



Selection of Ongole crossbred bulls in Indonesia based on genetic potential and semen quality

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Abstract

The improvement and long term sustainability of local cattle genetics in Indonesia are essential to support national beef productivity. This study aimed to identify superior Ongole Crossbred (OC) bulls through an integrated evaluation of genetic potential, semen quality, and the reproductive performance of their male offspring. A total of 82 heads consisted of 38 OC bulls and their 44 male offspring were evaluated for morphometric traits (body weight and withers height) and semen quality parameters (motility, concentration, and viability). Genetic evaluation was performed using phenotypic selection combined with Most Probable Producing Ability (MPPA) analysis to predict the consistency of inherited traits. The results showed that two of four selected bulls exhibited the most favorable combination of growth traits and reproductive parameters. Both bulls produced semen with motility and viability exceeding breeding standards (>70%), with body weights above population average. Heritability (h^2) values for semen traits ranged between 0.19 and 0.29, and repeatability (r) values were high (>0.49), indicating substantial genetic influence and stability of trait expression across ejaculate records. Among the 11 progeny that were selected, high performance of bulls had sperm motility, ranging from 45.0-87.3%; sperm concentration (899.1-2066.0 million/mL); viability (57.0-94.2 %). Repeatability (r), heritability (h^2) and MPPA values of selected offspring for semen traits; motility (0.49; 0.20; 69.12); concentration (0.49; 0.29; 1101.16); viability (0.51; 0.19; 79.92); and body weight (0.50; 0.14; 509.10). Overall, bull A.219/1 showed the most optimal combination of genetic and reproductive characteristics, followed successively by bulls 12.12.34, 13.12.26, and 14.2.2.

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Introduction

Ongole crossbred (OC) cattle (*Bos indicus*) are one of Indonesia's indigenous cattle, designated by Minister of Agriculture Decree No. 2907/Kpts/OT. 140/6/2011 (1). Smallholder farmers commonly keep this breed, as the local cattle have many advantages, including being able to adapt to different agroecosystem conditions (tropical climate),

resistant to hot weather, resistant to parasites (mosquitoes and ticks), resistant to animal diseases, tolerant to feed, produce meat and power to plow land before planting season (2,3). The breed is often crossed with European breeds such as Limousin bull x OC cow (LIMPO) and Simmental bull x OC cow (SIMPO) to produce hybrid vigour for increasing productive performance. The OC cattle are often crossed with other local breeds, such as OC bulls and Balinese cows

(POBA) cattle; however, the new crossbred can cause bull infertility and low reproductive rates (4). The very rapid development of artificial insemination using European cattle, the breed preferences among farmers towards Ongole cattle declined as this breed is seen as non-profitable, and low market values of Ongole calves (5) has caused the population of OC cattle to decline, thus threatening the preservation of OC cattle germplasm.

Selection program can be seen as an effort to maintain the OC cattle germplasm as well as improve the productive performance of OC cattle. This resulted in the development of several improved Ongole Crossbred populations, including Kebumen Ongole Grade cattle, which have been established through community-based breeding and village breeding programs in Kebumen Regency (6), as well as POGASI Agrinak cattle (7), and selection of local Indonesian cattle breeding, especially in the breeding source area (8). The selection program of OC cattle as local cattle in Indonesia will ensure OC cattle that are adaptive and have genetic advantages, including being adaptive and having high productive performance in the tropical climate of Indonesia.

Improving the genetic quality of beef cattle is a crucial aspect of beef cattle production. Beef cattle production contributes to the supply of a vital animal protein and nutrition, as well as to the livelihoods of many communities, especially in rural areas (9). A study also reported that the beef cattle industry can support the economic role of farmer households and become a leading commodity for economic development in Indonesia (10). Therefore, the utilization and genetic improvement of sustainable local cattle and the genetic improvement of Indonesian local cattle are pivotal actions that should be taken (11).

