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Effects of crossbreeding Black Australorp with SassoC431 chickens on F1 growth performance

NCUBE, T.W., JOMANE, F.N., MUGOTI, A., MATSHISELA, A.U. and MOYO, S.

Department of Animal Science and Rangeland Management, Lupane State University, Lupane, Zimbabwe
*Corresponding author: moyo.sizo@yahoo.com

ABSTRACT

Crossbreeding can increase productivity without sacrificing genetic merit. The current study compared the live weights, carcass weights, and sensory meat qualities of F1 progeny resulting from the crossbreeding of purebred Black Australorp and purebred SassoC431 chickens within a semi-intensive system. We compared F1 crossbred Black Australorp and SassoC431 (n = 15 males and 15 females) with purebred Black Australorp (n = 15 males and 15 females) and SassoC431 (n = 15 males and 15 females) chickens. The assessed productive traits included growth rate, live body weight and carcass weight. Additionally, sensory meat qualities were evaluated. From the age of 4 to 16 weeks, the chickens' live weight was measured at a two-week interval. Data for productive traits and sensory meat qualities were analyzed using two-way ANOVA and the Kruskal-Wallis test. Mean comparisons were conducted using the least significant difference test at the 0.05 significance level. Growth curves were computed using the logistic growth model. The study demonstrates that both chicken breed and sex exerted a significant influence ($p < 0.05$) on live weight, carcass weight, and sensory meat qualities. In terms of slaughter weight, the Sasso C431 had an average weight of 1516.65g, the crossbreed had 1179.0g and pure breed Black Australorp had 911.65g. Thus, an average net weight gain of 267.35g was realised through crossbreeding. The Sasso C431 were 0.28% more superior than the crossbreed in terms of weight at 16 weeks. The average dressing out percentages were 70.38%, 70.24%, and 70.17% for Sasso C431, crossbreed and Black Australorp respectively. A net gain of 0.07% dressing out percentage was realised through crossbreeding. From week 4 until slaughter age, males were significantly heavier than their age-matched female counterparts. Furthermore, live weights, carcass weights, and sensory meat qualities were significantly higher in purebred SassoC431, followed by crossbred Black Australorp and SassoC431, and finally, purebred Black Australorp. This research confirms that crossbreeding can effectively enhance the productivity of underperforming breeds.

Keywords: Black Australorp, carcass weight, Cross—chickens, growth parameters, live-weight, SaSSO, C431, sensory meat qualities

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RÉSUMÉ

Le croisement de races peut améliorer la productivité sans compromettre le potentiel génétique. Cette étude compare les poids vifs, les poids de carcasse et les qualités sensorielles de la viande chez des poussins F1 issus du croisement de Black Australorp et de SassoC431 en race pure, élevés dans un système semi-intensif. Les individus examinés incluent : F1 croisés Black Australorp × SassoC431 (n = 15 mâles et 15 femelles), Black Australorp pur (n = 15 mâles et 15 femelles) et SassoC431 pur (n = 15 mâles et 15 femelles). Les paramètres productifs évalués étaient le taux de croissance, le poids vif et le poids de carcasse, complétés par une analyse des qualités sensorielles de la viande. Les poids vifs ont été mesurés de la 4e à la 16e semaine, par intervalle de deux semaines. Les données relatives aux performances de croissance et aux qualités sensorielles ont été analysées par ANOVA à deux facteurs et par le test de Kruskal-Wallis, tandis que la comparaison des moyennes s'est appuyée sur le test de la plus petite différence significative ($p < 0,05$). Les courbes de croissance ont été ajustées à l'aide du modèle de croissance logistique. Les résultats montrent que la race et le sexe influencent significativement ($p < 0,05$) le poids vif, le poids de carcasse et les qualités sensorielles de la viande. Au moment de l'abattage, la SassoC431 présentait un poids moyen de 1516,65 g, les hybrides 1179,0 g, et la Black Australorp pure 911,65 g, révélant ainsi un gain net de 267,35 g attribuable au croisement. Les SassoC431 dépassaient de 0,28 % les hybrides en termes de poids à 16 semaines. Les rendements à l'abattage moyens s'élevaient à 70,38 %, 70,24 % et 70,17 % pour respectivement la SassoC431, le croisement et la Black Australorp, soit un gain net de 0,07 % du rendement dû au croisement. De la 4e semaine à l'abattage, les mâles étaient significativement plus lourds que les femelles du même âge. Enfin, sur l'ensemble des paramètres, la SassoC431 pure s'avère la plus performante, suivie du croisement Black Australorp × SassoC431, puis de la Black Australorp pure. Cette étude confirme donc l'utilité du croisement pour accroître la productivité de races moins performantes.

