The Prolific Variation, Body Morphometrics, and Breeding Value of Indonesian Local Etawah Goat Based in East Java

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ABSTRACT. A crucial trait of a high economic value of goats is calving to more than one kid (prolificacy potency). The high prolificacy potency (> 1 kid) has a higher income compared to single kids. This study described the potential of Indonesian Local Etawah Goat (ILEG) for prolific trait and the morphometric of body and breeding values in various environments as a basis for selection. It involved smallholder farmers who breed ILEG does from 14 villages in East Java. The research was conducted on a field survey to obtain primary data about the phenotypic superior ILEG goats based on the status of the prolific trait. The study used 520 does with 1347 prolific records obtained. The results showed that the prolificacy values ranged from 2.12-1.42 heads/calving (medium to high category). The variation of prolificacy was 0.53, and the breeding values of the prolificacy trait were 1.48-1.74. The average of body morphometrics was varied with the following details. Chest circumference was 81.06 ± 4.63 cm, body length was 76.64 ± 4.33 cm, shoulder height was 75.34 ± 5.83 cm and ear length were 27.44 ± 3.02 cm. This study concluded that the prolific rate was medium to high category. The prolific variation was higher than body morphometry variation, and the prolificacy EBVs of breeding villages divided into four unique pattern boxplots. The prolific trait could be the basis for new considerations in the ILEG breeding program, either through selection or mating.

Keywords: doe, village breeding center, productivity

ABSTRAK. Salah satu sifat yang krusial dan bernilai ekonomi tinggi pada kambing adalah kemampuan melahirkan lebih dari satu anak (potensi prolifik). Potensi prolifik yang tinggi (> 1 anak) memiliki nilai ekonomi yang lebih tinggi dibandingkan dengan anak tunggal. Tujuan penelitian ini adalah untuk mengetahui potensi kambing Peranakan Etawah (PE) pada sifat prolifik dan morfometri tubuh serta nilai pemuliaan (EBV) di berbagai lingkungan sebagai dasar seleksi. Untuk mencapai tujuan tersebut maka penelitian ini melibatkan peternak rakyat yang membudidayakan PE yang berasal dari 14 wilayah pembibitan kambing di peternakan rakyat di Jawa Timur. Penelitian dilakukan dengan survei lapangan untuk mendapatkan data primer tentang fenotipe kambing PE unggul berdasarkan status sifat prolifiknya. Penelitian ini menggunakan 520 induk dengan 1.347 catatan prolifik. Hasil penelitian menunjukkan nilai prolifik berkisar antara 2,12-1,42 anak/kelahiran (kategori sedang sampai tinggi) dengan rerata variasi prolifik 0,53 dan EBV sebesar 1,48-1,74. Rataan morfometri tubuh adalah bervariasi dengan rincian berikut. Rataan lingkar dada sebesar 81,06 ± 4,63 cm, panjang tubuh adalah 76,64 ± 4,33 cm, tinggi pundak adalah 75,34 ± 5,83 cm dan panjang telinga adalah 27,44 ± 3,02 cm. Kesimpulan dari penelitian ini adalah rataan prolifik kambing PE termasuk kategori sedang sampai tinggi. Variasi prolifik adalah lebih tinggi dibandingkan dengan morfometri tubuh dengan profil EBV prolifik terbagi empat pola unik *boxplot*. Sifat prolifik berpotensi menjadi dasar pertimbangan baru dalam program pemuliaan kambing PE baik melalui seleksi maupun perkawinan.

Kata kunci: Induk, village breeding center, productivitas

Introduction

Local livestock has been continuously investigated as a source of global germplasm. Smallholder farmers mainly raise indigenous goats as a common practice in the tropical and subtropical regions of Indonesia like East Java. Local goats are well adapted to the environment (feed and weather) and exhibit resistance to diseases (Bett et al., 2012; Goddard and Hayes, 2009; Mdladla et al., 2017; Mudawamah et al., 2019; Pai and Chakravarty, 2020; Schwartz, 2017).

The goat that has existed for decades and adapted to the Indonesian environment is the Indonesian Local Etawah Goats, abbreviated as ILEG (also known as PE goats in Indonesia). ILEG comes from the crossing of Etawah goats with indigenous or Kacang goats. Etawah Goat was

earlier imported from India during pre-independence era under the Dutch government. The characteristics of ILEG are the combination of Etawah goats from India and indigenous goats, with exterior features similar to those of Indian Etawah goats, such as a convex face with long, drooping ears. However, the body size is smaller than that of Etawah goats but bigger than Kacang goats (Mudawamah et al., 2015).