Genetics is a crucial aspect to improve the productivity of beef cattle. Farmers need qualified, proven bulls that have high productive performance. The bull productivity is defined as the ability of bulls to produce calves. This trait can be inherited and responds to selection (12). Bull selection programs can support the improvement of livestock productivity by providing superior bulls. However, the limitation of superior bulls that can be used as breeders (in natural mating) or semen sources is one of the issues in the selection program. Selection can be based on genetic and phenotypic factors (13), superior trait selection (such as semen quality, body weight, and libido) (14), and environmental factors (including age and frequency of ejaculation) (15). Heritability value is one of the genetic parameters in bull selection (16). It has been reported that selection based on high heritability values in semen traits can drive genetic improvement through enhanced semen quality (17). Bull selection can also be done by estimating breeding value. Estimation of breeding value can be observed through two methods: the short-term Most Probable Producing Ability (MPPA) method and the long-term Estimated

Breeding Value (EBV) method (18). The use of MPPA or EBV methods can result in optimal bull selection, particularly in smallholder farms (19).

Selection based on reproductive traits is called Breeding soundness evaluation (BSE). The evaluation is a practical method of selecting potential breeding bulls. The stages in BSE include bull performance testing, followed by reproductive selection. Specific selection of bulls from a reproductive aspect, through BSE, includes both basic and additional assessments. The main assessment consists of: physical condition, reproductive organs, scrotal circumference, and semen evaluation (20, 21). Additional (non-essential) assessments include: mating ability (libido), pelvic measurement, and trichomoniasis test. Selection of a superior bull is one of the efforts to improve the quality of cattle through artificial insemination technology and natural mating succession. Cattle productivity as superior bulls can be considered through their reproductive potential and production performance (21). This study aims to select superior bulls based on genetic parameters and semen quality, as well as the quality of their offspring.

Materials and Methods

Location and Ethical approval

This research was conducted at experimental pens and the laboratory of the Beef Cattle Research Institute (BCRI), from January 2020 to December 2021. This research has been reviewed and approved by the Experimental Animal Welfare Commission (EAWC), Indonesian Ministry of Agriculture, for the care and use of animals for scientific purposes (Balitbangtan/Lolitsapi/ Rm/ 06/ 2020).

Materials

The selection was done in 82 Ongole crossbred bulls, started at the age of 24 months old. Consisting of 38 bulls and their 44 male offspring. All materials were evaluated for morphometric traits (body weight and withers height) and semen quality parameters (motility, concentration, and viability). Genetic evaluation was performed using phenotypic selection combined with Most Probable Producing Ability (MPPA) analysis to predict the consistency of inherited traits.

Housing, feeding, and health status

All bulls were kept in the communal pens, and selected bulls were in individual pens. The duration semen collection data was sixteen weeks. All bulls were fed at 3% of body weight on DM basis, containing elephant grass (18.98% dry matter, 11.73% ash, 34.15% crude fiber, 10.19% crude protein, 1.64% crude fat, 0.46% calcium, 0.37% P, 72.34% Neutral Detergent Fiber, 52.4% Total Digestible Nutrient) and commercial concentrate (87% dry matter, 12% ash, 13% crude protein, 12% crude fiber, 7% crude fat, 0.6-1.2%

calcium, 0.4-0.8% P, 35% Neutral Detergent Fiber, 70% Total Digestible Nutrient). Feeds were given twice a day at 08:00 AM and 15:00 PM. All bulls had free access to the fresh drinking water. Before the start of the experiment, all bulls were checked for the health status and treated with anthelmintic.

Height of withers and body weight measurement

Measurement of withers height and body weight was conducted monthly during the study using the method described previously (22).

Fresh semen collection and evaluation procedures

Fresh semen was collected weekly for 16 weeks at the end of the research and was carried out using an artificial vagina. The oestrus cow was used as a teaser during the fresh semen collection. The semen collection was conducted at 08:00-10:00 AM. The fresh collected semen were directly brought to the Laboratory for semen evaluation and was subjectively assessed using light Microscope (Nikon ECLIPSE Ci-L, Japan).

