

Comparison of the favorable gain values of genetic improvement among Indonesian grade cow breeds selected for agrotechnopark intensification

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ABSTRAK

Penelitian ini bertujuan membandingkan batas terkecil dan terbesar titik pangkas seleksi proporsi untuk menilai pertambahan bobot badan yang menguntungkan dalam peningkatan genetik bangsa sapi lokal Indonesia yang dipilih pada intensifikasi Agrotechnopark (sistem pertanian siklus-bio terpadu). Bobot hidup ternak dikoleksi dari 674 induk bangsa-bangsa sapi lokal dewasa yang dipelihara peternak di Sulawesi Utara. Data induk dikoreksi dengan penyesuaian ternak umur enam tahun. Semua induk dibagi kedalam tiga kelompok bangsa yang berbeda komposisi genetik dari generasi perbaikan bangsa Bali (BG) berjumlah 207 induk, generasi perbaikan bangsa Ongole (OG) berjumlah 189 induk, dan persilangan bangsa sapi lokal (LG) berjumlah 178 induk. Perbaikan genetik induk sapi BG, OG dan LG dianalisis dengan melibatkan intensitas seleksi (i), ketepatan seleksi (r), dan standar deviasi (SD) bobot hidup kelompok bangsa sapi lokal yang diseleksi. Hasil kajian menunjukkan bahwa komponen kritis adalah peningkatan genetik bangsa sapi lokal melalui pemilihan proporsi terkecil dari titik batasan pangkas 10% untuk persiapan intensifikasi Agrotechnopark dari induk unggul yang terseleksi antara kelompok populasi bangsa sapi BG, OG dan LG dengan kenaikan positif sifat bobot hidup induk sesuai urutan masing-masing ketiga bangsa sapi tersebut sebesar 58,6 kg, 23,15 kg, dan 28,62 kg per generasi dibandingkan dengan batasan proporsi titik pangkas 20% dan 30%.

Kata Kunci: bangsa sapi lokal Indonesia, intensifikasi agrotechnopark, peningkatan genetik.

ABSTRACT

This research was aimed to compare the small and big truncation point proportions intended to evaluate gain values of genetic improvement for Indonesian Local cow breed groups selected for Agrotechnopark (integrated bio-cycle farming system) intensification. Animal live weights were collected from 674 Indonesian grade breed cows kept by local household farmers in North Sulawesi province. Data of cows were corrected by adjusting to six years old ages. All cows were divided into three breed groups with different genetic compositions of Bali breed cow generation (BG) of 207 cows, Ongole grade cow generation (OG) of 189 cows, and Local grade cow generation (LG) of 178 cows. The genetic improvements of BG, OG and LG were analyzed involving selection intensity (i), accuracy of selection (r), and standard deviation (SD) of breed group traits under selection. Results of this study showed that the critical components was genetic development of local grade breeds by choosing small proportion of 10% truncation point for Agrotechnopark intensification of selected elite cows groups among BG, OG and LG populations with the positive live weight gains of 58.6 kg, 23.15 kg, and 28.62 kg per generation, respectively compared with larger percentages of 20% and 30% proportions of truncation

points.

Key Words: agrotechnopark intensification, genetic development, Indonesian grade-breed cattle.

INTRODUCTION

The Indonesian local-grade breed cattle have had the ability to adapt into harsh environment under hot and humid climates as well as low-quality feed to produce meat and power to plough a farm land prior to planting (Papatungan *et al.*, 2016). In North Sulawesi province of Indonesia, the increasing incomes of smallholder farmers were contributed of about forty percent by the local-grade cattle (Papatungan *et al.*, 2015, Papatungan *et al.*, 2018). The birth of a calf with prominent growth and body weight is a key to generate meat production (Henchion *et al.*, 2014, Isnaini *et al.*, 2019). Therefore, the most essential efforts enhancing higher reproductive performance at the same way of genetic improvement of the animals were including the artificial insemination (AI) technical application in the rural areas (Morrell 2011, Thundathil *et al.*, 2016, Chawala *et al.*, 2017).

