Original article

Reproductive performance of crossbred cows on lowland terrain

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ABSTRACT

This study aims to identify the differences in reproduction performance of Ongole cross (PO), Limousine cross (Limpo), and Simmental cross (Simpo) in Kerek district, Tuban regency. Primary data was taken by interviewing inseminators and farmers, while secondary data was taken from the Fisheries and Animal Husbandry Department of Tuban regency. The total sample was 360 cows consisting of 30 PO, Limpo, and Simpo cows aged 3, 4, 5, and 6 years respectively which were calculated based on the Roscoe formula. Data was analyzed using the Simple Linear Regression and ANOVA followed by Duncan's multiple range test at a significance level of 95%. The results showed that the services per conception (S/C), conception rate (CR), and calving rate (CvR) were not significantly different ($p > 0.05$) between PO, Limpo and Simpo cows. Meanwhile, days open (DO) and fertility status (FS) of PO cows were higher ($p < 0.05$) than Limpo and Simpo cows. There was no significant difference ($p > 0.05$) in DO and FS between Limpo and Simpo cows. The linear equation with age as a predictor (X) of S/C, DO, and CI (Y) values were not significant ($p > 0.05$) in PO, Limpo, and Simpo cows. It could be concluded that the reproductive performance of PO cows was better than Limpo and Simpo cows.

Keywords: Limousin cross, Ongole cross, reproductive performance, Simmental cross

INTRODUCTION

In order to increase the productivity of beef cattle, the government imported superior breeds of Simmental and Limousin cattle to produce frozen semen at Artificial Insemination Centers in Indonesia (Harissatria *et al*., 2023). The implementation of artificial insemination using frozen semen on local (Ongole cross breed, PO) cows resulted in better birth weight and weaning weight of Simmmental-PO (Simpo) crossbred and Limousin-PO (Limpo) crossbred calves compared to PO calves. Limpo and Simpo cows were further bred with frozen semen from superior Limousin and Simmental bulls, with the hope of producing calves that are heavier in body weight than their dams. Genetically, the superior traits of Simmental or Limousin in F1, F2, and

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F3 were 50%, 75%, and 87.5%, respectively. At the age of 2.5 years, the body weight of Limpo and Simpo, in both dams and heifers, was heavier than PO (Setiyono *et al*., 2017; Dhita *et al*., 2017; Ridho *et al*., 2017).

Simmental cattle is a Bos Taurus breed from the Simme Valley area, Bernese Oberland, Switzerland. Superior Simmental cattle first entered Indonesia in 1976 in the West Sumatra region to improve the genetic quality of PO cattle by crossbreeding programs between the two types of cattle. Limousin cattle is a beef cattle breed first developed in France (Sutarno and Setyawan, 2016). Limousin cattle were first bred in the Limousin and Marche regions in west-central France 7000 years ago. Limousin was introduced in 2001 to produce frozen semen for artificial insemination in Indonesia (Baharun *et al*., 2023). Simmental cattle were successfully raised under subtropical climate conditions, with reproductive performance indexes (gestation length, service period, calving interval, services per conception, and first calving age) values within standards (Bolacali and Öztürk, 2017). Simmental and Limousin are less adaptable to the tropics (Priyo *et al*., 2020). Limousin and Simmental cattle come from subtropical climates and have problems when kept in tropical climate regions. Tropical climate conditions (temperature, sunlight intensity, air humidity, wind speed, and rainfall) are very different from subtropical conditions as the natural habitat of Simmental and Limousin cattle. Climate influenced the level of heat stress in cows. Continuous heat stress will cause a decrease in cow reproductive performance (Jaenudin *et al*., 2018).

Beef cattle farming in Indonesia is partly carried out in the lowlands with a tropical climate. Environmental pressure from a tropical lowland climate that is different from a subtropical climate could suppress the reproductive performance of cattle (Widyas *et al*., 2022). Studies on the reproductive efficiency of Limpo and Simpo cattle compared to PO cattle in the lowlands have yet to be widely studied. Therefore, this study aims to identify the differences in the reproduction performance of PO, Limpo, and Simpo cows as measured by S/C, CR, CvR, DO, CI and FS.

