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Research note: Pre-weaning performance in Indonesian Local Rabbits and Crossbred Progeny with Exotic Bucks

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ABSTRACT

This research assessed the pre-weaning growth of local rabbits (L × L) and their hybrids with New Zealand White (NZW × L) and Hycole (HL × L) bucks, concentrating on birth weight, weekly body weight, average daily gain (ADG), and growth trends. The findings indicated that the crossbred kits (NZW × L: 53.51±12.07 g; HL × L: 51.09±10.21 g) had notably higher birth weights compared to the local kits (40.67±10.69 g; $p < 0.0001$). Throughout the weeks, the body weights of the crossbred groups consistently exceeded those of the L × L group, with NZW × L kits reaching 907.49±199.95 g by the sixth week, in contrast to 785.90±150.87 g (HL × L) and 602.24±79.57 g (L × L). The ADG was significantly greater in the crossbreds, peaking at 39.99±17.04 g/day (NZW × L) during weeks 5–6, compared to 24.79±6.24 g (HL × L) and 18.84±3.71 g (L × L). The growth curves showed accelerated gains in the crossbreds, attributed to heterosis and enhanced genetic potential. These results highlight that crossbreeding local rabbits with NZW and Hycole bucks improves pre-weaning growth performance, emphasizing the advantages of strategic genetic enhancement in smallholder rabbit farming.

Introduction

Local rabbits are a breed of Indonesian rabbits that have adapted to tropical climates. These rabbits are known for their rapid reproduction, impressive growth rates, adaptability to the local climate and diet, and ease of cultivation (Abdullah *et al*., 2017). Compared to imported rabbits, local rabbits have smaller bodies and exhibit a range of fur colors, including white, brown, gray, and combinations thereof. Their ears are also shorter than those of imported rabbits. However, their smaller body size is a disadvantage when it comes to meat production.

NZW rabbits have been raised extensively for meat production. These rabbits are distinguished by their white fur, wide ears, and compact muscular build (Widyanto *et al*., 2018). One of the benefits of the NZW rabbit is its rapid growth rate (Marhaeniyanto *et al*., 2015). Additionally, NZW rabbit carcasses were of high quality and exhibited strong maternal characteristics. However, a disadvantage of the NZW rabbit is its less-than-ideal adaptation process, due to inadequate development in Indonesia. Hycole rabbits, originally from France, were brought to Indonesia in 2012 by the Livestock Research Center for breeding purposes (Brahmantiyo *et al*., 2017). Hycole rabbits have plain white fur and elongated heads (Astuti *et al*., 2020). This breed is considered superior because of its rapid growth, large litter size, and relatively high weight. The carcass weight of Hycole rabbits can reach 58.9% (Metzger *et al*., 2004). However, Hycole rabbits are prone to scabies and have a relatively poor adaptation to the local environment. A potential solution is to implement planned crossbreeding between local rabbits and superior breeds such as NZW and Hycole as sires, aiming to produce offspring with the combined benefits of large body size, scabies resistance, and good adaptability to local conditions.

This study evaluated the pre-weaning performance of crossbred rabbit kits. The anticipated advantages of this study include enhancing the genetic quality and boosting rabbit productivity. This study hypothesized that the pre-weaning performance of crossbred kits, resulting from local and Hycole bucks, would surpass that of local rabbits.

Materials and methods

Materials

The materials used in this study included 90 kits, consisting of 30 local rabbit kits, 30 kits from crossbreeding with NZW bucks, and 30 kits from crossbreeding with Hycole bucks. The average weight of does used was 2.13 kg with a CV of 23%, while the average weight of bucks used was 3.07 kg with a CV of 29%.

Methods

The approach employed involved direct observation by closely monitoring the materials under study, which was organized into pre-research and research execution phases. During the pre-research phase, comprehensive preparations were made, including setting up the cage, acquiring the equipment and materials, and preparing the rabbits. This involved cleaning, fumigation, obtaining necessary equipment, administering vitamins, treating scabies, and selecting breeding stock based on the Body Condition Score (BCS). The research execution phase encompassed the breeding process, conducting health assessments, detecting pregnancies, preparing for births, and managing pre-weaning kits.

Data collection

Performance traits were assessed on the basis of pre-weaning measurements, including birth weight (g) and body weight at weeks 1–6 (g). The average daily gain (ADG, g/day) was calculated for each weekly interval. Data collection followed the procedures outlined by Harahap *et*

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al. (2020).

