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*Full Length Research*

# Evaluation of reproductive performance in Dutch and New Zealand White rabbits and their crosses

**Amana, O. C.[1]* and Igbatigbi, L. O.[2]**

[1]Department of Animal Production, Faculty of Agriculture, Prince Abubakar Audu University, PMB 1008, Anyigba, Kogi State, Nigeria.
[2]Department of Zoology, Federal University, PMB 1154, Lokoja, Kogi State, Nigeria.

*Corresponding author. Email: amanacharles2014@gmail.com



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**ABSTRACT:** The study evaluated the reproductive performance of Dutch and New Zealand White rabbits and their crosses under tropical management conditions. Sixty kits representing four genetic groups were produced from a foundation stock of 10 does and 8 bucks. The genetic groups included purebred New Zealand White (NZW×NZW), purebred Dutch (DU×DU), and two crossbreds (NZW×DU and DU×NZW). Results showed that the genetic group significantly (p≤0.05) influenced all the reproductive traits measured. Correlation analysis showed strong and significant positive and negative relationships among the measured reproductive traits. The study concluded that the genetic group significantly affected reproductive and growth traits in rabbits. The NZW showed shorter gestation length and good litter performance, confirming its value as a maternal line. The DU×NZW cross had a lower litter size but superior weaning weight, indicating improved growth. Strong positive correlations between litter size at birth and weaning, and between birth and weaning weights, suggest early traits predict later performance, although negative associations with litter size indicate a trade-off with growth. These results highlight the need to balance prolificacy and growth, and to carefully consider crossbreeding strategies for optimal productivity in rabbit production.

**Keywords:** Crossbreed, Dutch and New Zealand White, performance, rabbits, reproductive.

## INTRODUCTION

Rabbit production has been identified as an alternative choice, especially in developing countries where the traditional livestock species (cattle, sheep, goats and chickens) cannot keep up with increasing demand for animal protein. The unique features of the rabbit include a small-sized body, rapid growth, premium quality meat with low fat, high fecundity, early reproductive age and short gestation (Lukefahr *et al.,* 2022; Qodirova and Ruzikulova, 2023; Erdaw and Beyene, 2022). These attributes make rabbit rearing a suitable choice for smallholder and commercial farmers in tropical regions.

Rabbit production in the tropics is plagued by several constraints, including high prenatal and postnatal mortality estimated at 40% in young rabbits (Sibanda *et al.,* 2024). Pre-weaning survival percentage of kit rabbits (Fadare and Fatoba, 2018) and litter size at birth (Nofal *et al.,* 2005) are the major determinants of a successful rabbit enterprise as they are vital in evaluating the net income of farmers (Rashwan and Marai, 2000). In addition, litter traits can be used to judge nursing and mothering abilities in rabbits to identify good mothers.

Crossbreeding has been utilised to improve livestock production globally (Kebede *et al.,* 2018; Setiaji *et al.,* 2024). Crossbreeding aims to improve production, produce better crosses and to exploit different traits in which the crossbred animals are better than their parents through heterosis (Abdel-Hamid, 2015; Kumar *et al.,* 2023). It has been successfully applied to enhance desirable economic traits such as growth rate, disease resistance, and meat yield. Heterosis and maternal additive effects are some of the effects considered in crossbreeding experiments (Hutu and Onan, 2019), especially since the greater the genetic variation, the greater the value of heterosis (Tomkowiak *et al.,* 2020).

There is evidence in published literature that the NZW is a popular dam breed based on its outstanding maternal genetic merits for litter size, milk production and mothering qualities (Lebas, 1997). However, United States rabbit breeding experiments have documented that the commercial NZW is generally inferior to other breeds and crosses for growth rate, feed efficiency and meat yield (Roberts and Lukefahr, 1992). Irekhore (2017) reported a higher litter size at birth in the Dutch breed compared to the NZW. Breed complementarity and heterotic effects may be exhibited by crossbred kittens from Dutch sires and NZW dams to increase economic returns in commercial rabbit production.