In recent decade, the government program for genetic improvement of local-grade cattle in rural areas of North Sulawesi province are using semen of the Ongole bull collected from the Artificial Insemination Center Institution in Singosari, West Java province of Indonesia, sent to the rural areas of several provinces in Eastern part of Indonesia. The benefits of AI programs by government are including to gives the opportunity to use superior genetics from the Ongole sire that household farmers could never afford to purchase (Hendrik and Papatungan, 2016). In contrast, the beneficial of natural breeding are including bull does all the work, so not spending hours heat detecting each day and no facilities needed, cows can get bred right out in the pasture (Bhakat *et al.*, 2011). The questionable practice was that how the gain values of genetic improvement for live weight in the Indonesian Local grade-beef cattle under a truncation point proportion of each cow population to be involved into agrotechnopark intensification purpose. This study provided farm-level data of intensive selection under truncation point proportions of each breed group of Indonesian Local grade cows supporting intensification of agrotechnopark. The objective of this study was to compare the small and the big truncation point proportions intended to evaluate the gain values of genetic improvement for

Indonesian Local grade cows at each breed group selected for the Agrotechnopark (Integrated Bio-cycle Farming System) intensification in North Sulawesi Province of Indonesia.

MATERIALS AND METHODS

Location of research study

Research study was carried out in several regencies with bio-gas unit system concentrated in Bolmut regency of North Sulawesi province in Indonesia applying the natural breeding of animals belong to household farmers around rural areas. These regencies were categorized as agricultural areas with various altitude ranges of 1 to 400 m above sea level. It was characterized by ambient temperature and humidity of 25 to 28 °C and 70 to 80 percents, respectively.

The Indonesian local-grade cattle were raised by smallholder under traditional management using local grass around coconut plantations and opened grass field surrounding rural areas. Cows and their progeny grazed onto places within local grass pasture all days starting at 07.00 to 17.30 without supplementary feeds of concentrate as the main management system practiced by 222 farmers as the animal owners at rural areas used in this study. The breeding herds were on the range pasture year around. For application of the artificial insemination (AI) around area of AI center program, some farmers supervised their cows and when they showed signs of estrus, cows were brought to the rural artificial insemination (AI) service center of government to be mated freely by inseminator using thawing straw of frozen germ plasmas of the Ongole-breed bulls stored in liquid Nitrogen supporting the animal breeding development program by the government for local community development at rural areas.

Experimental animals

The totals of 674 female Indonesian Local breed cows were randomly chosen in this research. All animals used in this study were non-pregnant and healthy cows of age groups ranging from four to six years old adult animals (Mallick *et al.*, 2016). Ages of animals were primarily determined by dentition with the indication as follows: cows showed six changed milk teeth

indicating the age of three and half to four and half years old; cows showed eight changed milk teeth indicating the age of the above five years old (Papatungan *et al.*, 2018). Dentition indicators were verified with household farmer information and direct observation using information by household farmers at the period of animal body measurements.

Weight records of the above cows after calving accumulated over five years (2014-2019) were used in this study. All cows were reared in private areas belonging to 222 farmers. All cows were divided into three breed groups with different genetic compositions. The first group of pure Bali grade cow generation (BG) was the total of 207 cows, generated from the natural breeding belong to 69 household farmers. The second group of Ongole grade cow generation (OG) was the total of 189 cows, generated from the AI breeding among local dams and Ongole bull with genetic composition of 50 % Local-grade cattle and 50 % Ongole belong to 63 household farmers. Progeny were born from those cows mated by artificial insemination (AI) technique using germ plasmas (semen) of the two sires of Ongole breeds called “Kirsta” with genotype of B^{+/+} and “Tunggul” with genotype of B^{-/-} as the parental stocks taken from “the artificial insemination (AI) sire germ plasma center” at the Singosari district, East Java province of Indonesia (Papatungan *et al.*, 2016). The third group of unknown Local breed compositions of Madura and Benggalagrade cow generation (LG) was the total of 178 cows generated from the natural breeding, belong to 60 household farmers. The breeding scheme information of parental cow genetic ancestor using natural breeding and artificial insemination (AI) were traced at the AI centers around rural areas for the research study.