Data analysis

The data were adjusted to account for the effects of sex and birth type, necessitating correction for body weight. As stated by Baehaki (2016), the formula for corrected body weight is as follows:

CBW = RBW × CBT × CBS

Explanation:

CBW= corrected body weight

RBW= real body weight

CBT= correction factor for type of birth

CBS= correction factor for sex

In this study, the correction factors were determined based on sex and birth type. The correction factor for birth type was standardized to the sextuplet (6) birth type, as shown in Table 1, which was adapted from the formula by Hardjosubroto (1994). This standardization is essential for comparing individual performances across different birth types. Similarly, the correction factor for sex was standardized to the male, which is crucial for comparing individual performances across different sex. The sex correction factors for kits, where males have a correction factor of 1, while females have a higher correction factor of 1.1543 adapted from Fauzan *et al.* (2024).

The corrected data were analysed using one-way ANOVA with SAS software to determine the differences in birth weight, weekly body weight, and average daily gain between crossbred and local rabbit offspring.

Table 1. Birth type correction factor for kits.

Litter size	Correction factor
3	0.56
4	0.82
5	0.87
6	1
7	1.04

Results

Based on the average birth weights shown in Table 2, the birth weights of the NZW x L (53.51±12.07 g) and HL x L (51.09±10.21 g) groups were significantly higher compared to the L x L group (40.67±10.69 g) with significance at ($p < 0.0001$). The data in Table 3 shows an increase in body weight in all three breeding groups (L × L, NZW × L, and HL × L) from week to week. In the first week, the body weight of the L x L group was 75.16±16.70 g, while NZW x L and HL x L reached 102.15±25.18 g and 100.95±19.62 g, respectively. This difference was statistically significant ($p < 0.0001$). A similar pattern of growth was observed up to the sixth week, where the NZW x L group reached 907.49±199.95 g, higher than the HL x L group (785.90±150.87 g) and the L x L group (602.24±79.57 g).

Table 2. Birth weight (g) for in local rabbits and crossbred progeny with exotic bucks.

Type of Crossing	N	Mean±SD	T Value	Signification
L x L	30	40.67±10.69		
NZW x L	30	53.51±12.07	11.53	<0.0001
H x L	30	51.09±10.21		

The average daily gain (ADG), shown in Fig. 1, also indicated significant differences among the groups. In weeks 0–1, the ADG of the L x L group was 10.74±2.39 g, while NZW x L and HL x L were 14.55±3.55 g and 14.42±2.80 g, respectively ($p < 0.0001$). The highest increase in ADG occurred in the NZW x L group in weeks 5–6, reaching 39.99±17.04 g, while the HL x L and L x L groups reached 24.79±6.24 g and 18.84±3.71 g, respectively. Based on Illustration 1, rabbit growth followed a stable and upward trend. It was observed that the L x L rabbit kits experienced slower growth compared to the NZW x L and HL x L crossbred kits.

Table 3. Body weight (g) in local rabbits and crossbred progeny with exotic bucks.

Ages	Body weight (g)			Signification
	L x L	NZW x L	HL x L	
Week 1	75.16±16.70	102.15±25.18	100.95±19.62	<0.0001
Week 2	156.60±29.15	208.48±31.15	202.87±33.37	<0.0001
Week 3	237.90±44.43	311.35±46.42	306.17±38.78	<0.0001
Week 4	329.65±66.56	430.65±57.40	431.72±78.66	<0.0001
Week 5	470.38±73.86	627.56±97.00	612.36±115.84	<0.0001
Week 6	602.24±79.57	907.49±199.95	785.90±150.87	<0.0001

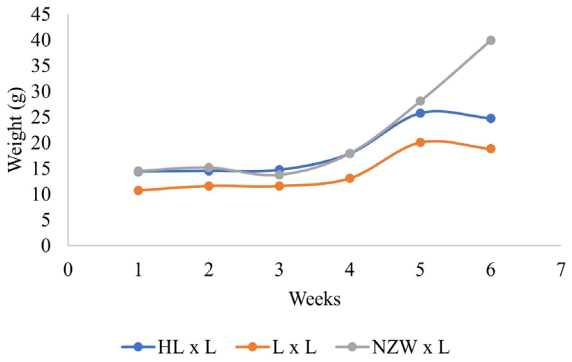

Fig. 1. Average daily gain.