Despite the recognised importance of crossbreeding in rabbit production, there is still limited information on the comparative reproductive performance of some commonly reared breeds and their crosses under tropical management conditions. In particular, the Dutch and NZW breeds are widely utilised in breeding programs, yet comprehensive evaluations of their breed and cross effects on reproductive traits remain relatively scarce in many developing regions. Such information is important for identifying suitable breeding combinations that can maximise reproductive output and enhance overall productivity.

Therefore, the evaluation of reproductive performance in Dutch and NZW rabbits and their crosses is necessary for developing efficient genetic improvement strategies.

## MATERIALS AND METHODS

### Experimental location

The study location was the rabbit unit of the livestock teaching and research farm, Prince Abubakar Audu University, Anyigba. Anyigba has weather coordinates of latitude 7°30'N and longitude 7°09'E, with an average altitude of 420 meters above sea level. The area is situated within the tropical wet and dry climate zone of the Guinea savanna, characterised by an average annual rainfall of approximately 1600 mm and a daily temperature range between 25 and 35°C (Hameed *et al*., 2020).

### Animal breeding and management

A total of 60 kits representing four genotypes were obtained from a foundation stock comprising 10 does and 8 bucks. The genotypes were purebred Dutch (Du × Du), purebred New Zealand White (NZW × NZW), and two crosses (Du × NZW and NZW × Du). The breeding stock (bucks and does) were housed individually in hutches, each with a feeder and a drinker. The house had a concrete floor and a metallic roof. It had an open-sided wire mesh with a dwarf wall to support adequate ventilation. The rabbits were observed daily, and other routine management practices were strictly followed.

At breeding age, each doe was transferred to the buck's cage for mating. Each doe was palpated 10 days post-mating for pregnancy detection. Does that failed to conceive were returned to the same mating buck for rebreeding. On the 25th day after detection of pregnancy, kindling boxes were placed in the does cages in preparation for kindling. Litters were weaned at 42 days post-kindling. A commercial grower ration (Hybrid ™) containing 16 % crude protein, 0.8 % lysine, 0.4 % methionine, 3.8 % calcium, 0.44 % available phosphorus, 4 % crude fibre and 2650 Kcal/kg Digestible energy was provided in the morning, while forage (*Tridax procumbens*) was offered to the rabbits in the evening throughout the experiment. Fresh, clean water was available to the rabbits throughout the experiment. Hutches of bucks and does were cleaned and disinfected regularly. All genetic groups of rabbits were subjected to the same environmental, medication and managerial conditions.

### Data collection

Litter size at birth and at weaning, as well as litter weight at birth and at weaning, gestation length for each doe, were considered for each genetic group.

### Statistical analysis

The data generated were subjected to analysis of variance using the GLM-multivariate procedure of IBM SPSS (version 20). Only the main effects of breed-type were considered. Where significant differences were observed, a post hoc test by least significance was conducted at a probability level of 5 % ($P \leq 0.05$). The statistical model used was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: $Y_{ij}$ = observation on the $j^{th}$ litter in the ith genetic group; μ = overall mean; $T_i$ = effect of the $i^{th}$ genetic group (purebred or crossbred); $e_{ij}$ = random error associated with each observation

## RESULTS

Table 1 shows the reproductive performance of pure and crossbred rabbits. Genetic group significantly ($p \leq 0.05$) influenced gestation length (GL), litter size at birth (LSB), litter size at weaning (LSW), birth weight (BW) and weaning weight (WW). The NZW rabbits recorded significantly ($p \leq 0.05$) lower gestation length (31.00 days) than the other genetic groups, but similar to the NZW×DU (31.46) crossbred rabbits.