Mots clés : Black Australorp, poids de carcasse, poulets croisés, paramètres de croissance, poids vif, Sasso, C431, qualités sensorielles de la viande.

INTRODUCTION

Poultry production is an important part of Zimbabwe's animal production sector (Gobvu *et al.* 2023). A growing number of Zimbabwean farmers are turning to free-range poultry production due to the high cost of feed and laborious management requirements for broilers (Chamboko and Erasmus, 2014). This practice of raising free-range chicken breeds is also driven by its increased demand because it is organic, making them free of chemicals or drugs, which contributes to their being healthier for human consumption (Assan, 2015). The Sasso, Potchefstroom Koekoek, Light Sussex, Boschveld, Black Australorp, and Rhode Island Red are the most popular scavenging breeds in Zimbabwe's commercial poultry sector, while indigenous breeds dominate the small-scale sector (Manyelo *et al.,* 2020). These scavenging chickens have traits such as high disease tolerance, thermostability, organic eggs that are highly nutritious, and a tough meat texture (Ngogo *et al.,* 2023).

The majority of small-scale free-range chicken farmers in Zimbabwe employ inadequate management techniques, which result in high

mortality rates that affect both populations and productivity (Maumburudze *et al.,* 2016). Diseases are the main cause of the loss of free-range chickens (Jambwa *et al.,* 2022). Predators and parasites also contribute to high free-range chicken mortalities. Nutritional limitations, which occur as a result of the scavenging resource base's regional and temporal variability, especially during the dry season, also limit free-range chicken productivity (Nzioka *et al*., 2017; Mugoti *et al*., 2022).

The purpose of crossbreeding is to take advantage of the possible improvement in the performance of the progeny above that of the parent in terms of genetic diversity and growth rate in terms of live weight (FAO, 2018; Moyo *et al.,* 2023). Crossbreeding between these breeds can be used to complement the favourable traits that are found in these different breeds (Kwatalala *et al*., 2015). Black Australorps feature slate blue or black legs and beaks, as well as glossy black feathers with a greenish-purple sheen and big red combs (Gericke, 1950). They can reach a weight of 2.3kg when reared for meat production within a period of 16–24 weeks (Thamaga *et al.,* 2021). The Sasso C431 is a multi-coloured, slow-growing broiler; therefore, its meat is firmer, has that rich chicken flavour, and is juicy and tasty like the meat of indigenous chicken (Ndiweni, 2013). Both males and females can reach a weight of 2.2kg to 2.5kg within a period of 12 weeks under an intensive production system (Ndiweni, 2013). Thus, the current study's purpose was to investigate the effects of crossbreeding Black Australorp with SassoC431 on F1 productivity performance.

MATERIALS and METHODS

Study site. The study was conducted at plot number 36 in Nyamandlovu under Ward 15, Umguza District, Matabeleland North Province, Zimbabwe. The rainfall ranges from 450 to 650 mm per year. The annual average temperature is 26.17°C, with a range of 25°C–31°C during summer and 21°C–24°C in winter, and an annual average humidity of 52.42%.

Animal management. Automatic egg incubators at 37.8 °C and 65% relative humidity were used for hatching all the collected eggs from the breeding hens since the SassoC431 hens do not sit on their eggs. The eggs were incubated for 21 days. Upon hatching, the chicks were housed according to breed in separate brooding units and fed Sasso starter from day one to four weeks of age. Water was given ad libitum throughout the experimental period. At the age of 4 weeks, the chicks were individually identified using strings tied on their left legs for males and right legs for females, with black strings tied on SassoC431 chickens, red strings tied on crossbred Black Australorp and SassoC431, and green strings tied on the Black Australorp chickens at four weeks of age. The number of strings tied per bird was according to its pen replication number. Five chickens of the same sex and breed were put in each compartment measuring 0.3–0.5m^2. From 4 weeks of age to 16 weeks, the chickens were fed Sasso Grower inside the pens in the morning, and from 10 a.m. they were let out to scavenge until 5 p.m. During the growth phase, chickens were vaccinated orally against Newcastle disease and Gumboro disease at two and eight weeks of age, using ND 78 and Ma clones, respectively.

