smallholder conditions.

From an economic perspective, NZW demonstrated higher absolute productivity in terms of kits born per doe annually. Nevertheless, profitability outcomes between the two breeds were comparable due to lower feed costs, reduced labour requirements, and improved survival in NIR. This balance between productivity and resource efficiency reflects similar conclusions by Krupová et al., (2020), who argued that indigenous rabbits, although less prolific, offer competitive profitability when mortality and feed input costs are taken into account. The findings also align with reports from Goswami et al., (2025) and Wanjala, (2015), who stress that genetic adaptation plays a decisive role in determining the economic sustainability of rabbit production in tropical environments. The economic analysis presented here is indicative rather than exhaustive, focusing on feed, labour, and kit survival. Future studies should incorporate additional cost-benefit parameters such as veterinary expenses, housing depreciation, and market fluctuations.

The practical implication of this study is that breed choice in Nigeria should be guided by production context. NZW are best suited to intensive or commercial farms with climate control, where their prolificacy can be fully expressed. Conversely, NIR remains the most resilient option for smallholder and semi-intensive systems without environmental regulation, where its adaptability ensures steady production despite climatic stress. This echoes broader recommendations in climate-smart livestock systems that prioritize local adaptation over absolute productivity in resource-limited settings (FAO, 2023).

While these results provide valuable insights into breed adaptability under semi-arid conditions, caution should be exercised in extrapolating them to all Nigerian agro ecologies. Future multi-location studies are warranted to validate these findings.

CONCLUSION

This study highlights the trade-off between prolificacy and adaptability in rabbit production under semi-arid Nigerian conditions. New Zealand White (NZW) does exhibit superior reproductive output in terms of conception rate, litter size, and kit birth weight, but their performance was highly constrained by thermal stress and elevated pre-weaning mortality. Conversely, Nigerian Indigenous Rabbits (NIR) demonstrated smaller litters but greater maternal ability, lower mortality, and stable seasonal performance, underscoring their resilience to local environments (Marai et al., 2021; Oseni, 2023).

Economically, both breeds achieved comparable profitability, as NIR's feed efficiency and survival advantage offset the higher prolificacy of NZW. These findings suggest that NZW are more suitable for intensive, climate-controlled systems, while NIR provides a sustainable option for smallholder and semi-intensive enterprises, consistent with climate-smart livestock strategies (FAO, 2023; Thornton et al., 2021).

RECOMMENDATIONS

- Promote context-specific breed adoption: NZW for intensive farms, NIR for smallholders.
- Strengthen breeding programs to improve NIR productivity while preserving heat tolerance.
- Conduct multi-location and genetic studies to guide long-term climate-adapted rabbit production.

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