**Table 1**. Least square means (± SE) of reproductive traits for pure and crossbred rabbits

| Traits | Breed | | | | |
|---|---|---|---|---|---|
| | **NZW** | **DU** | **NZW×DU** | **DU×NZW** | **p-value** |
| GL (days) | $31.00^{b}$±0.00 | $31.83^{a}$±0.51 | $31.46^{ab}$±0.30 | $32.00^{a}$±0.00 | 0.00 |
| LSB | $6.54^{a}$±0.14 | $6.54^{a}$±0.10 | $6.17^{a}$0.30 | $4.56^{b}$±0.18 | 0.00 |
| LSW | $6.08^{a}$±0.29 | $6.17^{a}$±0.14 | $6.04^{a}$±0.30 | $4.00^{b}$±0.00 | 0.00 |
| KBW (g) | $49.52^{a}$±1.11 | $44.96^{b}$±0.71 | $44.38^{b}$±0.37 | $53.01^{a}$±1.45 | 0.00 |
| KWW (g) | $325.00^{b}$±21.90 | $313.33^{b}$±12.25 | $300.87^{b}$±6.89 | $497.50^{a}$±18.97 | 0.00 |

[abc] Means with different superscripts on the same row are statistically different (p<0.05). NZW=New Zealand White, DUC = Dutch, GL = gestation length, LSB = litter size at birth, LSW = litter size at weaning, KBW = average kit birth weight, KWW = average kit weaning weight.

**Table 2**. Pearson correlation of some reproductive traits of rabbits

| | **GL** | **LSB** | **LSW** | **KBW** | **KWW** |
|---|---|---|---|---|---|
| GL | 1 | | | | |
| LSB | -0.779** | 1 | | | |
| LSW | -0.637** | 0.893** | 1 | | |
| KBW | -0.111 | -0.354** | -0.377** | 1 | |
| KWW | 0.167 | -0.594** | -0.718** | 0.676** | 1 |

Key: * = Significant at 0.05; ** = highly Significant at 0.01; GL= gestation length, LSB= litter size at birth, LSW= litter size at weaning, KBW= average kit birth weight, KWW= average kit weaning weight.

Litter size at birth was similar (P≤0.05) for NZW×NZW (7.00 kits), NZW×DU (7.00) and DU×DU (6.00 kits) but significantly (P≤0.05) lower in DU×NZW crossbred rabbits (5.00 kits). For litter size at weaning, a similar pattern to litter size at birth was observed. NZW×NZW (6.08), NZW×DU (6.04) and DU×DU (6.17) recorded significantly (P≤0.05) higher litter sizes compared to DU×NZW (4.00) kits.

Birth weight was similar (P≤0.05) for NZW×NZW (49.52 g) and DU×NZW (53.01 g) but significantly higher (p≤0.05) compared to DU×DU (44.96 g) and NZW×DU (44.38 g). Weaning weight ranged from 300.87 g (NZW×DU) to 497.50 g (DU×NZW), with DU×NZW crossbred rabbits showing superior (p≤0.05) weaning weight compared to the other genetic groups.

The correlation matrix showed a strong and significant association among the traits (Table 2). Gestation length was negatively correlated with litter size at birth (r = - 0.799**) and litter size at weaning (r = -0.637**). Litter size at birth had a strong positive correlation with litter size at weaning (r = 0.893**). However, litter size at birth was negatively correlated with kit birth weight (r = - 0.354**) and kit weaning weight (r = - 0.594**). Finally, kit birth weight was positively correlated with kit weaning weight (r = 0.676**).

## DISCUSSION

The observed values for gestation length in this study were slightly higher than the range of 28.10 to 30.4 days reported by Odeyinka *et al.* (2008). This study showed significant variation in litter size at birth and litter size at weaning, consistent with earlier reports of Ogundimu (2001), Nwakpu and Ucheji (2018), who individually observed differences in litter size at birth for purebred and crossbred rabbits. Ewegbemi *et al.* (2018) observed that the NZW does have a higher litter size at birth and litter size at weaning than the Dutch does. In contrast, Kumaresan *et al.* (2011) and Apori *et al.* (2015) observed an insignificant difference for litter size at birth in NZW and Dutch rabbit breeds. The presence of significant differences for litter traits may be related to breed differences in uterine capacity, conception rate, established ova and fertilisation (Pinto-Pinho *et al.,* 2023; Popli *et al.,* 2022).