MATERIALS AND METHODS

This study was conducted in Kerek District, Tuban Regency (Figure 1). Geographically, Kerek District, Tuban Regency is located at coordinates 111°30'–112°35' East Longitude and 6°40'–7°18' South Latitude. Kerek District has karst topography with a height of +63 m above sea level, some of which are lowlands and limestone hills. Rainfall is 0-218mm/month (average 55.3 mm/month), with 90-120 rainy days per year. The average temperature and relative humidity are 26.0°C (22.4-34.8°C) and 86% (70%-97%), respectively.

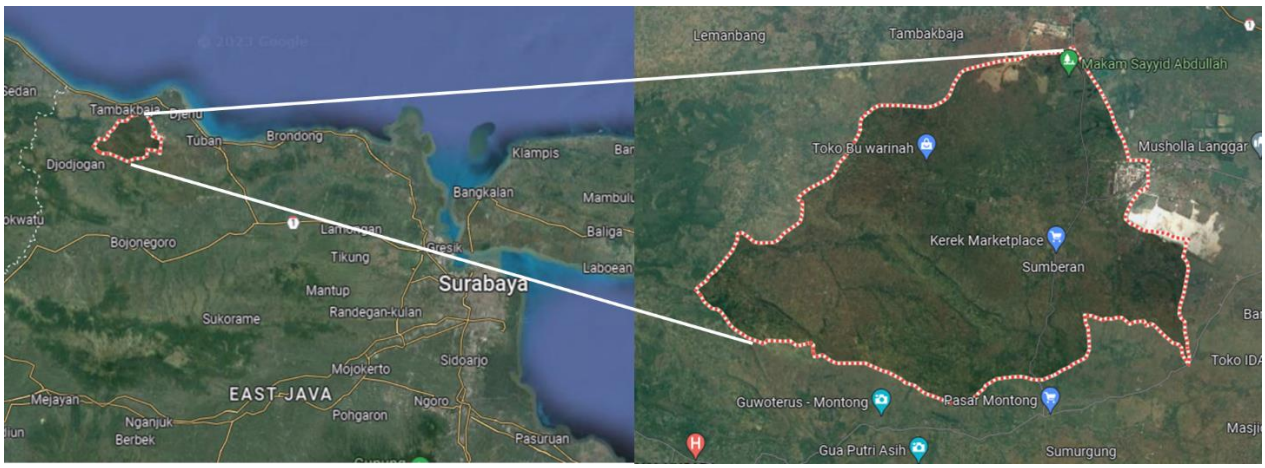

Figure 1 Map of study location in Kerek district (red dots), Tuban regency, East Java, Indonesia

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Data on pregnancy and calving after AI of beef cattle in Kerek District, Tuban Regency was collected. The population of beef cattle in Kerek District, Tuban Regency, is 27,662 consisting of 11,421 male and 16,241 female. The sample size in this study was calculated using the Roscoe formula (Memon *et al*., 2020), with n = 10 multiplied by the number of variables (three breeds of PO, Limpo, and Simpo cows resulted in 30 cows for each group and to a total 360 cows for the four ages of 3, 4, 5, and 6 years.

Data of each cow was explored based on questionnaire-guided interviews with inseminators and farmers, while secondary data of reproductive records of cows (artificial insemination, pregnancy, and calving) from the Tuban Regency Fisheries and Livestock Service for S/C, CR, CvR, DO, CI, and FS calculation. S/C is the number of artificial insemination services required by a cow to become pregnant. CR is the percentage of cows that become pregnant at the first insemination of the entire population of inseminated cows (Mutmainna *et al*., 2022). CvR is the percentage of calves born as a result of artificial insemination divided by pregnant females resulting from artificial insemination (Setiawan, 2018). DO is the interval between parturition and the next pregnancy (Temesgen *et al*., 2022). CI is the period between one calving and the next calving (Ananda *et al*., 2020). FS is the fertility rate of the cow, which is calculated using the formula (Saputra *et al*., 2019):

$$\mathrm{FS} = \frac{\mathrm{CR}}{\mathrm{S/C}} - (\mathrm{DO} - 125)$$

Data analysis

The collected data was then processed using Statistics Product and Service Solution (SPSS) version 25.0 at a confidence level of 95%. Data on CR, CvR, and FS were analyzed using one-way ANOVA followed by Duncan's multiple range test. Simple linear regression was used to determine the relationship between age and S/C, DO, and CI of cows' breeds.