Genetic Analysis Method

Repeatability (r)

$$r = \frac{\sigma^2 b}{\sigma^2 b + \sigma^2 w}$$

r = Repeatability, $\sigma^2 b$ = Between-individual variance, $\sigma^2 w$ = Within-individual variance

Heritability (h^2)

$$h^2 = \frac{4^2 s}{\sigma^2 s + \sigma^2 e}$$

h^2 = Heritability, $\sigma^2 s$ = Between-sire variance component, $\sigma^2 e$ = Within-sire variance component/Environmental variance.

Viability

$$\% \text{viability} = \frac{\text{Total number of live sperm}}{\text{Total number of sperm (live and death sperm)}} \times 100\%$$

Most Probable Producing Ability (MPPA)

Most Probable Producing Ability (MPPA) assessment was obtained using the following equation (23):

$$\text{MPPA} = \frac{nr}{1+(n-1)r} \times (\bar{P}x - \bar{P}o)$$

MPPA: Most Probable Producing Ability, $\bar{P}o$: probable breeding value, $\bar{P}x$: regression coefficient of an individual's genotype with its phenotype, N : Average phenotype of the contemporary individual, r : phenotype value of selected individual.

Parameter and statistical analysis

The parameters observed were morphometric (body weight, wither height), and semen quality (motility, sperm concentration, viability, semen volume). Data were analyzed using one-way ANOVA (SPSS software version 23). Duncan's multiple range test was performed to differentiate the means of treatments at 5% probability.

Results

Performance of the Selected Bulls

Among 38 bulls in the selection program, this study found four selected bulls based on body weight and wither height. Parent performance data from the four selected bulls are presented in Table 1.

Semen Quality of Selected Bulls

The fresh semen quality (motility, concentration, and viability) from the 4 selected bulls is presented in Table 2.

Table 1: Body weight (kg) and wither height(cm) of bulls and their parents at 48 months of age

Bull number	Body weight (kg)			Wither height (cm)		
	Bull	Sire	Dam	Bull	Sire	Dam
12.12.34	700 ±9.4	689	624	153	151	140
14.2.2	716 ±9.8	708	631	151	150	139
A.219/1	648± 7.4	639	608	146	145	137
13.12.26	654 ±13.7	656	606	150	150	138

Table 2: Semen quality of selected OC bulls

Bull number	Semen quality of bulls			Rank
	Sperm motility (%)	Sperm concentration (million/mL)	Sperm viability (%)	
13.12.26	80.0 ± 0.1 ^a	1210.0 ± 4.3 ^a	90.0 ± 0.1 ^a	I
A.219/1	76.90 ± 0.2 ^b	1041.8 ± 6.1 ^b	81.8 ± 0.2 ^b	II
14.2.2	76.90 ± 0.2 ^b	996.1 ± 6.3 ^c	75.8 ± 0.1 ^c	III
12.12.34	45.00 ± 0.3 ^c	599.8 ± 10.8 ^d	55.6 ± 0.3 ^d	IV

Note: Different subscripts in the same column show a significant difference ($P < 0.05$).

Semen Quality of Progeny of Selected Bulls

Evaluation of 11 progenies from each selected bull at 36 months of age. Data are presented in Table 3 covering motility, concentration, and viability.

Most Probable Production Ability (MPPA)

Calculation of r , h^2 , and MPPA values for each variable (motility, concentration, viability, and body weight) is presented in Tables 4 and 5.

