Evaluation of the productivity of the Belgian Blue x POGASI crossbred cattle raised at the Beef Cattle Research Station

M Primananda, Aryogi and P W Prihandini

Indonesian Beef Cattle Research Station, Jalan Pahlawan, Grati - Pasuruan, Indonesia
Corresponding author e-mail: peniprihandini@pertanian.go.id

Abstract. This study aimed to evaluate the productivity of the Belgian Blue x POGASI crossbred cattle raised at the Beef Cattle Research Station located at Grati, Pasuruan. Therefore, data on productivity, such as body measurements, birth, weaning, and yearling weight, as well as reproductive performances, were collected and analyzed using t-tests from 11 calves of Belgian Blue x POGASI (F1) crossbred cattle consisting of 5 males and 6 females, and also 11 calves of POGASI cattle consisting of 3 males and 8 females. From the results, there were significant differences (P<0.05) in body measurements between Belgian Blue x POGASI crosses and the POGASI cattle. Specifically, the Belgian Blue x POGASI crossbred calves had birth, weaning, and a yearling weight of 34.45±6.55 kg, 218.08±37.99 kg and 368.05±41.77 kg, respectively, as well as age at first estrus and libido of 12.99±3.13 months and 16.53±1.45 months, respectively. Also, the crossbred calves had body weight at first estrus and libido of 413.25±38.46 kg and 489.75±42.60 kg, respectively. In conclusion, the productivity of Belgian Blue x POGASI crossbred calves was higher than that of POGASI calves. Therefore, it was concluded that BB x POGASI calves produced greater performances than POGASI calves.

Keywords: Birth weight, weaning weight, yearling weight, POGASI cattle, crossbred cattle

1. Introduction
The Indonesian government has initiated efforts to improve domestic beef cattle production, including the selection of superior species of local cattle and the development of crossbred cattle, such as local cattle x Bos taurus. Furthermore, local cattle in Indonesia have outstanding characteristics such as high adaptability to extreme climatic conditions, the ability to digest low-quality feed, and disease resistance. POGASI cattle also known as “Peranakan Ongole Grati Hasil Seleksi”, is local cattle breed that has resulted from selection. It is local Indonesian cattle breed that has been selected for more than 13 years or up to four generations by the Agricultural Research and Development Agency through the Beef Cattle Research Station [1]. Furthermore, it is derived from the Peranakan Ongole (PO) cattle raised in Tuban, Lamongan, and Nganjuk of the East Java Province and also Rembang, Blora, Grobogan, and Sragen of the Central Java Province. POGASI cattle have superior characteristics such as the ability to digest high crude fiber feed while consuming low crude protein. As a result, this local cattle breed is appropriate for rearing in remote areas [1]. Meanwhile, crossbreeding between local cattle and Bos taurus, hopefully increases local cattle productivity since the superior characteristics of both breeds are expected to be passed down to their offspring. Also, the Belgian Blue cattle are a breed of beef cattle from Belgium that have low fat and high protein content, as well as a double muscling phenotype due to mutations in the myostatin gene. [2].

This study aimed to evaluate the productivity of POGASI cattle compared with that of the Belgian Blue x POGASI crossbred cattle.
2. Materials and methods

2.1. Time and location
This study was conducted from January 2018 to December 2020, where animals were raised in experimental pens at the Beef Cattle Research Station of Grati, Pasuruan, East Java, which is located at 7.30' - 8.30" south latitude and 112°30" - 113°30" east longitude. This location is classified as a lowland, which is 0-100 m above sea level, with temperatures ranging from 18.70°C to 36°C at an average of 28.5°C, as well as relative humidity ranging from 31.8 % to 96.2 % at an average of 74.7 %.

2.2. Materials
This study included 11 POGASI calves as well as 11 BB x POGASI crossbred calves. Furthermore, the calves in both groups are from the same cows, which were inseminated with BB straws in thirty POGASI cows.