Data collection

Body weights of animals were determined by using a digital weighing scale. The parameters of the animal body weight were measured using digital weighing scale when animals were standing as described in Ozkaya and Bozkurt (2008). Data of these cows were corrected by adjusting for the six years old of age for the weighing for elimination of different effects of age on animals using the formula (Zulkharnaim *et al.*, 2010) as follows:

$$X_{i-corrected} = \frac{\bar{X} - standard}{\bar{X} - obserbed} \times X_{i-observed}$$

Data of age adjustment were analyzed using simple software of the statistical program function in Excel XP 2007.

Data analysis

The data on live weights of animals were analyzed using the General Linear Models (GLM) procedure of SAS (2016) with mathematical model as follows (Byrkit, 1987, Steel and Torrie, 1993),

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where: Y_{ij} = observation from the kth genotypic cows with the jth genotypic parental cow grade groups, μ = general mean common to all animals in the experiment, B_i = the fixed effect associated with the ith genotypic parental cows grade groups (i=3, BG, OG, LG), and e_{ij} = random effects peculiar to each individual cow.

Comparison of the significant means of live weight measurement variables within animal genotype breed group was tested using Least Significant Different (Byrkit, 1987). The selection differential (S) defining the superiority of the selected parental cows over the population mean was analyzed by formula (Van Vleck *et al.*, 1987; Thekkoot, 2017) as follows:

$$S = \bar{X}_{Selected} - \bar{X}_{Population}$$

Where $\bar{X}_{Selected}$ is the mean weight of the selected parental cows and $\bar{X}_{Population}$ is the mean weight of the cow population. The population of cows with certain mean values and standard deviations were considered in this study. The typical selection within chosen group that fall above certain values was defined as the truncation point (Thekkoot, 2017) as shown in Figure 1.

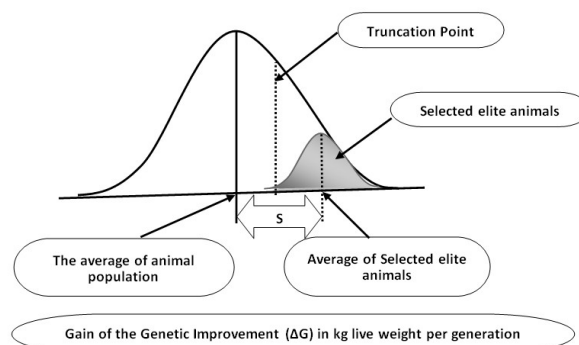


Figure 1. Live weight distribution pattern of animal population and selected elite animals at the truncation point gaining values of the genetic

improvement per generation.

The selection differential (S) was standardized by dividing it with standard deviation (SD) of the weight of the cow population. The standardized selection difference termed selection intensity (*i*) was expressed in the formula (Van Vleck *et al.*, 1987; Thekkoot, 2017) as follows:

$$i = \left(\frac{S}{SD} \right) = \left(\frac{\bar{x}_{\text{Selected}} - \bar{x}_{\text{Population}}}{SD} \right)$$

From the above equation, the higher the selection differential, the higher will be the genetic improvement (G). Genetic improvement (Δ_G) per generation of cows from breeding program depend on three key factors (Thekkoot, 2017) including selection intensity (*i*), the accuracy of selection (*r*), and the standard deviation of the trait under selection (*SD*) calculated in formula as follows:

$\Delta_G = (i \cdot r \cdot SD)$ Per Generation, or

$$\Delta_G = \left(\frac{i \cdot r \cdot SD}{L} \right) \text{ Per Year}$$

The accuracy of selection (*r*) was based on full sib parental correlation of 0.71, Half sib parental

correlation of 0.50 and Half sib progeny correlation of 0.10 (Ellen *et al.*, 2007). The Half sib parental correlation of 0.50 was applied in this study. The generation interval (*L*) expressed in years of local cows in this study was varying from 2.5 to 2.9 years (Paputungan *et al.*, 2018).