Study design. The experiment was setup following a Randomized Complete Block Design with 18 replicates, made up of three male replicates and three female replicates per breed. The breed classes were F1 progeny of the purebred SassoC431 (n = 30), crossbred Black Australorp and SassoC431 (n = 30), and purebred Black Australorp (n = 30). The chicks were the product of 30 hens and 3 cockers for each breed class. For the crossbreed, 30 SassoC431 hens were crossed with 3 Black Australorp cockerels. The experiment was conducted from September 2022 to April 2023.

Data collection. Data on chicken growth rate in terms of live body weights, carcass weights, and sensory meat qualities for each breed was collected and recorded. Chicken live body weights were measured using a Salter hanging scale (model 235) on a gram basis. Chicken live body

weights were recorded every 2 weeks from 4 weeks up to 16 weeks for all the F1 progenies.

At the age of 16 weeks after weighing, a total of 54 chickens, three from each replicate, were randomly selected for slaughter. The chosen chickens were fasted overnight, slaughtered the following morning, scalded in boiling water, and manually plucked. Prior to being slaughtered, the chicken's live weight was measured. The carcass weight was found by removing the head, liver, heart, intestine, kidney, gizzard, caecum, and spleen from bled, plucked, and eviscerated chickens.

Twelve chickens of the same sex, comprising of four females from each breed with the highest carcass weights, were boiled simultaneously and added equal amounts of salt (breast and thigh meat) without flavouring, each breed in a different pot, and they were used to conduct a survey to assess sensory meat qualities. Twenty panellists were used in the study. Ten were community members who were not trained in any food testing industry. These assessed the sensory meat qualities and filled out a questionnaire by scoring the meat attributes using a five-point hedonic scale. Cooked meat samples from each treatment were presented in a random order and coded with different letters to avoid bias and the order effect. The waiting period between meat sample tastings was 10 minutes. After tasting, the panellists were instructed to rinse their mouths with water before tasting the next sample to avoid crossover effects. The major attributes of meat that were assessed are taste, tenderness, flavour, and color.

Data analysis. Growth data were subjected to a normality test using Shapiro-Wilk's test, and a two-way ANOVA was computed to examine breed variations in growth rates using Genstat® 18th Edition. The model included the fixed effects of breed and sex and the interaction between breed and sex. The means were separated using Fisher's protected least significant difference test at a 0.05 level of significance. The Logistic growth model was used to plot growth curves in Stat-Proc software, which was then used to predict growth patterns for the three chicken breed groups. The Kruskal-Wallis test was also computed using IBM SPSS version 23 to analyze none normal data on sensory meat quality variations between breeds. The resultant means were separated using Kruskal-Wallis test, and they were considered significantly different at the 0.05 level of significance.

RESULTS and DISCUSSION

The ANOVA results showed that breed and sex had a significant influence ($p<0.001$) on live weights, with the males significantly heavier ($p<0.003$) than their age-matched female counterparts from 4 to 16 weeks of age. The purebred SassoC431 was observed to have higher mean live weights mainly due to genetic makeup, since the breed is a slow growing broiler breed mainly selected for higher body weights, with adaptability to varying rearing conditions (Adeyonu *et al.,* 2021). Fekede *et al.* (2021) reported similar results for the mean weights of the male and female Sasso breed chickens at 16 weeks of age of 1619g and 1311g, respectively. The crossbred Black Australorp and SassoC431 had higher mean live weights when compared to the purebred Black Australorp. Keambou *et al.* (2015) and Munisi *et al*. (2015) reported that experiments on the inheritance of live weight in chickens resulted between the parents studied, which is similar to the results found in this study.

