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To cite this article: S Suyadi *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **478** 012080

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Some Factors Affecting the Semen Production Continuity of Elite Bulls: Reviewing Data at Singosari National Artificial Insemination Center (SNAIC), Indonesia

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Abstract. Singosari National Artificial Insemination Center (SNAIC), East Java is one of the most important Government Institution which produces frozen semen from elite bulls and distributes it to overall Indonesia regions of the most part and to overseas of the other small part. The local elite bulls at SNAIC were originated and selected from the population based on the phenotypic characteristics and pedigrees. While the exotic breed was originated from the certified elite bulls from company in overseas. This paper was aimed to review the consistency of semen production of elite bulls over the years from 2012 to 2018. The semen production was controlled by the age of bulls. The semen volume was quite low from the age of 2 – 4 years old, increased from 5 – 8 years old, and reached maximum volume by 9 years old and forward. The individual motility of sperm was low in first phase of semen collection by age of 2 years and then reached stable motility from the age of 3 years old and forward. While the sperm concentration was stable normal and not affected the age of bulls, ranged from 1004 ± 289 to 1124 ± 306 ($\times 10^6$) sperm / ml. When the body weight was grouped as low, medium and high, the semen volume, sperm motility and sperm concentration per ml were significantly increased in all parameters. The semen could be collected continuously by months over year although the ejaculate volume and sperm motility were significant different three monthly might be due to the different climate and quality of consumed feed. The higher semen production was during the period of October – December and the lowest was from January to March. The semen production during the periods of April – June was similar to those from July – September. In conclusion, by excluding the feed and feeding factors, the semen production of elite bulls at Singosari National Insemination Center (SNAIC) were affected by age of bulls, body weight and months of semen collection.

1. Introduction

Artificial insemination is a very efficient tool for spreading superior genetic material of male cattle to the female through the spread of male gametes, spermatozoa, to fertile females. Thus Artificial Insemination is the right step to accelerate genetic improvement in offspring inherited from parents in



more short time period than with natural mating system, in order of breeding program in cattle farming [1].

To support the implementation of Artificial Insemination with guaranteed genetic quality and sustainable supply of bull semen, it is needed an Institution or Center that produces frozen semen from superior bulls. The Singosari National Artificial Insemination Center (SNAIC), is the largest Center for Artificial Insemination in Indonesia that produces semen from several breeds of superior bull such as Bali cattle, Madura Cattle, Ongole Grade or PO Cattle, Limosin Cattle, Simental Cattle and Holstein Friesian Dairy bulls [2]. The SNAIC is a semi-commercial government institution that markets semen from elite bulls to all regions of Indonesia and a small portion of them has been exported abroad.

To ensure the sufficient quantity and quality of semen supply that available continuously across the year, the bulls as source of semen should be maintained and reared under optimal condition [3]. The capacity of bull for producing semen, however, is not only influenced by the management system, but is also affected by some other factors such as age, body weight, seasons / climate, disease, breed as well as breed of bull [4, 5, 6]. Other researchers reported the reported correlations pattern between body weight and scrotal circumference with the semen production in Indonesia local cattle. The body weight of bull showed high correlation to the semen production (volume, progressive motility and sperm abnormality), while the scrotal circumference showed only low to medium correlations to semen production [7]. On the other hands, the Sahiwal crossbred and Friesian Holstein bull in Bangladesh showed the positive significant correlation between scrotal circumference with semen production characteristics when the scrotal circumference ranged between 28 to 34 cm [8, 9]. In dairy bull kept in subtropical country, the semen production was significantly affected by seasons, where the higher production was reported during rainy and winter season than those during summer season [10]. In contrast results was reported in Bali cattle bull in Indonesia, that the semen production (volume, sperm concentration per ejaculate and sperm motility) was higher during dry season than those for rainy season [11]. The season was observed as the factor affecting the production and reproduction of Bali cattle [12]. This paper presents the analysis and review results if the semen production capacity and continuity are affected by some factors such as age, body weight, scrotal circumference of some breed of bulls and different climate or season conditions at Singosari National Artificial Insemination Center, East Java, Indonesia.

2. Age of bull and semen production

Semen from bull could be firstly ejaculated when the bull candidate reached already at puberty age [13]. It is important to observed and control the age of bull candidate to reach the first-time ejaculation, since the earlier age of bull that could ejaculate semen will give positive effect of increasing efficiency of bull management. In Bali cattle of elite bull, although the puberty is reached at about 9 months old, but the acceptable continuous semen production begins in 2 years old. Semen volume was constant from 2 – 4 years old (4.7 – 4.9 ml/ejaculate), then tended slightly to increase from 5 – 8 years old and constant from those periods, and then again increased until 10 years old. The similar pattern was observed for sperm motility (56.7% - 60.1%, 62.5% - 62.8%, and 65.5%, respectively), but not for sperm concentration where it was in constant value in overall the age of bull ranging from 1004 to 1088 million sperm cell/ml semen. Age of bulls correlated significantly to semen volume, sperm motility and sperm concentration [6]. In Simental bull, the pattern of semen production in relation to age of bull was similar to the Bali bulls. The semen production (volume, sperm motility and sperm concentration per ejaculate were constant from the age 2 to 10 years old, and then decreased from 10 to 13 years old [14].