RESULTS AND DISCUSSION

The results in Table 1 showed the least squares mean for live weight of cow genotypes associated with Bali grade generation cows (BG), Ongole grade generation cows (OG) and Local grade generation cows (LG). From the total of 674 parental cows in this study, the 207 cows were Bali grade cow group (BG), the 189 cows were generated by AI technique using genotype local cows and germ sperms of Ongole breed sire (OO) forming genotype Ongole grade cows (OG), and the 178 cows were generated by natural breeding using local cows and local bull breed sires forming genotype local grade cow (LG).

The overall mean for live weight of adjusted 5-yr old cows was 325.70 ± 66.05 kg. The means for live weights of Bali genotypic grade cows (BG), Ongole grade genotypic cows (OG) and

Table 1. The averages and standard deviations of live weights of cows generated from natural breeding (NB) of Indonesian local cattle and from artificial insemination (AI) at the rural areas AI service center in Minahasa regency of North Sulawesi province, Indonesia

Sources of parental genotypic groups of cows	No. of cows	Live weight (kg)
<i>Overall mean of BG, OG & LG Breeds:</i>	674	325.70 ± 66.05
The average of Bali breed generation (BG)	207	270.06 ± 66.20^a
The average of Ongole grade generation (OG)	189	379.97 ± 27.08^b
The average of Local crossbred generation (LG)	178	335.00 ± 34.84^c
<i>Proportions of 10% selected BG, OG and LG for genetic improvements:</i>		
The average of 10% selected elite BG	21	387.12 ± 5.93^d
The average of 10% selected elite OG	19	426.29 ± 12.84^e
The average of 10% selected elite LG	18	392.25 ± 7.07^f
<i>Proportions of 20% selected BG, OG and LG for genetic improvements:</i>		
The average of 20% selected elite BG	42	371.70 ± 17.51^g
The average of 20% selected elite OG	38	415.04 ± 14.81^h
The average of 20% selected elite LG	36	384.88 ± 9.15^i
<i>Proportions of 30% selected BG, OG and LG for genetic improvements:</i>		
The average of 30% selected elite BG	63	353.58 ± 31.49^j
The average of 30% selected elite OG	57	408.19 ± 16.05^k
The average of 30% selected elite LG	54	379.36 ± 10.82^b

The values bearing different superscripts in the same column differ significantly ($p < 0.01$).

Local grade genotypic cows (LG) have indicated 270.06 ± 66.20 kg, 379.97 ± 27.08 kg, and 335.00 ± 34.84 kg, respectively. The mean of the highest weight for 10% proportion of BG, OG and LG were 387.12 ± 5.93 kg, 426.29 ± 12.84 kg and 392.25 ± 7.07 kg, respectively (Table 1). Moreover, the mean of the highest weight for 20% proportion of BG, OG and LG were 371.70 ± 17.51 kg, 415.04 ± 14.81 kg and 384.88 ± 9.15 kg, respectively (Table 1). In addition, the mean of the highest weight for 30% proportion of BG, OG and LG were 353.58 ± 31.49 kg, 408.19 ± 16.05 kg and 379.36 ± 10.82 kg, respectively (Table 1). These results were in agreement with the trends of truncation points for the selected elite animal proportions from the animal population.

The lower the proportions of selected elite cows based on live weight from their total of breed population, the higher the averages of their live weight as reported by Thekkoot (2017). High values of selection differential (S) of live weight (kg) of selected cow group in BG might occur due to high variation in live weight as indicated by high standard deviation in the population group (66.20 kg) compared with those in OG and LG

groups of 27.08 kg and 34.84 kg, respectively (Table 1).

Live weight averages of the selected elite cows under different truncation points of the three breed groups were also significantly different ($P < 0.01$) with the highest live weight of the OG breed group, followed by LG and BG breed groups, respectively. However, the coefficient of variance in BG, OG and LG were 24.51%, 7.13% and 10.40%, respectively; indicating cows in BG group were categorized into high variance compared with cows in OG group with low variance and cows in LG group with medium variance. The animal group populations with the coefficient of variance over 15% were categorized into high variance, those with the coefficient of variance between 10 to 15% were categorized into medium variance, and those with coefficient of variance below 10% were categorized into low variance (Kurnianto, 2010). The proportion of 10% selected cows of BG, OG and LG from each breed cow population indicated selection differential (S) in live weight of 117.06 kg (BG), 46.32 kg (OG) and 57.25 kg (LG), respectively (Table 2).