Discussion

Table 2 shows that NZW × L (53.5 g) and HL × L (51.09 g) had significantly higher birth weights ($p < 0.0001$) than L × L (40.67 g). This indicates that crossbreeding with NZW and Hycole males has a positive effect on the birth weight of their offspring. This finding suggests that males influence the birth weight of kits produced by does of the same breed. Afifi *et al.* (1994) stated that males indeed contribute to the birth weight of rabbit kits through the genetic influence they pass on. The difference in birth weight between crossbred kits and local kits is due to the heterosis effect, where the combination of genetics from two different breeds results in offspring performance that exceeds that of the local parent stock. This aligns with the opinion of Pinem and Hanafi (2015), who stated that crossbreeding increases heterozygosity, as indicated by improved performance beyond that of parents.

Based on the average birth weight of crossbred kits between NZW × Local (53.51 g), the birth weight of crossbred kits was comparable to that of NZW rabbits. This is in line with the statement of Widitania *et al.* (2016), who stated that the birth weight of NZW rabbits ranges from 50.78 g to 60 g. Based on the research results, the birth weight of the Lokal × Lokal kits (40.67 g) matches the standard stated by Putri *et al.* (2013), who found that local rabbits have an average birth weight of 40–49 g. The birth weight of HL × L crossbred kits (51.09 g) was also within the birth weight range of pure Hycole rabbits, which, according to Setiaji *et al.* (2022a) ranges from 50.4 to 56.6 g.

Table 3 shows a notable difference ($P < 0.0001$) in body weight across the various mating groups (L × L, NZW × L, and HL × L) on a weekly basis. The NZW × L and HL × L groups consistently exhibited higher body weights than the L × L group did. This suggests a distinct genetic impact on the bodyweight of the kits. Kits from the crossbred groups experienced significantly greater weekly weight increase than those from the local rabbit groups. According to Dughita and Fitroh (2022), rabbits with superior genetics can transmit their enhanced growth performance to their

offspring. The dominant genes from the Hycole and NZW breeds, known for their high growth potential, contributed to the increased pre-weaning body weights of the kits, making them superior to local rabbits.

In the first week, the average body weight of kits from the NZW × L cross was 102.15 g, while those from the HL × L cross weighed 100.95 g. In contrast, local kits had an average weight of just 75.16 g. This variation was due to genetic differences among the breeds. Hycole and NZW breeds are recognized for their superior growth performance compared to local rabbits. As noted by Brahmantiyo *et al*. (2017), choosing the right genotype is essential for enhancing growth performance, including body weight and carcass quality, in rabbit farming. The lower body weights of local kits are attributed to the morphological traits of the local breed, which typically has a smaller body size. This observation aligns with that of Sarwono (2003), who described local rabbits as having small bodies and relatively light weight.

In the second week, the average body weight for kits from the NZW × L cross was 208.48 g, and for the HL × L cross, it was 202.87 g, both surpassing the local kits, which weighed 156.60 g. Mudawamah *et al*. (2020) noted that local breeds tend to grow more slowly, likely due to genetic adaptation to their environment. Conversely, the Hycole and NZW breeds have been selectively bred for production purposes, resulting in quicker and more efficient growth. The body weight data for the third week mirrored this pattern, with crossbred NZW and Hycole kits weighing 311.35 g and 306.17 g, respectively, while local kits weighed only 237.90 g. This disparity can be attributed to the increased heterozygosity observed in crossbred offspring. Wahyono *et al*. (2021) stated that greater heterozygosity can improve growth performance in livestock.

In the fourth week, the average weights of kits from the NZW and Hycole crosses were (430.65 g) and (417.50 g), respectively, whereas local kits weighed just (327.96 g). The steady weekly weight increase in crossbred kits highlights the potential impact of heterosis. Van Vleck *et al*. (1987) described heterosis as the enhanced performance of crossbred offspring compared to the average performance of their parents. Afifi *et al*. (1994) also noted that heterosis could enhance animal growth performance through superior genetic combinations. The average body weight at weeks fifth and sixth weeks further supported this trend. Crossbred NZW and Hycole kits had average weights of (627.56 g) and (612.26 g) in the fifth week, and (907.49 g) and (785.90 g) in the sixth week. In contrast, local kits only reached (470.38 g) in the fifth week and (602.24 g) in the sixth week. This consistently demonstrates that crossbred kits outperform the local kits in terms of growth performance. From weeks 1 to 6, local rabbits consistently had lower body weights than crossbred rabbits did. According to Setiaji *et al*. (2023), local rabbits exhibit significant genetic differences compared to NZW and Hycole rabbits in terms of mitochondrial genome length, genetic variation, and adult body weight. This indirectly suggests varying potential in pre-weaning performance, particularly in local adaptation ability, metabolic efficiency, and growth, which may be slower compared to commercial rabbits, such as NZW and Hycole, which are known for their higher adult body weights. Setiaji *et al*. (2022b) also opined that imported rabbits possess superior traits compared to local rabbits.