2.3. Procedures
Data on cattle productivity were obtained by direct measurements.
- Birth weight (BW) is the weight of the calves at birth, which is maximum at 3 days of age [3]
- Weaning weight (WW) is the weight of the calves during weaning, which was adjusted to 205 days of age, as follows [4]:
  \[
  WW_{205} = \left( \frac{WW - BW}{Age} \times 205 + BW \right)
  \]
  Where,
  \[
  WW_{205} \quad : \quad \text{weaning weight adjusted to 205 days of age (kg)}
  
  WW \quad : \quad \text{weight at weaning (kg)}
  
  BW \quad : \quad \text{calf birth weight (kg)}
  
  Age \quad : \quad \text{age of calves at weaning (days)}
  
- Yearling weight (YW) is the weight of the calves at yearling, which was adjusted to 365 days of age, as follows [4]:
  \[
  YW_{365} = \left( \frac{YW - WW}{Age} \times 160 + YW_{205} \right)
  \]
  Where,
  \[
  YW_{365} \quad : \quad \text{yearling weight adjusted to 365 days of age (kg)}
  
  YW \quad : \quad \text{weight at yearling (kg)}
  
  WW \quad : \quad \text{weight at weaning (kg)}
  
  Age \quad : \quad \text{interval between weaning and weighing (days)}
  
Cows were evaluated for their reproductive performances, which includes S/C, conception rate (CR) and gestation length. In this study, mating was conducted by natural breeding for the POGASI breed and artificial insemination for the BB x POGASI cross.
- S/C is the number of insemination services until a cow becoming pregnant [5].
  \[
  S/C = \frac{\text{Number of insemination services to make pregnant}}{\text{Number of pregnant cows}}
  \]
- Conception ratio is the percentage of pregnant cows in the first insemination [5].
  \[
  CR = \frac{\text{Number of pregnant cows in the first insemination}}{\text{Number of inseminated cows}} \times 100 \%
  \]
- Gestation length was determined as the interval between the day of AI or natural mating that resulted in pregnancy and the day of calving.

Data obtained were tabulated as mean and standard deviation and analyzed using the t-tests, as follows [6].
Where,
X1 is the means of the group 1
X2 is the means of the group 2
N1 is the number of observations in group 1
N2 is the number of observations in group 2
S is the pooled standard deviation

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{S \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \]

Where,
X1 is the means of the group 1
X2 is the means of the group 2
N1 is the number of observations in group 1
N2 is the number of observations in group 2
S is the pooled standard deviation

\[ S = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}} \]

Where,
n1 is the number of observations in group 1
n2 is the number of observations in group 2
S1 is the standard deviation of group 1
S2 is the standard deviation of group 2

3. Results and discussion

3.1. Calf productive performances
Productive performances of POGASI and BB x POGASI cross calves are shown in Table 1. At birth, BB x POGASI cross calves had significantly higher (P < 0.05) performances than POGASI calves, which includes bodyweight, shoulder height, body length and chest circumference of 34.45±6.55 kg against 25.55±2.62 kg, 71.82±2.71 cm against 63.27±4 cm, 66.82±3.68 cm against 60.36±4.27 cm, and 73.36±4.03 cm against 64.91±3.45 cm, respectively.

Table 1. Productive performances of POGASI and BB x POGASI cross calves.

| Trait                      | POGASI       | BB X POGASI |
|----------------------------|--------------|-------------|
| Birth weight (kg)          | 25.55±2.62\textsuperscript{a} | 34.45±6.55\textsuperscript{b} |
| Shoulder height* (cm)      | 63.27±40\textsuperscript{a} | 71.82±2.71\textsuperscript{b} |
| Body length* (cm)          | 60.36±4.27\textsuperscript{a} | 66.82±3.68\textsuperscript{b} |
| Chest circumference* (cm)  | 64.91±3.45\textsuperscript{a} | 73.36±4.03\textsuperscript{b} |
| Weaning weight (kg)        | 142.88±31.28\textsuperscript{a} | 218.08±37.99\textsuperscript{b} |
| Yearling weight (kg)       | 217.75±46.47\textsuperscript{a} | 368.05±41.77\textsuperscript{b} |
| Daily weight gain (kg/days) | 0.42±0.24\textsuperscript{a} | 0.96±0.16\textsuperscript{b} |

\textsuperscript{a,b} different superscript letters within same rows indicate significant difference (P<0.05).

Crossbreeding has two advantages, which includes heterosis and the combination of characteristics from both parents that are inherited by their offspring [7]. Also, bulls have a genetic influence on body size and the double muscling phenotype, which is passed down from parents to their offspring [8].