3. Scrotal circumference and semen production

Semen of bull is developed and produced in the lumen of tubuli seminiferi in the testes. Therefore, it is possible to analyze the correlation between the volume of testis as well as the scrotal circumference. In Ongole Grade (PO) cattle, scrotal circumference showed low correlation to semen volume ($r = 0.1$), but medium value for sperm motility ($r = 0.36$) and sperm concentration ($r = 0.38$) [7]. This might be due to the limited sample included in this study ($n = 9$). On the other hands, high correlations were showed

in Bali cattle between scrotal circumference and semen volume ($r = 0.63$) and sperm concentration ($r = 0.60$), but correlated weakly to sperm motility ($r = 0.23$) [15].

4. Effect of body weight

Body weight and growth rate are functions of production of the ability of bulls to produce semen. This is because normal reproduction activities can take place only if the male cattle are able to achieve optimum body growth. In Bali bull, body weight was significantly depending on the age of bull, and both of the variables showed closed correlation ($r = 0.66$). Furthermore, the body weight correlated closely to semen volume, sperm motility and sperm concentration ($r = 0.39, 0.13$ and 0.18 , respectively, $P < 0.01$) [6]. In PO cattle, closed correlation ($P < 0.01$) between body weight and semen production was also observed. Higher correlation was found between body weight and sperm motility ($r = 0.65$), body weight and semen volume ($r = 0.48$), and then followed by the correlation between body weight and sperm concentration ($r = 0.33$) [7]. An unusual fact is found in the relationship between body weight and semen production in Limosin cattle, where the correlation value between body weight and semen volume, sperm motility and sperm concentration are all zero ($r = 0.00$, $P > 0.05$) [14].

5. Effect of seasons

Indonesia is a tropical country that does not have very extreme seasonal differences in a year. In Indonesia there are only two seasons, the rainy- and dry season. For the beef cattle farming and breeding, the possibility of influencing factors may be limited to the providing of feed, little difference in the average daily temperature and relative humidity during rainy and dry seasons. However, the possibility of accumulation of various differences in environmental conditions between the rainy and dry season may also have a noticeable influence on the physiological and reproductive processes, thus allowing differences in producing semen of bulls. The semen production (semen volume, sperm motility and sperm concentration) during rainy season and dry season was not significantly different, although the semen production during rainy season tended to be higher than those for dry season (Volume: 5.35 vs. 5.221 ml; Concentration: 1156.9×10^6 vs. 1101.07×10^6 sperm/ejaculate; Sperm motility: 63.8% vs. 62.72%, for rainy and dry seasons, respectively). Figure 1 illustrates the slight differences of semen production of PO bull during rainy and dry seasons in Singosari National Artificial Center of Indonesia.

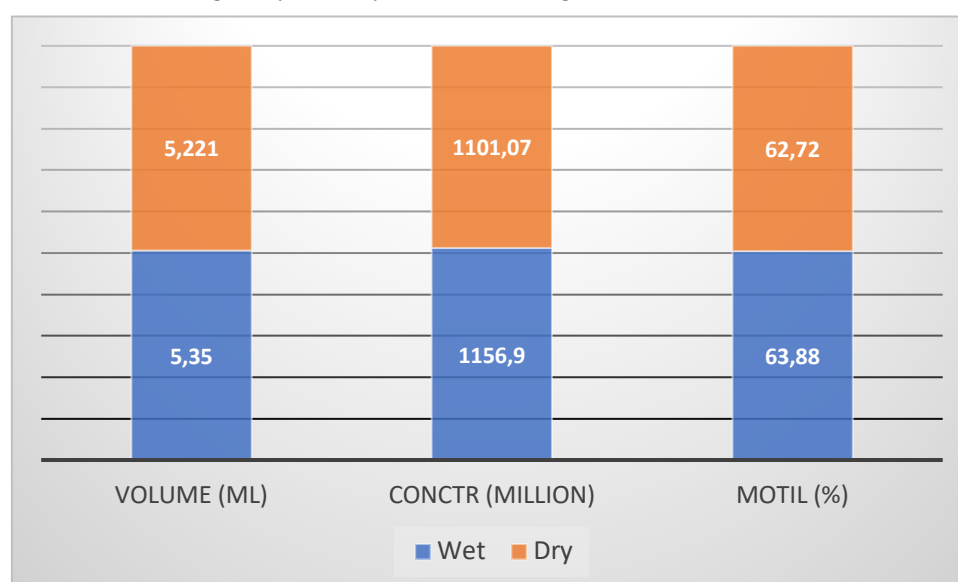


Figure 1. Illustration of difference in the semen volume, sperm concentration and sperm motility of PO bull during rainy and dry season