According to the analysis, there was a highly significant difference ($P<0.0001$) ADG of crossbred and local rabbit kits from weeks 1 to 6, highlighting a strong genetic impact on their daily growth. The crossbred kits, specifically NZW × L and HL × L, exhibited greater ADG compared to the local L × L kits. In the first week, the ADG for NZW and HL crossbred kits were 14.55 g/day and 14.42 g/day, respectively, whereas the local kits only achieved 10.73 g/day. This disparity is attributed to the genetic influence of NZW and Hycole sires, which are known to have high growth potential. This aligns with Brahmantiyo *et al*. (2018), who noted that Hycole rabbits excel in their reproductive performance and growth rate. Wahyono *et al*. (2021) also found that NZW rabbits demonstrated rapid body weight growth. The genetics of imported rabbits not only enhances body weight but also improves morphometric traits compared to local rabbits. According to Sanah *et al*. (2024), synthetic line rabbits, comparable to Hycole rabbits, possess higher protein and fat content along with superior morphometric characteristics.

The average daily gain (ADG) for crossbred kits increased, with NZW × L reaching 15.19 g and HL × L reaching 14.55 g/day, whereas local rabbit kits averaged only 11.63 g/day. These results suggest that the growth performance of crossbred kits aligns with the typical standard for purebred rabbits. According to Rinanto *et al*. (2018), Hycole rabbits can achieve daily weight gain ranging from 9 to 16 g/head/day. Mahendra *et al*. (2019) reported that NZW rabbits have an average body weight gain of 100 g/head/week. Additionally, in the third week, ADG for NZW x L crossbred kits was 13.79 g, and for HL x L, it was 14.75 g/day, both surpassing the local kits, which only reached 11.61 g/day. The lower ADG in local rabbit kits can be attributed to their slower growth rate compared to superior breeds. This was corroborated by Purwanti *et al*. (2018), who found that the daily growth rate of local rabbits was generally lower than that of imported rabbits.

In the fourth week, ADG for crossbred kits, specifically NZW x L and HL x L, was recorded at 17.95 g and 17.93 g per day, respectively, whereas local kits only managed 13.10 g per day. This disparity is likely due to the enhanced heterozygosity observed in crossbred kits. According to Hakim *et al*. (2019), heterozygosity significantly contributes to improved growth performance of rabbit kits. The fifth week's results mirrored this pattern, with the ADG for NZW x L crossbred kits reaching 28.13 g and HL x L at 25.80 g per day, while local kits achieved just 20.10 g per day. This further underscores the impact of genotypic differences on body weight gain. Momoh *et al*. (2015) highlighted that genotypic variations significantly influence growth traits such as final weight and ADG, underscoring the substantial role of genetic diversity in growth performance.

During the sixth week, the ADG of crossbred kits remained elevated, with NZW x L at 39.99 g and HL x L at 24.79 g/day, surpassing that of local kits, which was 18.89 g/day. This outcome highlights the impact of heterosis or hybrid vigor, which enhances performance through genetic blending of two distinct breeds. According to Setiaji *et al*. (2024), crossbreeding can lead to enhanced performance owing to the high potential for heterosis. Heterosis not only boosts growth, but also enhances reproductive and metabolic efficiency, which is crucial for establishing highly productive rabbit farming systems. Brun and Baselga (2005) also observed that heterosis could significantly enhance the growth parameters of livestock.

Conclusion

The results of this study show that crossbreeding between NZW and Hycole males with local females has a positive effect on the performance and growth rate of the offspring produced. The analysis indicated that the offspring resulting from crossbreeding demonstrated faster growth and better performance than the local offspring.

Conflict of interest

The authors have no conflict of interest to declare.

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