Aryogi et al. [1] obtained a lower birth weight of 25.5 kg for POGASI cattle, but Rasyid and Efendy [9] obtained a higher shoulder height, body length, and chest circumference of 73.0±3.6 cm, 61.7±6.0 cm, and 70.3±8.4 cm, respectively, for POGASI cattle. Furthermore, the birth weight of BB x POGASI crossbred calves in this study was higher than 26.83±5.10 kg as observed by Jakaria et al. [10]. Meanwhile, there are several factors affecting birth weight, including the age of cows, sex, bull breed, litter size and time of birth [11]. Subsequently, calf birth weight ranges from 20 to 35 kg [12].
Table 1 shows the weaning and yearling weights of the cattle studied, which have been adjusted to 205 and 365 days of age, respectively. Furthermore, the weaning and yearling weight gain in BB x POGASI cross calves was higher (P<0.05) than in POGASI calves. Conversely, Arista et al. [13] obtained 112.58±24.17 kg for the weaning weight of PO calves, which is less than the weaning weight of POGASI calves obtained in this study. More so, Ainur and Jauhari [9] discovered 150.3±10.2 kg as the weaning weight of PO calves, which was greater than the weaning weight of POGASI calves obtained in this study. Jakaria et al. [10] obtained 165.2±21.3 kg and 240.7±28.1 kg for weaning and yearling weight, respectively, for the BB x POGASI crossbred calves, which were lower than those obtained in this study.

Crossbred cattle outgrew local cattle in general, but they are less adaptable to tropical climates like those found in Indonesia. In addition, they also require high-quality feed, a suitable temperature, and a high-volume production system. A variety of factors influence weaning weight, including cow management during lactation, breed, feed, and disease [9].

The daily weight gain of the investigated cattle is presented in Table 1. From the results, BB x POGASI crossbred calves gained more weight daily than the POGASI calves given by 0.96±0.16 kg/day against 0.42±0.24 kg/day, respectively. Furthermore, the results of this study were comparable to those of Jakaria et al. [10], who reported that daily weight gain of PO and BB x PO cross calves was 0.47±0.14 kg/day and 0.52±0.14 kg/day, respectively. Genetic and environmental factors (feed) have a strong influence on growth performance [14].

3.2. Body weight and age at first estrus and libido of BB x POGASI cross calves

| Trait               | Reproductive performance |
|---------------------|--------------------------|
| First estrus        |                          |
| Body weight (kg)    | 413.25±38.46             |
| Age (month)         | 12.99±3.13               |
| Libido              |                          |
| Body weight (kg)    | 489.75±42.60             |
| Age (month)         | 16.53±1.45               |

Several signs, such as estrus (in females) and libido, can be used to identify reproductive behavior in cattle in bulls. In addition, reddening and swelling of the vulva, mucus discharge, restlessness, and loss of appetite are all signs that a cow is about to enter estrus. These signs, such as flehmen response, restlessness, climbing the wall, and penis in mid-erection, increase the libido of bulls, shown by prepuce unfolds along the penis.

The mean body weight of BB x POGASI cross calves at first estrus was 413.25±38.46 kg, and the age at first estrus was 12.99±3.13 months, as presented in Table 2. In addition, male calves with an average body weight of 489.75±42.60 kg developed a strong libido at the age of 16.53±1.45 months. Previously, Affandhy et al. [15] discovered that the age at first estrus of Simmental and Limousin crosses was 14-19 months. As a result, PO x Limousin and PO x Simmental crosses had a higher age at first estrus (270±15 days) and an average bodyweight of 283.4±20.1 kg [16] when compared to the results of this study.

A proper maintenance system during the growth phase is essential for producing optimal weight gain, allowing cattle to reach puberty and sexual maturity sooner since estrus can be inhibited by low body weight. Also, Heifers entering their estrous cycles require optimal body weight and condition because long-term underweight can lead to reproductive problems [9].