One of the contributing factors to the productivity of goats is the number of offspring per calving that exceeds one (He et al., 2001; Haldar et al., 2014). Such prolific trait would be well expressed if supported by a conducive environment (Ling et al., 2015). One of the representative areas for research is East Java province because it is the second-ranked region of 34 provinces in Indonesia regarding the number of goat populations (Ministry of Agriculture Republic of Indonesia, 2018). Therefore, the objective of this study is to examine the prolific of ILEG through genetic parameters and body morphometrics, and breeding values in breeding centers.

Materials and Methods

There were 140 farmers involved in this study with the criteria of having ILEG does calving at least two times. The numerators were the students from Animal Husbandry study program who were specifically pre-trained by a team of experts to observe prolific data and measure body morphometrics, to conduct an interview with farmers, and to write data on recording paper.

The research method was a survey by purposive sampling. The prolific data was the primary data obtained from a face-to-face interview with each farmer in the goat houses while we pointed at a specific doe directly. The talk included the litter size of dams and the number of does that had calved. The farmer was interviewed in a cage while looking directly at the dam in a house, discussing the potential fecundity and measuring body morphometrics.

The farmer ownership was 3-10 does, and the calving number was 2-7 times.

Body morphometrics studied included eight types of measurement as follows: (1) chest circumference (CC) from the front of the ribs to just behind the front legs, (2) body length (BL) from a distance pulled straight from the shoulder joints (tubal humerus) to the lumps of the filter (*Tuber ischiadicus*), (3) shoulder height (SH) is the highest distance of *Tuber coxae* to bottom, (4) ears length (EL) from the range of the ear's base to the tip of the ear, (5) ears width (EW) from a distance between the edges of the ear, (6) tail length (TL) from the reach of the base of the hair tail to the tip of the hair tail, (7) length of hairtail (LHT) from the bottom to the most extended tail hair's end, and (8) pelvis height (PH) from the highest distance (*Lumbar vertebrae*) from perpendicular to the ground surface.

The selected 14 samples of rural regions in East Java included Banyuwangi Licin (BL), Blitar Ponggok (BP), Gresik Delik Sumber (GDS), Jombang Wonosalam (JW), Kediri Papar Bulurejo (KPB), Lumajang Bruno (LB), Malang Ampel Gading (MAG), Malang Dampit (MD), Malang Wonosari (MW), Nganjuk Sumber Urip (NSU), Sumenep-Kalianget (SK), Sumenep-Porteran (SP), Sumenep-Saronggi (SS), Trenggalek Sumber Bening (TSB). The necessary consideration was that the regions had does that calved at least one time, available feed resources and breeding regions.

The statistical analysis used one-way ANOVA and Least Square Difference (LSD) to know the difference body morphology among breeding village centers in East Java.

Heritability was estimated for the prolific traits of ILEG does and used dam-daughter relationship with formulas $h2 = 2\sigma2X/COVXY$, no correction data because the does parity and the environment were relatively identical. The repeatability estimates were analyzed using ANOVA's (Becker, 1992) with formulas $r = \sigma2s/(\sigma2s + \sigma2w)$. The prolific data of genetic

parameter estimations were from does calving at least three kids and the relatively same environment (feed and management).

The Estimated Breeding values (EBVs) were used to select goat ILEG candidates based on their prolificacy value. The formula as follows:

$$EBVs = \frac{h^2}{1 + (n-1)r} (Pi - P_P) + P_P$$

Results and Discussions

Prolific Data of ILEG Does

Results that obtained including data of prolific does in 14 difference villages in East Java (Table 1). Data gathered 1195 recording as prolificacy information, record from 452 does

Table 1. Mean and Phenotype Variance of ILEG in 14 Regions of East Java based on prolific traits

No	Area Code	Number of prolific data	Number of does	The average of birth frequency	Prolific average (heads/calving)	Prolific variations (VP)	Average of prolific category
1	BL	105	49	1.74	1.42	0.53	Medium
2	BP	114	47	2.06	1.75	0.46	Medium
3	GDS	85	49	1.67	1.48	0.50	Medium
4	JW	100	53	1.69	1.84	0.47	High
5	KDR	48	27	1.81	1.71	0.21	Medium
6	LB	136	55	2.01	1.76	0.56	Medium
7	MAG	116	26	2.79	2.12	0.69	High
8	MD	105	60	1.87	1.75	0.72	Medium
9	MW	327	39	2.94	1.84	0.48	High
10	NSU	39	22	2.05	1.77	0.67	Medium
11	SK	19	16	1.95	1.58	0.51	Medium
12	SP	37	16	1.84	1.68	0.53	Medium
13	SS	51	42	2.00	1.49	0.50	Medium
14	TSB	65	19	2.50	1.81	0.58	Medium
	Total	1347	520	28.92	24.00	7.41	
	Average	97.83	36.52	2.09	1.72	0.53	Medium