Their selection intensities (*i*) were 1.77

Table 2. Analysis of genetic improvements from the proportions of different cow breeds of Bali grade generation (BG), Ongole grade generation (OG) and Local crossbred grade generation (LG)

Parameters involved in the formulations of the genetic improvement analyses	Values		
	BG	OG	LG
<i>Proportion of 10% selected elite cows:</i>			
Selection differential (S) of live weight (kg) of selected cow groups	117.06	46.32	57.25
Selection intensity (<i>i</i>) of selected cow groups	1.77	1.71	1.64
Genetic improvement (Δ_G) of live weight (kg) per generation in selected elite cow groups	58.60	23.15	28.62
<i>Proportion of 20% selected elite cows:</i>			
Selection diferential (S) of live weight (kg) of selected cow groups	101.64	35.07	49.88
Selection intensity (<i>i</i>) of selected cow groups	1.54	1.30	1.43
Genetic improvement (Δ_G) of live weight (kg) per generation in selected elite cow groups	50.98	17.60	24.92
<i>Proportion of 30% selected elite cows:</i>			
Selection diferential (S) of live weight (kg) of selected cow groups	83.52	28.22	44.36
Selection intensity (<i>i</i>) of selected cow groups	1.26	1.04	1.27
Genetic improvement (Δ_G) of live weight (kg) per generation in selected elite cow groups	41.71	14.07	22.11

(BG), 1.71 (OG) and 1.64 (LG), respectively. The value of i depends on the proportion of animals selected as the elite parents for the next generation (Thekkoot, 2017). High variation in live weight of BG might produce high difference between the selected elite average and the population average.

the accuracy of selection (r), and the standard deviation of the trait under selection (SD). In this study, higher value of SD for cow live weight was 66.2 kg in BG breed cow population compared with those in OG and LG breed cow population of 27.08 kg and 34.84 kg, respectively (Figure2).

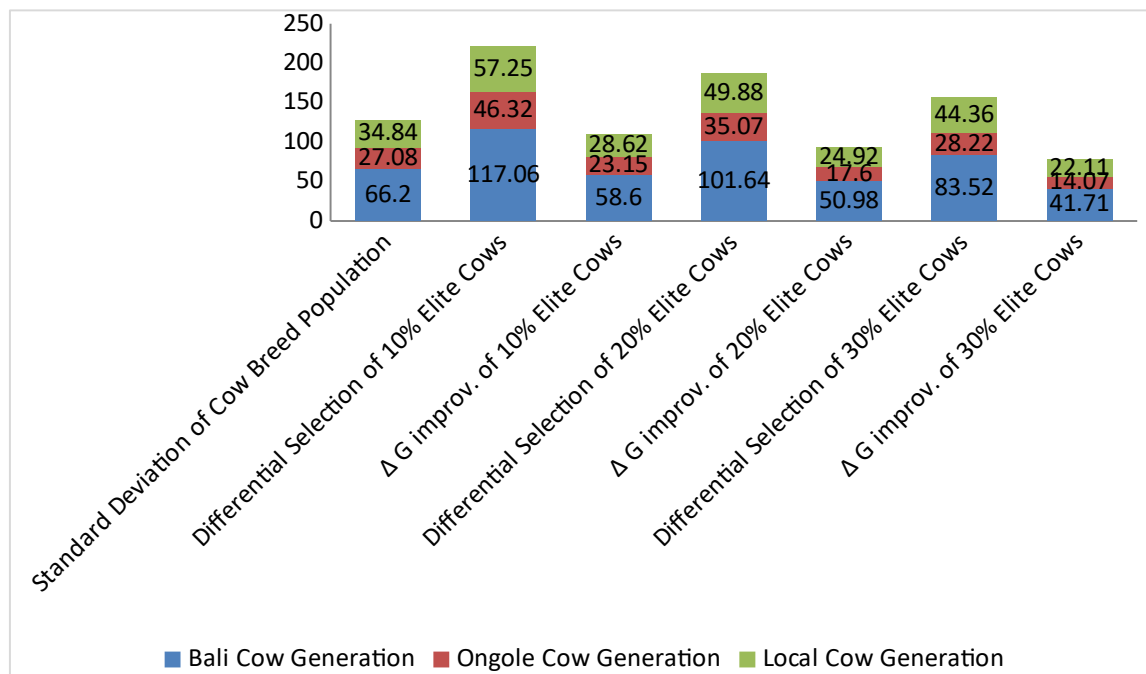


Figure 2. Live weight gain values (kg) of the genetic improvement of three breed group populations per generation.