Table 3: Semen quality of offspring derived from selected bulls

Parameters	Levels of quality	Selected Bulls (VID)			
		12.12.34	14.2.2	A.219/1	13.12.26
Sperm motility (%)	Highest	85.0 $\pm$ 4.6	87.3 $\pm$ 5.2	85.0 $\pm$ 3.0	80.0 $\pm$ 3.4
	Lowest	50.0 $\pm$ 5.8	59.7 $\pm$ 7.8	45.0 $\pm$ 4.8	64.3 $\pm$ 4.3
	Mean	71.1 $\pm$ 5.2	66.7 $\pm$ 5.1	72.8 $\pm$ 3.9	67.0 $\pm$ 3.6
	>Mean*(heads)	6	5	7	5
	<Mean*(heads)	5	6	4	6
Sperm concentration (million/mL)	Highest	2066.0 $\pm$ 327.3	1930.1 $\pm$ 406.7	1938.0 $\pm$ 283.9	1563.5 $\pm$ 355.5
	Lowest	920.0 $\pm$ 272.4	1025.0 $\pm$ 254.9	996.1 $\pm$ 243.3	899.1 $\pm$ 140.1
	Mean	1193.0 $\pm$ 0.4	1044.3 $\pm$ 0.5	1044.3 $\pm$ 0.5	905.7 $\pm$ 0.4
	>Mean*(heads)	5	3	4	3
	<Mean*(heads)	6	8	7	8
Sperm viability (%)	Highest	91.0 $\pm$ 3.6	94.2 $\pm$ 4.5	90.0 $\pm$ 2.6	90.0 $\pm$ 3.4
	Lowest	57.0 $\pm$ 5.8	57.3 $\pm$ 4.7	74.0 $\pm$ 6.7	65.0 $\pm$ 4.7
	Mean	77.6 $\pm$ 0.2	77.5 $\pm$ 0.1	80.0 $\pm$ 0.1	76.3 $\pm$ 0.1
	>Mean*(heads)	8	5	6	5
	<Mean*(heads)	3	6	5	6

*Number of offspring.

Table 4: Values of repeatability (r), heritability (h^2), and Most Probable Production Ability (MPPA) of semen quality of selected OC bulls

Parameter measured	Bull	r	h^2	Mean of MPPA	Individual MPPA
Motility (%)	A.219/1	0.49	0.20	69.12	71.58
	12.12.34				71.04
	13.12.26				67.48
	14.2.2				66.38
	A.219/1				1193.00
Concentration (million/mL)	12.12.34	0.49	0.29	1101.16	1179.50
	13.12.26				980.91
	14.2.2				1051.10
	A.219/1				81.08
	12.12.34				81.28
Viability (%)	13.12.26	0.51	0.19	79.92	78.31
	14.2.2				78.83
	A.219/1				568.66
	12.12.34				565.76
	13.12.26				485.99
Body weight (kg)	14.2.2				416.03

Note: n = selected bull offspring; * = value of its mean (%).

Discussion**Performance of sires and dams from selected bulls**

A total of 38 bulls in the herd population were selected in two stages, with the selection criteria based on both their

parents and themselves. Selection was made on the traits of ability to achieve body weight and height of withers above the average plus one standard deviation of the base population. The selection results showed that four bulls were selected based on body weight and wither height. During the

study, supporting data were also collected in the form of body performance of the elders of the four selected bulls.

Table 1 showed that bulls with greater body weight and wither height are the offspring of bulls and cows that also have greater body weight and wither height. Body weight and linear body size are heritable traits that can be used to identify bulls with superior genetic potential (24). Good sires and dams will produce high-quality offspring. Good sires and dams will produce high-quality offspring. This is in

agreement with previous findings that production traits based on cattle body weight have a positive correlation, are cumulative, and are inherited by their offspring (25). In the current experiment, the highest wither height was in selected bull number 12.12.34. Although a study reported that the wither height is less correlated with body weight, and positively correlated with girth (26). It was also found that morphometric variables and live body weight had positive correlations (24).