The lower values observed for litter size at birth and weaning in the DU×NZW crossbred may suggest that the combination of genes in the crossbred did not yield the expected hybrid vigour for the traits examined. In animal breeding experiments, heterosis is not always guaranteed, and the magnitude of crossbreeding effects largely depends on the genetic compatibility and the reproductive characteristics of the parental breeds. Ewegbemi *et al.* (2018) observed that crossing NZW bucks with Dutch does resulted in higher pre-weaning mortality and lower litter size at weaning, in contrast to pure NZW crosses and pure Dutch crosses.

The higher value for kit birth weight observed in pure NZW rabbits over the pure Dutch rabbit may be related to the breed effect. A similar observation was reported by Nwakpu and Ucheji (2018). The superiority of kit weaning weight in the DU×NZW crossbred over the NZW×DU crossbred and pure breed rabbits may be attributed to the effect of heterosis, which occurs when genetically distinct populations are crossed. The NZW has been identified as an excellent dam breed based on its outstanding maternal genetic merits (Lebas, 1997). Therefore, using the NZW breed as a dam favoured higher kit birth weight and weaning weight than when the breed was used as a sire in the breeding program.

The strong positive correlation between LSB and LSW implies that does with larger litters at birth tend to have more kit survival until weaning, consistent with previous research (Nwakpu, 2013; Nwakpu and Omeje, 2004) that there is a significant positive correlation between litter size, weaning weight and survival rate of piglets. The high correlation implies that variation in LSW is largely explained by variation in LSB. Therefore, LSB is a reliable predictor of LSW and improving LSB through selection or management will likely enhance overall reproductive performance, provided that maternal capacity and management conditions are adequate to support the larger litters.

The negative correlation between LSB and KBW and KWW could have resulted from a negative genetic correlation between the traits, which implies these traits were controlled by the same additive genes but in opposite directions. A similar observation was documented by Ayoola *et al.* (2016) that there exists a strong negative correlation between litter size at birth and kits' weight at birth in tropical rabbit breeds.

The strong positive correlation between KBW and KWW implies that kits born heavier tend to remain heavier at weaning, which indicates that birth weight is a reliable predictor of early growth performance. This observation is consistent with Abou Khadiga *et al.* (2010), who reported that selection for high litter weight at birth is generally associated with genetic improvement of this trait at later ages.

## Conclusion

The findings of this study clearly demonstrate that genetic group plays a significant role in determining reproductive performance and early growth traits in rabbits. Purebred NZW exhibited shorter gestation length and competitive litter sizes, confirming its strength as a maternal line. While the DU×NZW cross showed reduced litter size at birth and weaning, it produced significantly superior weaning weights, indicating improved postnatal growth performance. Conversely, NZW×DU and pure lines maintained better litter size performance but lower weaning weights. The correlation analysis further revealed that larger litter sizes were associated with reduced individual kit weights, highlighting a trade-off between quantity and growth. Additionally, the strong positive relationship between birth weight and weaning weight confirms that early life performance is a reliable indicator of later growth. The practical implications of these findings are;

1. First, breeders should carefully consider the crossbreeding direction. Using NZW as a dam line appears advantageous for improving kit growth performance, while its use as a sire may not yield optimal reproductive outcomes.
2. Second, the observed trade-off between litter size and kit weight indicates that selection goals must be balanced. Focusing solely on increasing litter size may negatively affect individual growth performance and survival. Therefore, breeding objectives should integrate both reproductive efficiency and growth traits.
3. Third, the strong correlations among traits suggest that indirect selection strategies can be effective. For example, selecting for higher birth weight could lead to improvements in weaning weight, thereby enhancing overall productivity without directly selecting for later growth traits.

## CONFLICT OF INTEREST

The authors declare no competing interests.

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