The semen production in PO cattle cross the year of two consecutive years of 2017 and 2018 was significantly affected by the months of the seasons. Although Indonesia principally has only two seasons

a year, however, it can be divided into 4 sub-seasons such as from October to December (Pre-Rainy), January to March (Rainy Season), April to June (Pre-Dry season) and July to September (Dry season). The semen production of PO bull over the year (2017-2018) is illustrated in Figure 2.

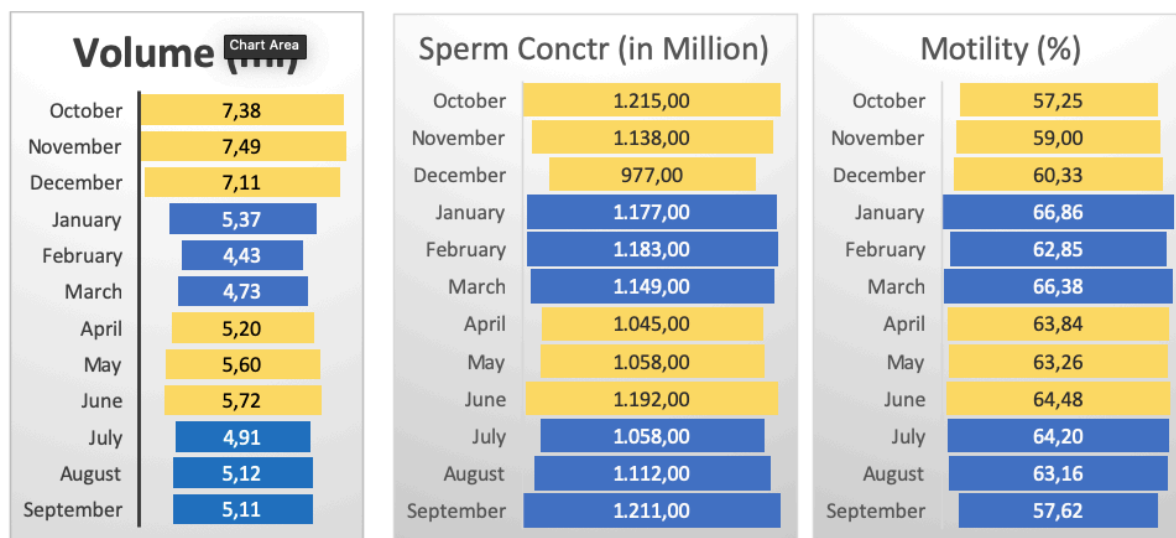


Figure 2. Illustration of semen volume (mL), sperm concentration (in Million) and sperm motility (%) over the year of PO bull at Singosari National Artificial Center, Indonesia

Semen volume and sperm concentration were significantly higher ($P < 0.01$) during Post-Dry (or Pre-Rainy) season as well as during Wet and Dry season, while the sperm motility was not affected by the season. This might be during the pre- and post-rainy season the weather is cool and very comfortable environment for optimal physiological mechanisms, so that the bulls were able to produce semen optimally, where SNAIC is located on the highlands with an altitude more than 800 m above sea level, so the environment temperature is cooler during the turn summer to the rainy season, and the turn rainy season to summer.

6. Conclusions

Some factors should be considered in the rearing of elite bull to ensure the high semen production and continuously volume, sperm concentration and sperm motility. The body weight of bull is one of important indicator for predicting the vigour of bull in the producing semen as expected since the body weight has close correlation to the semen production, while the scrotal circumference is discussable when to use in semen production predictor. Seasons showed an important factor should be noted as determinant in the semen volume and sperm concentration. So the technician should control the micro environment condition over the year to ensure the constant semen production. Feed and feeding for bull should consider the quality and quantity of feed to adapt the needs of the bull requirement during the rainy and dry seasons.

Acknowledgment

Authors thank very much to Directorate General of Higher Education of the Republic of Indonesia for grand funding to conduct research, although this research has not fully been completed and is continuing to analyze genetic factors using molecular genetic techniques. To Enniek Herwijanti, DVM, MSc. Director of Singosari National Artificial Insemination Center for providing valuable data of semen

production in different breeds of bull and to Aldyon Restu Azkariahman for his support in preparing the manuscript, thank very much.

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