Table 5: MPPA value of semen quality of the offspring of each selected bull

Bull number	The Highest of MPPA			The Lowest of MPPA		
	Motility (%)	Concentration (million/mL)	Viability (%)	Motility (%)	Concentration (million/mL)	Viability (%)
12.12.34	83.5	1976.6	92.3	49.1	440.1	57.8
14.2.2	89.5	1994.7	97.5	43.8	314.2	67.3
A.219/1	83.0	1841.6	91.4	43.9	570.0	56.4
13.12.26	80.6	1705.7	88.4	42.4	493.1	62.7

Semen quality of selected bulls

Observations were made on selected OC bulls for their reproductive potential, i.e., fresh semen quality, including motility, concentration, and viability of sperm. Table 2 shows the difference in semen quality between bulls. The best semen quality was in bull number 13.12.26, and the lowest values were in bull number 12.12.34. Bull number A.219/1 had a higher sperm concentration and viability than bull number 14.2.2, so that the overall semen quality of bull number A.219/1 was considered better than that of bull number 14.2.2. The low sperm quality in bull number 12.12.34 is thought to be due age. Bull number 12.12.34 is the oldest bull material in this study (27).

Our results showed that the highest sperm motility, concentration, and viability were in bull number 13.12.26, which were 80%, 1210 million/mL, and 90% respectively. A study reported that the standards for motility, concentration, and viability of spermatozoa that are suitable for breeding are above 50%, 800-2000 million/mL, and 70%, respectively (28). Our bull had sperm quality above the standard, indicating a good candidate for a sperm donor (including bull numbers A 219/1 and 14.2.2). Those parameters indicate the quality of sperm. For example, the progressive motility of spermatozoa is positively correlated with concentration, live spermatozoa, resistance to cold shock and freezing, and fertility. Sperm motility of fresh semen above 70% indicates feasibility when processed into liquid or frozen semen.

Differences in semen quality among bulls can be biologically explained by several interacting factors. Semen traits are influenced by genetics, age, body condition, nutritional status, health, and environmental conditions such as temperature and season (29). For instance, poor semen quality in some bulls may be associated with suboptimal nutritional intake, lower body condition score, heat stress, or

individual genetic differences affecting spermatogenesis. Therefore, the observed variation should not be interpreted solely as individual shortcomings but as a natural biological response to complex genetic and environmental interactions.

Relationship between body weight (morphometric traits) and semen quality

The relationship between body performance and semen quality observed in this study appears to be positive but moderate and not always consistent at the individual level. At the group level, bulls with superior body weight and morphometric traits tended to show semen quality within acceptable or high standards. This supports previous findings that growth traits and reproductive traits are biologically related (17,26).

However, the relationship was not strong or linear in all cases. Some bulls with high body weight did not necessarily show the highest semen quality, and conversely, bulls with moderate body size were sometimes able to produce semen with excellent quality. This inconsistency can be explained biologically. Growth traits primarily reflect muscle and skeletal development influenced by nutrition and growth hormones, whereas semen quality depends on testicular function, endocrine regulation, spermatogenesis efficiency, and thermoregulation. As a result, body size alone is not a sufficient predictor of semen quality.

These findings indicate that the relationship between morphometric traits and semen quality in the present study is moderate and sometimes inconsistent, which agrees with previous literature reporting that reproductive traits are more sensitive to environmental and physiological disturbances than growth traits. Thus, selection based solely on body weight or size may not guarantee optimal semen quality, and reproductive evaluation must be conducted directly.

Semen quality of selected bulls based on the semen quality of their offspring

Further observations were made by measuring the quality of fresh semen from the offspring of four selected bulls. Each selected bull has produced 11 offspring (bulls). Observations were made when the offspring of the selected bulls were 36 months old. Semen quality observation data of the selected bulls are listed in Table 3. Showed that the best spermatozoa motility and viability averages were achieved by bull A.219/1, while the highest spermatozoa concentration was achieved by bull 12.12.34. Even though the 12.12.34 bull produced the lowest spermatozoa, the quality of the spermatozoa in his offspring was good. This is due to the old age factor in bull 12.12.34, which causes the quality of spermatozoa to be lower compared to the quality of spermatozoa in other bulls.