The logistic growth model was used to compute growth curves. The male chicken growth curve showed that the purebred SassoC431 breed had the highest growth rate from 4 to 16 weeks, followed by the crossbred Black Australorp and SassoC431 and lastly the purebred Black Australorp (Figure 1). The highest individual weight of the purebred SassoC431 at 16 weeks was 1800g, with the lowest individual weight being 1550g, while the crossbred Black Australorp and SassoC431 attained a highest individual weight of 1525g and the lowest being 1300g, and lastly, the purebred Black Australorp reached the highest individual weight of 1320g and the lowest individual weight of 1125g at 16 weeks of age

The growth curve showed that the purebred SassoC431 females had the highest individual weight of 1500g and the lowest of 1300g, while the crossbred Black Australorp and SassoC431 achieved the highest individual weight of 1350g and the lowest weight of 1175g, and lastly, the purebred Black Australorp attained the highest individual weight of 1000g and the lowest weight of 775g (Figure 2). The live weight of the purebred Sasso females at 16 weeks observed in this study was similar to observations by Fekede *et al.* (2021).

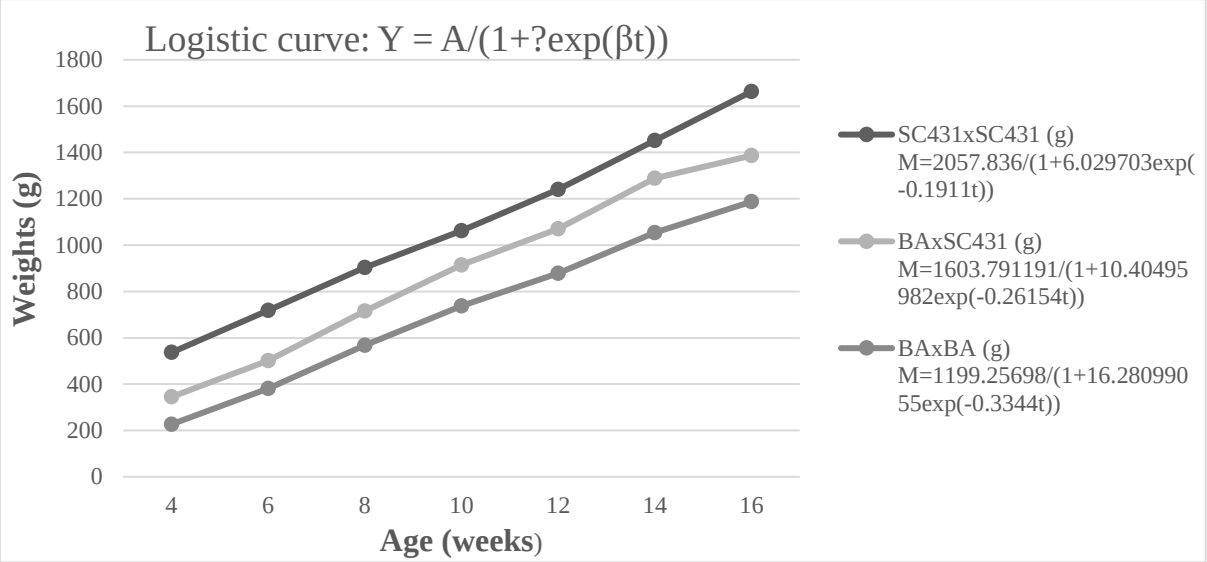

Figure 1. Male growth curves of three classes of chicken breeds estimated using the Logistic growth model

Table 1. Mean weights (g) (SE Mean) between the sexes of three breeds of chickens in different growth stages

		Breed Classification		
Age (weeks)	Sex	SC431xSC431 (n= 30)	BAxSC431(n= 30)	BAxBA (n= 30)
4	M	536.67 ± 7.26[a]		
Age (weeks)	F	379.67 ± 7.80[a]		
6	M	718.3 ± 10.1[a]	345 ± 7.64[b]	226.67 ± 7.26[c]
	F	533.3 ± 10.1[a]	224.33 ± 6.36[b]	168.33 ± 8.82[c]
8	M	903.3 ± 14.5[a]	501.7 ± 12[b]	381.7 ± 11.7[c]
	F	683.3 ± 14.5[a]	398.3 ± 10.1[b]	297.0 ± 10.4[c]
10	M	1061.67 ± 22[a]	715.0 ± 14.4[b]	568.3 ± 14.8[c]
	F	870.0 ± 21.8[a]	546.7 ± 14.8[b]	434.0 ± 14.3[c]
12	M	1240.0 ± 30.1[a]	914.3 ± 21.9[b]	738.2 ± 21.6[c]
	F	1034.7 ± 27.2[a]	738.3 ± 21.3[b]	588.3 ± 21.3[c]
14	M	1451.7 ± 43.2[a]	1070.0 ± 30.4[b]	878.0 ± 30.3[c]
	F	1223.3 ± 40.0[a]	889.3 ± 27.2[b]	661.7 ± 27.3[c]
16	M	1663.3 ± 60.1[a]	1288.0 ± 43.4[b]	1053.3 ± 43.4[c]
	F	1370.0 ± 55.7[a]	1070.0 ± 40.1[b]	770.0 ± 40.4[c]