Table 1. showed that the does with a calving rate at least twice had an average number of calving of 1.72 kids/doe, the highest value of 2.12 kids/doe, and the lowest value of 1.42 kids/doe and the medium category. The number of kids per calving from ILEG is higher than that of goats in Romania, with average kids per calving of 1.30 kids/doe (Pascal and Zaharia, 2016) and 1.43 kids/doe of Serrana goat (Margatho et al., 2019), 1.63 kids/doe of Begait goat (Abraham et al., 2018). It was almost the same as the average number of kids at German Improved Fawn goats with the kids per calving around 1.70 kids/doe (Samardzija et al., 2013), and the ordinary calving of Saanen goats were 1.74 kids/doe (Kasap et al., 2013).

Morphometric *Body of ILEG Does*

The average morphometric body components included CC, BL, BH, EL, EW, TL, LHT, and PH on ILEG Does in 14 different villages in East Java, could be seen in Table 2

The average morphometric body of the ILEG population (Table 2) at CC 81.06 $\pm$ 4.63 cm, BL 76.64 $\pm$ 4.33 cm, SH 75.34 $\pm$ 5.83 cm and EL 27.44 $\pm$ 3.02 cm.

The average value was higher than the national standard for ILEG does (National Standard Agency, 2015), in which ILEG standards were CC 72 cm, SH 69 cm, BL 65 cm, and EL 26 cm. Based on breeding centers, the regions with ILEG goats were similar to the four national standards: BP, GDS, JW, KPB, LB, MAG, MD, MW, NSU, and TSB. Some regions such as BL, SP, and SS only fulfilled national standards for CC, SH, and BL measurements but not up to the EL measurement standards. EL size was smaller than that of the national standard of ILEG because the ILEG had a more genetic composition of Kacang goats than Etawah goats

(ear length inherited from Etawah goats). The morphometric body at CC, BL, and SH was higher than goats in the central zone of Tigray, Ethiopia (Birhanie et al., 2019). The average body morphometry, especially HG, was also higher than that of other breed goats, such as Damascus goats (72.67 cm) and Kilis goats (69.70 cm) raised in the Southeastern Anatolia Region of Turkey (Tartar et al., 2019).

Table 2. The Average and Variance Components of Morphometric body ILEG Does

Traits	Terms	Village Breeding Centers														
		BL	BP	GDS	JW	KPB	LB	MAG	MD	MW	NSU	SK	SP	SS	TSB	
data	N	53	23.02	40	50	24	55	30	60	39	24	19	37	24	19	513
		--unit (cm)--														Mean
CC	Mean	75.3	85.26	81.18	83.8	85.5	85.7	84.77	81.64	81.67	84.73	71.6	78.5	75.3	80.05	81.06
	VP	5.53	2.91	6.36	4.93	5.79	2.64	3.38	4.42	4.66	6.67	4.53	3.14	4.96	5.13	4.63
BL	Mean	72.4	82	78.02	79.5	78.2	81.36	82.67	80.73	77.59	76.87	68.1	72.5	71.7	73.42	76.64
	VP	6.8	2.22	6.35	4.08	3.58	2.29	3.55	4.83	6.67	3.91	4.99	2.35	4.29	5.14	4.33
SH	Mean	73	81.08	78.18	77.8	77.7	79.67	82.67	78.73	76.13	70.53	65	69.2	69.6	78.32	75.34
	VP	5.04	2.11	4.68	7.43	4.59	2.19	3.03	4.51	11.15	18.23	5.12	1.94	4.92	4.14	5.83
EL	Mean	25.7	30	29.7	33.7	28.8	28.07	29.17	28.71	27.67	27.4	21.4	23.7	24.4	27.68	27.44
	VP	4.67	1.84	3.45	13	3.94	2.04	0.83	1.09	2.2	3.42	2.27	1.53	1.28	2.47	3.02
EW	Mean	10.5	15.62	10.73	13.9	11.4	12.8	17.13	17.36	12.67	10.6	11.5	10.9	11.5	10.32	12.49
	VP	4.58	1.55	1.63	4.85	2.08	1.8	1.36	1.11	1.47	1.06	0.85	0.9	0.83	1.16	1.73
TL	Mean	21.9	26.41	27.8	29.1	28.5	23	26.26	24.71	23.08	27.8	21.7	22.2	23.3	27.74	25.16
	VP	5.35	1.45	5.45	5.03	4.61	1.88	5.28	1.67	1.86	5.23	1.49	1.82	1.17	4.51	3.27
LHT	Mean	18.2	27.82	20.43	31.7	27.8	26.91	23.97	14.81	20.82	25.13	20.5	19.5	21.9	23.05	23.02
	VP	5.81	9.51	8.99	4.47	9.24	1.9	0.99	0.84	2.52	8.61	1.9	1.42	1.74	4.75	4.35
PH	Mean	76	83.1	80.75	77.6	82.3	20.3	83.57	39.36	80.97	81.47	68.2	72	72.6	81.58	71.00
	VP	4.68	2.17	4.53	14.4	3.48	0.89	3.01	2.22	5.12	4.7	5.03	2.37	5.27	3.67	4.31
PW	Mean	18.6	20.26	22.28	24.9	19.7	82.73	20.67	9.94	19.79	19.53	18	18.6	18.1	16.63	24.26
	VP	3.55	1.02	4.18	15	2.14	2.15	0.84	0.89	0.98	2.26	0.94	0.62	0.95	2.19	2.55