The semen quality of the offspring of selected bulls showed that, at the population level, sperm motility, concentration, and viability were within recommended standards. This suggests that the selected bulls were able to transmit acceptable reproductive performance to their progeny. The average sperm concentration remained within the range of 800–2000 million/mL (29), and sperm viability was above 70%, confirming the biological suitability of these animals for breeding purposes. These results support the hypothesis that semen quality has a genetic component, although environmental factors still play a substantial role. The maintenance of semen quality across generations indicates that selection based on combined growth and reproductive traits can contribute to sustainable genetic improvement.

Repeatability, heritability, and MPPA

The semen quality of the selected bulls was analyzed to obtain the mean values of repeatability (r), heritability (h^2), and most probable producing ability (MPPA) (Table 4). The r values for motility, concentration, viability of spermatozoa, and body weight of bulls were very high, ranging from 0.49 to 0.51. The value of repeatability is divided into three categories, namely low (0.0–0.2), medium (0.2–0.4), and high (>0.4) (30). This data indicates that four selected bulls had a high ability to maintain semen quality and body weight, and this trait is relatively heritable by their offspring. The high repeatability values (0.49–0.51) for semen quality traits and body weight indicate that these traits are relatively stable over time within individuals. Values above 0.4 are categorized as high, suggesting that early records of semen quality and body weight can reliably predict future performance (30). High repeatability implies that the observed superiority is not incidental but reflects a consistent biological capacity.

Low repeatability can be influenced by several factors, namely analysis method, time, environment, and the number of animals observed (31). This result is different from a

previous study, which showed that the heritability value for semen traits was in the low to medium category (0.02–0.14) (32). There is the largest coefficient variation of semen traits of Norwegian red bulls, including: concentration (23.6%), volume (20%), and fresh motility (5.3%). Another study reported that the repeatability values for bull sperm motility, viability, and concentration before cryopreservation were 0.38, 0.42, and 0.45, respectively (33).

This h^2 value indicates that the superior semen quality of the four high bulls has a high trait to be passed on to each of their offspring. The value of h^2 on the mature body weight trait is low, only 14%. It has been reported that the heritability value of body weight ranges from 50% to 70% (34). The results showed that the trait of the ability to reach mature body weight of the research material cattle is high (86%), influenced by environmental factors. The h^2 values for sperm motility, percent live, and concentration were 0.20, 0.19, and 0.29, respectively. This value is lower than those reported previously, which were 0.37, 0.34, and 0.20, respectively (33). A previous study reported a relatively low heritability value for semen volume (0.15), moderate heritability for sperm concentration (0.30), and high heritability for sperm motility (0.59) (17). The diverse heritability differences among studies are probably influenced by breed, indicating the genetic potential of every breed. The heritability estimates for semen traits (0.19–0.29) indicate low to moderate genetic control, which is consistent with previous studies (17,33). This means that genetic improvement of semen quality is possible, although progress may be slower compared to highly heritable traits. Differences in heritability values among studies are likely caused by breed differences, management systems, population structure, and environmental conditions. The relatively low heritability value for mature body weight in this study suggests a strong influence of environmental factors such as feeding regime, management, and housing. This differs from previous reports indicating higher heritability values, suggesting that local environmental conditions can significantly modify genetic expression (34).