[abc]Mean values within a row are significantly different if superscripts differ (*p < 0.05, ** p < 0.001), M-male, F-females, SC431xSC431 is the SassoC431 purebreed, BAxSC431 is the cross between Black Australorp and SassoC431 breed, BAxBA is the Black Australorp purebreed, n= is the number of chickens from each breed class.

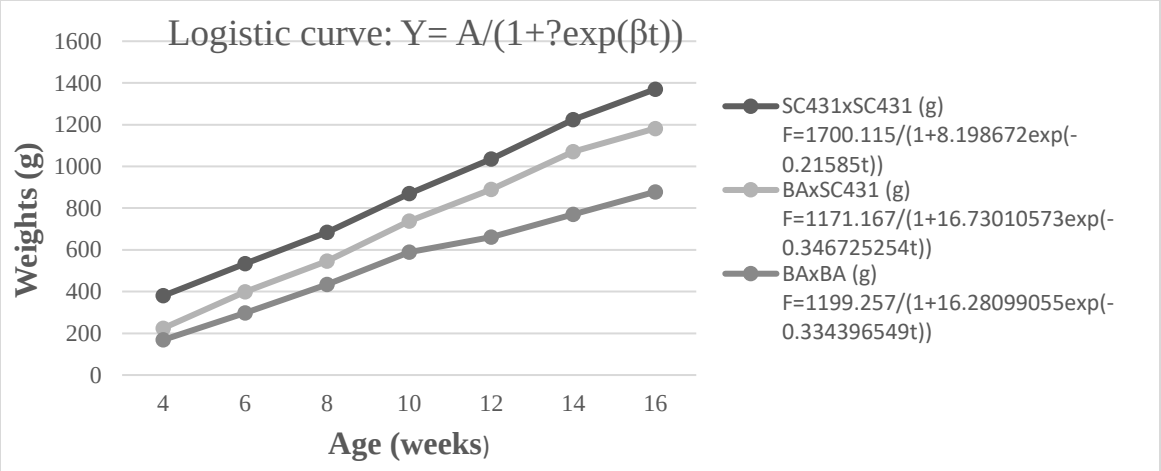

Figure 2. Female growth curves of three classes of chicken breeds estimated using the Logistic growth model

The study results showed that males had higher growth rate females. The higher growth rates in males than in the female might be due to the relatively large physical features of the male as a result of natural hormonal variations (Maria *et al*., 2003). Sexual dimorphism in the population of chickens under study had previously been shown by Sowande and Sobola (2008). Farmers and breeders can take advantage of this and promote a larger population of males so as to get higher meat yields. The live weights of the chickens at slaughter age had an influence on their carcass weight. The analysis of carcass weight showed the superiority of the SassoC431 breed for meat quality. The purebred SassoC431 had significantly higher carcass weights ($p<0.001$) compared to the purebred Black Australorp, while the values for the reciprocal cross were intermediate. Similar results of intermediate values for carcass weights of hybrids were reported by Keambou *et al.* (2015) when broiler chickens were crossed with local chickens in Cameroon. The range (70–70.4%) for dressing percent reported in this study was like the range (70.1–78.7%) reported by Itafa *et al.* (2021) in a pure and reciprocal cross experiment involving Sasso and Koekoek chickens in Ethiopia

Table 2. Mean weights (g) (SE Mean) carcass yield (g) and dressing out percentage between the sexes of three breeds of chickens at slaughter age