The higher the selection differential of animal population group compared relatively with its standard deviation, the higher the selection intensities (i). The values of the selection intensities (i) in each animal population groups of BG, OG and LG were presented in Table 2.

In this study, the magnitude proportion of selected elite cows of BG, OG and LG from 10% to 30% decreased their selection intensities (i), affecting also low genetic improvement (Δ_G) of live weight (kg) per generation in their selected elite cow groups (Table 2). Based on the formula of genetic improvement (Δ_G) of live weight (kg) per generation in selected elite cow groups, the higher the selection intensities (i) in each population group, the higher the genetic improvement (Δ_G) of live weight (kg) per generation (Thekkoot, 2017).

Key factors increase genetic development of cow population included selection intensity (i),

The lowest value of SD in OG cow population might indicate more uniformities in live weights of Ongole grade cows generated from the use of the same original source of semen collected from bull at the Artificial Insemination Center Institution in Singosari, West Java province of Indonesia applied in the artificial insemination for genetic development of the adult grade cows in North Sulawesi province as part of the central and eastern of Indonesia serviced by this institution. On the other hand, higher values of SD in BG and LG population groups might give high variabilities of animal live weights as the high possibility for selection of the elite cows in genetic improvement for the next generations.

Moreover, higher value of differential selection (S) for cow live weight was 117.06 kg in BG breed cow population reflecting higher value of selection intensity (i) compared with those of in OG grade and LG grade cow populations of 46.32 kg and 57.25 kg, respectively (Figure 2).

Consequently, the values of both differential selection (S) and selection intensity (i) gained the highest genetic improvement (Δ_G) in BG breed cow population of 58.6 kg compared with those of in OG and LG breed cow populations of 23.15 kg and 28.62 kg, respectively per generation.

The magnitude proportion of selected elite cows of BG, OG and LG from 10% to 20% decreased their genetic improvement (Δ_G) in BG breed cow, OG grade and LG grade cow populations of 13.00 %, 23.97 % and 12.93% per generation, respectively. Moreover, the magnitude proportion of selected elite cows of BG, OG and LG from 20% to 30% decreased their genetic improvement (Δ_G) in BG breed cow, OG grade and LG grade cow populations of 18.18 %, 20.06 % and 11.28 % per generation, respectively. Finally, the magnitude proportion of selected elite cows of BG, OG and LG from 10% to 30% decreased their genetic improvement (Δ_G) in BG breed cow, OG grade and LG grade cow populations of 28.82%, 39.22 % and 22.75% per generation, respectively (Figure 2). This finding of study indicated that increasing magnitude proportion for each 10% truncation point of selected elite cows of BG, OG and LG caused also reducing genetic improvement (Δ_G) over 10% per generation. These genetic improvements of three breed groups increased at the opposite patterns of magnitude proportion of truncation point from 10% to 30% (Figure 2). Therefore, reducing proportions of the truncation point from 30% to 10% of the selected elite cows from their breed populations indicated favorable higher genetic improvement (Δ_G) over 10% of live weight per generation.

CONCLUSION

High genetic improvements would be the attractive central component in gaining cow weight production by choosing small proportion of 10% truncation point of animal population for Agrotechnopark intensification of selected elite cows groups among Bali breed, Ongole grade and Local grade populations with the positive live weight gains of 58.6 kg, 23.15 kg, and 28.62 kg per generation, respectively compared with larger 20% and 30% proportions of truncation points for preparation of agrotechnopark intensification. Increasing magnitude proportion for each 10% truncation point of selected elite cows in each population of Bali breed, Ongole grade and Local

grade groups reduced genetic improvement (Δ_G) over 10% per generation.

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