RESULTS

The S/C, CR, and CvR values were not significantly different ($p > 0.05$) between PO, Limpo, and Simpo cows. The DO and FS values of PO cows were higher ($p < 0.05$) than Limpo and Simpo cows. There was no significant difference ($p > 0.05$) in DO and FS values between Limpo and Simpo cows (Table 1).

DISCUSSION

The S/C, CR, and CvR values were relatively the same between PO, Limpo, and Simpo cows. S/C, DO, and CI of the three breeds were not related to the age of the cows. It was presumably because the cows in this study were in their productive period, and their age range was very narrow (2-6 years). In rearing beef cattle, the optimum reproductive period for beef cattle dams is 2-7 years of age (Mutmainna *et al*., 2022). Heifers were first bred at the age of two years (López Valiente *et al*., 2021), and six years old cattle achieved the highest reproductive efficiency (Gottschall *et al*., 2007). Reproductive efficiency is influenced by the environment, nutrition, body condition score, farmers' knowledge, inseminators skill, and the quality of the semen used for insemination (Mutmainna *et al*., 2022). This study was conducted in sub-district areas where these controlled factors were relatively the same. Reports on the reproductive performance of PO and Limpo cattle were also not significantly different in Pilangkenceng, Madiun, revealing services per conception of 1.61 and 1.72, and conception rate was 53% and 59% (Bhaskara *et al*., 2018).

The normal range for S/C is 1.6-2.0 (Priyanto *et al*., 2023) and 60% in CR (Mutmainna *et al*., 2022). The ideal calving interval for cows is 365 days, with an average gestation period of 280 days and an interval of 53- 82 days from calving to the first post-calving estrus (days open) (Morris *et al*., 2016). The artificial insemination program for beef cattle in Manokwari Regency resulted in S/C of 1.8, CI of 12.9 months and CvR of 47.11% (Haryanto *et al*., 2019). The average calving rate was 60-70% and would never reach 100% due to failure of conception and death of the fetus or embryo (Khotimah *et al*., 2018). In Kalipuro district, Banyuwangi regency, S/C for January-March

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2020 was 1.71, 1.99, and 1.74, while CR was 58%, 50%, and 57%, respectively; and CvR was 44%, 84%, 53% (Dinul *et al*. 2022). In dairy cattle, S/C, DO, CR and FS were 1.5 ± 0.69, 95.6 ± 11.32 days, 65% and 72.4%, respectively (Saputra *et al*., 2019).

Table 1 Services per conception, days open, calving interval, conception rate, calving rate, and fertility status of PO, Limpo, and Simpo cows based on age group

	age	PO	Limpo	Simpo
Services/conception				
	3	1.77	1.77	1.77
	4	1.77	1.77	1.73
	5	1.70	1.70	1.73
	6	1.63	1.73	1.73
	Mean ± SD	1.72 ± 0.07	1.74 ± 0.03	1.74 ± 0.02
Days open (days)				
	3	126.69	141.07	131.74
	4	132.71	146.52	146.33
	5	124.39	148.79	147.68
	6	139.71	149.52	144.78
	Mean ± SD	130.88 ± 6.86 [a]	146.48 ± 3.82 [b]	142.63 ± 7.36 [b]
Calving interval (months)				
	3	13.31	13.7	13.37
	4	13.46	13.81	13.48
	5	13.11	14.00	13.61
	6	13.57	14.04	13.52
	Mean ± SD	13.36 ± 0.20	13.89 ± 0.16	13.50 ± 0.10
Conception rate (%)				
	3	56.67	60.00	63.33
	4	66.67	63.33	63.33
	5	66.67	66.67	63.33
	6	60.00	60.00	60.00
	Mean ± SD	62.50 ± 5.00	62.50 ± 3.19	62.50 ± 1.67
Calving rate (%)				
	3	86.67	90.00	90.00
	4	93.33	90.00	90.00
	5	90.00	93.33	93.33
	6	93.33	90.00	90.00
	Mean ± SD	90.83 ± 3.19	90.83 ± 1.67	90.83 ± 1.67
Fertility status				
	3	30.93	17.83	29.04
	4	29.96	14.26	17.21
	5	39.83	15.43	15.86
	6	22.10	10.16	16.83
	Mean ± SD	30.71 ± 7.26[b]	14.42 ± 3.21 [a]	19.74 ± 6.23 [a]

Regression analysis produced a linear equation with age as a predictor (X) of S/C, DO, and CI (Y) values, which were not significant (p >0.05) in PO, Limpo, and Simpo cows (Table 2).