3.3. Reproductive performances of POGASI cows that produce BB x POGASI cross calves

| Trait                | Reproductive performance |
|----------------------|--------------------------|
| S/C                  | 4.36                     |
| Conception Rate (%)  | 23.33                    |
| Gestation length (days) | 278±8.06                |
As shown in Table 3, the average S/C was 4.36, implying that POGASI cows required 4.36 times of AI services to produce a cross-calf pregnancy. Furthermore, S/C values within the normal range between 1.0 and 2.0 [17,18]. A higher S/C ratio indicated inefficiency in reproduction [19]. However, the S/C of POGASI cows was inefficient because it extended the days open and calving interval, resulting in delayed calving production. The high S/C found in this study could be attributed to early embryonic death.

Meanwhile, the conception rate of POGASI cows at the first AI service was quite low at 23.33 % because of the high S/C value. In this study, the average gestation length was 278±8.06 days. Management factors such as malnutrition, mineral deficiency, insemination techniques, and internal cow factors can all contribute to reproductive failure [19]. In this regard, both internal factors such as cow reproductive conditions and external factors such as AI, straw conditions, mating time, and feed have a significant impact on the conception rate [9].

More so, environmental factors such as altitude, which is closely related to temperature, and humidity can have an impact on cattle reproductive performance. Cattle raised in the lowlands will suffer from heat stress due to the relatively high temperature and humidity, which will decrease fertilization due to high cortisol levels, resulting in uterine contractions. Meanwhile, temperature and humidity can have an impact on cattle feeding behavior and estrous cycles, while heat stress can cause abnormally brief estrous cycles [20].

4. Conclusion
In conclusion, Belgian Blue x POGASI calves produced greater performances than POGASI calves. However, high AI services and a longer gestation period was needed in order to produce Belgian Blue x POGASI crossbred calves. As a result, extensive research is still required to assess the reproductive performance of Belgian Blue x POGASI cross calves.

References
[1] Aryogi, Pamungkas D and Efendy J 2020 Formation and Phenotypic Performance of The New Breed POGASI Agrinak Cattle IOP Conf. Ser. Earth Environ. Sci. 492 012106
[2] Fiems LO 2012 Double Muscling in Cattle: Genes, Husbandry, Carcasses and Meat J. Anim. Sci. 2: 472–506
[3] Direktorat Jenderal Peternakan 2007 Petunjuk Teknis Uji Performans Sapi Potong Nasional (Jakarta: Kementerian Pertanian)
[4] Hardjosubroto W 1994 Aplikasi Pemuliaan Ternak di Lapang (Jakarta: Gramedia)
[5] Feradis 2010 Bioteknologi Reproduksi pada Ternak (Bandung: Afabeta)
[6] Widjarjono A 2010 Analisis Statistika Multivariat Terapan (Yogyakarta: UPP STIM YKPN)
[7] Weaber RL 2015 Crossbreeding strategies: Including terminal vs. Maternal Crosses (Colorado: The Range Beef Cow Symposium) pp 117-130
[8] Warwick IJ, Astuti JM and Hardjosubroto W 1990 Pemuliaan Ternak (Yogyakarta: Gadjah Mada University Press)
[9] Rasyid A and Efendy J 2014 Bobot Lahir dan Bobot Sapih Pedet Hasil Turunan Pejantan Sapi PO Terpilih di Unit Pelaksana Teknis Daerah Budidaya Ternak Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner (Malang: Puslitbangnak) pp 55-60
[10] Jakarta, Edwar, Ulum MK and Priyanto R 2019 Evaluasi Kinerja Pertumbuhan Sapi Silangan Belgian Blue dan Peranakan Ongole Jurnal Agripet. 19: 136-141
[11] Hartati and Dikman DM 2007 Performans Pedet Sapi Peranakan Ongole (PO) pada Kondisi Pakan Low External Input Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner (Bogor: Puslitbangnak) pp 137-142
[12] Muslim KN, Nugroho and Susilowati 2013 Hubungan antara Bobot Induk dan Bobot Lahir Pedet Sapi Brahman Cross pada Jenis Kelamin Berbeda J. Ilmu-ilmu Peternakan 23: 18-24.
[13] Arista S, Sutopo and Kurnianto E 2019 Evaluasi Keunggulan Genetik Sapi Peranakan Ongole Betina Dengan Dua Metode Yang Berbeda Di Satker Sumberrejo-Kendal Jurnal Ilmu dan
Acknowledgments
This research was supported by The Agricultural Research and Development Agency of the Ministry of Agriculture.