			Effects			
	Sex	**Breed**		**Breed Classification**		
Slaughter age (weeks)			Sex	SC431xSC431 (n= 18)	BAxSC431 (n= 18)	BAxBA (n= 18)
16	*	*	M	$1663.3^{a} \pm 60.1$	$1386.7^{b} \pm 60.0$	$1187.7^{c} \pm 60.2$
			F	$1370.0^{a} \pm 55.7$	$1181.7^{b} \pm 55.5$	$878.0^{c} \pm 55.7$
Dressed carcass weight	*	*	M	$1170.6^{a} \pm 41.2$	$974.2^{b} \pm 42.1$	$833.4^{c} \pm 43.0$
			F	$964.4^{a} \pm 43.3$	$841.9^{b} \pm 22.4$	$616.0^{c} \pm 38.6$
Dressing out %			M	70.38	70.25	70.17
			F	70.37	70.24	70.16

[abc]Mean values within a row are significantly different if superscripts differ (* $p < 0.001$), M-male, F-females, SC431xSC431 is the SassoC431purebreed, BAxSC431 is the cross between Black Australorp and SassoC431 breed, BAxBA is the Black Australorp purebreed, n= is the number of chickens from each breed class.

The Kruskal-Wallis test revealed that chicken breed had a significant influence ($p<0.001$) on sensory meat qualities. Slaughter age also has an influence on sensory meat qualities, especially meat tenderness; hence, the chickens were slaughtered at the same age of 16 weeks, but these chickens had different weights. The purebred SassoC431 had the highest mean ranks for all the sensory meat qualities that were assessed, followed by the crossbred Black Australorp and SassoC431 and lastly the purebred Black Australorp. The purebred SassoC431 had the highest mean ranks in all the meat attributes because it is a slow-maturing broiler breed; therefore, its superior genes for better meat superiority in terms of tenderness, taste, and color were expressed. Similar results for Sasso chickens sensory meat quality values were reported by Hoan and Khoa (2016) when they compared meat quality between fast-growing broiler Ross 308 and slow-growing Sasso chickens reared in a free-range system. They reported that the meat quality of Sasso chickens is higher, mainly due to the fat content.

Dyubele *et al*. (2010) reported substantial breed impacts on the majority of sensory qualities, with broiler meat receiving the top ratings. This demonstrates that even if various breeds are raised in the same conditions, they have varied sensory properties. Genetic variables affect the sensory qualities of chicken flesh, which is in accordance with the results found in this study. According to Wattanachant *et al*. (2004), the shear values of the indigenous chicken muscles, whether raw or cooked, are significantly higher than those for the commercial broiler, which is similar to the results found in this study, with the purebred SassoC431 meat being softer, juicer, and easier to chew when compared to the purebred Black Australorp meat which was tougher. This suggest that crossbreeding the two helps improve the meat quality of the Black Australorp which was found to be tougher.

Table 3. Kruskal-Wallis Test for Sensory Meat Qualities

	Breed Classification Mean Rank							
Dependent variable	SassoC431	Crossbreed	Black Australorp	N	df	Kruskal Wallis Test		P.value
Taste	49.45[a]	25.58[b]	16.48[C]	20	2	41.034		<0.001
Aroma	50.50[a]	20.50[b]	20.50[b]	20	2	56.663		<0.001
Tenderness	48.93[a]	27.40[b]	15.18[C]	20	2	41.950		<0.001
Colour	48.93[a]	27.43[b]	15.15[b]	20	2	41.355		<0.001

[ab]Mean values within a row are significantly different if superscripts differ at the 0.05 level.

CONCLUSION

Crossbreeding was not fully exploited since the crossbreed did not perform better than both breeds in the parameters measured in this study, but it was intermediate between the parents studied. The crossbreed however, performed better than the pure breed of Black Australorp showing an advantage of crossbreeding. In this study, crossing Sasso C431and Black Australorp improved the weight gain of crossbred, indicating that it is better for breeders to cross breed Black Australorps with Sasso C431 than breeding pure Black Australorps if weight gain is the main priority. Male chickens were significantly heavier than their age-matched female counterparts from four to sixteen weeks of age. This suggests that male population are to be promoted for increased meat yields. The purebred SassoC431 meat was softer, juicer, and easier to chew than the purebred Black Australorp meat, which was rough. This implies that crossbreeding the two improves the flesh quality of the Black

Australorp, which was discovered to be tougher. Based on the results of this study, we discourage pure breeding of Black Australorps when the Sasso C431 is available. Crossbreeding the two breeds will benefit the Black Australorp through improved meat quality and yields.

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DECLARATION OF NO CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in the publication of this article

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