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This result is different from a study around the Special Region of Yogyakarta which showed that PO and Limpo cows had better reproductive performance than Simpo cows. The S/C of the Simpo group was higher than the PO and Limpo groups. The study was conducted at an age range of between two and more than eight years. Age does not affect S/C but does affect the pregnancy rates. The older group had the highest pregnancy rate. Based on parity, less parity had the highest S/C and the lowest pregnancy rate, while DO was relatively the same in all groups. More parity and older age had relatively good reproductive performance compared to less parity and younger age (Priyo *et al*., 2020).

Table 2 Regression equation of S/C, DO, and CI (as Y) with age (as X) in PO, Limpo and Simpo cows

	Equation	R	R Square	Sign.
PO				
S/C	Y = 1.927 – 0.47 (X)	0.049	-0.002	0.598
DO	Y = 116.992 + 3.084 (X)	0.104	0.011	0.281
CI	Y = 13.166 + 0.044 (X)	0.045	0.002	0.643
Limpo				
S/C	Y = 1.805 – 0.12 (X)	0.011	-0.009	0.904
DO	Y = 139.181 + 1.367 (X)	0.037	0.001	0.715
CI	Y = 13.530 + 0.071 (X)	0.062	0.004	0.538
Simpo				
S/C	Y = 1.787 – 0.10 (X)	0.009	-0.008	0.919
DO	Y = 115.079 + 6.595 (X)	0.189	0.036	0.057
CI	Y = 13.036 + 0.112 (X)	0.103	0.011	0.301

Y= parameter; X= age; R= correlation coefficient, R Square= determination coefficient; Sign.= significance levels

The DO of Ongole cross cattle was better than that of Limousin cross cattle and Simmental cross cattle, this was thought to be because these two cattle are still adapting to the environment in the lowlands with rainfall of 0-218mm/month (average of 55.3 mm/month) with rainfall of 90-120 days per year. The average temperature was 26.0°C (22.4- 34.8°C), with an average relative humidity of 86% (70%-97%), and a temperature humidity index (THI) of 77.18. Bali cows raised in lowland tended to have 7.8 days shorter days open than those raised in highland areas. Daily environmental temperatures, such as air temperature, relative humidity, and THI, were 31.3°C, 63.4%, and 78.1 for lowland areas, and 24.5°C, 87.6%, and 69.4 for highland areas, respectively. Crossing Bali cattle with the Simmental breed in the lowland may lead to reduced reproductive efficiency for DO, PR, CI, and CvR compared to those in a highland environment (Pribadi *et al*., 2015).

Fertility Status is the fertility figure of the cow, which is calculated based on CR, S/C, and DO. The normal FS value is 60 (Saputra *et al*., 2019). The FS value of PO cows in this study was higher than the FS value of Limpo and Simpo cows due to the longer DO. Crossbred cattle weigh more at maturity, requiring more nutrition and energy. Meanwhile, purebred cows consumed less energy than crossbreds (Mendonça *et al*., 2019). It was suspected that the nutrition and energy were insufficient to produce optimum FS in Limpo and Simpo cows raised in Kerek District, Tuban Regency. Crossing has been widely used to increase livestock productivity in several countries to benefit from genetic diversity that produces phenotypic advantages (Widyas *et al*., 2022). However, it is necessary to investigate their reproductive physiology further to increase the

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reproductive efficiency of Limpo and Simpo cows.

CONCLUSION

The reproductive performance of Ongole cross cows was better than that of Limousin cross and Simmental cross cows. It is suggested that Ongole cross cows are more suitable for breeding in Tuban Regency, especially Kerek District, and further studies need to be conducted regarding the factors that influence differences in reproductive performance in Ongole cross, Limousin cross, and Simmental cross cows.

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AUTHOR'S CONTRIBUTIONS

Septiana Alafia Yusi Ardiyansyah (SAYA), Sri Agus Sudjarwo (SAS), Nusdianto Triakoso (NT), Tri Wahyu Suprayogi (TWS), Ismudiono Ismudiono (II), Oky Setyo Widodo (OSW)

SAYA: conceived the idea, designed the mainframe of this manuscript, acquisition, analysis, and interpretation of data, and manuscript drafting. SAS and NT: supervised the study. TWS, II, and OSW: critically read and revised the manuscript for intellectual content. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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