Most Probable Producing Ability values provide a practical tool to predict the long-term productive and reproductive performance of bulls. Bulls with higher MPPA values have a higher probability of consistently producing superior semen quality and maintaining optimal body performance. Since MPPA integrates repeatability and individual performance, it offers a biologically meaningful and statistically reliable criterion for selection. The mean MPPA value of bull numbers A.219/1 and 12.12.34 on semen quality and body weight variables showed higher results than the mean of all bulls. Based on the MPPA value, it is suspected that bull numbers A.219/1 and 12.12.34 can produce semen quality and achieve maximum body weight; meanwhile, bull numbers 13.12.26 and 14.2.2 showed performance of semen quality and maximum body weight

below average. Based on Table 5, the highest MPPA value for motility, concentration, and viability was in bull 14.22. Another study reported that the MPPA values in Bali cattle for sperm motility were 46.60-68.15% and concentration was 864.02 -1143.60 million/mL (31). The most probable producing ability is a close estimate of the actual production ability of an animal expressed as a deviation from the group average, and the values also indicate the consistent performance of semen quality in a certain period. The MPPA value is determined by the repeatability value, where a high r value results in a more accurate MPPA value. An accurate MPPA value can be a criterion for livestock selection.

Positive genetic correlations of conformation traits were found for semen volume and concentration (per ejaculation), total number of sperms and motile sperms, especially for scrotal circumference, body weight, withers height, and hip height traits (0.87-1.00). These results indicate a strong relationship between growth traits with semen traits, so genetic improvement of semen production and quality traits for selection can be done (17).

Conclusion

Bull A.219/1 demonstrated the best combination of genetic and reproductive traits, followed by 12.12.34, 13.12.26, and 14.2.2.

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Conflict of interest

There is no conflict of interest.

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اختيار ثيران الأونجول المهجنة في إندونيسيا بناء على الإمكانات الجينية وجودة السائل المنوي

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الخلاصة

يعد تحسين وراثته الماشية المحلية واستدامتها على المدى الطويل في
إندونيسيا أمراً ضرورياً لدعم إنتاجية لحوم البقر الوطنية. هدفت هذه
الدراسة إلى تحديد ثيران أونجول المتفوقة من خلال تقييم متكامل
للإمكانات الجينية وجودة السائل المنوي والأداء الإنجابي لنسلهم الذكور.
يتكون ما مجموعه ٨٢ رأساً من ٣٨ ثيراناً تم تقييم نسلهم البالغ عددهم
٤٤ ذكراً من أجل السمات المورفومترية (وزن الجسم وارتفاع الكاهل)
ومعايير جودة السائل المنوي (الحركة والتركيز والقدرة على البقاء). تم
إجراء التقييم الجيني باستخدام الانتقاء المظهري جنباً إلى جنب مع تحليل
القدرة الإنتاجية الأكثر احتمالاً للتنبؤ اتساق الصفات الموروثة. أظهرت
النتائج أن اثنين من أربعة ثيران مختارين أظهروا أفضل مزيج من سمات
النمو ومعايير التكاثر. أنتج كلا الثيران السائل المنوي بحركة وقابلية
للحياة تتجاوز معايير التكاثر ($< 0.7\%$)، وأوزان الجسم أعلى من متوسط
عدد السكان. تراوحت قيم التوريث لسمات السائل المنوي بين ٠.١٩ و
٠.٢٩، وكانت قيم التكاثر عالية (< 0.49)، مما يشير إلى التأثير الجيني
الكبير واستقرار تعبير السمات عبر سجلات القذف. من بين ١١ ذرية تم
اختيارها، كان الأداء العالي للثيران لديه حركة الحيوانات المنوية،
تتراوح من ٨٧.٣-٤٥.٠٪؛ تركيز الحيوانات المنوية (٨٩٩.١-
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٠.٦٩، ١٢)؛ الموافقة (٠.٤٩؛ ٠.٢٩؛ ١١.٠١، ١٦)؛ الجدوى (٠.٥١؛
٠.١٩؛ ٧٩.٩٢)؛ ووزن الجسم (٠.٥٠؛ ٠.١٤؛ ٥٠.٩، ١٠). بشكل
عام، أظهر الثور أ. ١/٢١٩ أفضل مزيج من الخصائص الجينية
والتناسلية، متبوعاً على التوالي بالثيران ١٢، ١٢، ٣٤ و ١٣، ١٢، ٢٦ و
١٤، ٢، ٢.