One SK breeding village did not comply with the criteria of the three national standards (CC, SH, and EL size were lower than national standards). The ILEG in the region had genetic composition dominated by Kacang goats rather than Etawah goats. It noted that the does standard of Kacang goats from the Ministry of Agriculture Republic of Indonesia (2015) was CC 66.7 $\pm$ 5.2 cm, BL 58.9 $\pm$ 5.6 cm, SH 55.6 $\pm$ 4.2 cm, and EL with a medium category. In contrast, the ILEG in SK village breeding was higher than the Kacang goat with CC of 71.6 $\pm$ 4.53 cm, BL 68.1 $\pm$ 4.99 cm, SH 65 $\pm$ 5.12 cm, and EL 21.4 $\pm$ 2.27 cm.

The variance of the morphometric body in this research (3.93) was lower than 28.17 reported by Belkhadem et al. (2019) who investigated the variation of local does of 5 areas in Western Algerian countries. It showed that the morphometric body of ILEG was more uniform compared to that of local goats in western Algerian countries.

Based on one way, ANOVA showed a highly significant difference (P < 0.01) in various areas of goat breeding based on morphometry body. The size of CC, EL, EW, TL, and PH in various regions > 50% were not significantly different (P> 0.05). In contrast, in BL, SH and LHT, only <

36% village breeding center was not significantly different (P> 0.05). It indicated that BL, SH, and LHT were more varied than CC, EL, EW, TL, and PH. Therefore, selection based on BL, SH, or LHT was more effective than CC, El,

EW, TL, or PH. The coefficient of variance the prolific trait and morphometric bodies was calculated from standard deviation divided by the means are presented in Table 3

Table 3. The Coefficient of variance in the prolific trait and morphometric body of does ILEG

No	Area Code	Coefficient of Variation for prolific trait (%)	Coefficient of Variation for morphometric body (%)
1	BL	51.27	5.20
2	BP	38.76	3.31
3	GDS	47.78	4.72
4	JW	37.26	5.68
5	KDR	26.80	4.28
6	LB	42.52	2.87
7	MAG	39.18	3.14
8	MD	48.49	3.71
9	MW	37.65	4.32
10	NSU	46.24	5.20
11	SK	45.20	4.27
12	SP	43.33	3.11
13	SS	47.46	3.89
14	TSB	42.08	4.12
	Average	42.43	4.13

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The expression of the prolific trait was more diverse than the morphometric body (Table 3.) because the breeders did not make the selection with considering prolificacy potential but solely on external performance, especially in buck selections with a natural mating system. The variation of a trait in a livestock population, including genetic variation, was significant as an asset for selection to increase the livestock's genetic trend in the future for economic sustainability (Hassan et al, 2016 and Atoui et al., 2018).

Estimation of Breeding Values (EBVs) of prolific potency

Heritability estimates of prolific traits were 0.20 (n = 20) with variance component of dam 0.18, covariance component of dam and daughter 0.02. Repeatability estimates of the prolific characteristic were 0.89 with variance component of dam 2.18 and variance component between progeny within female 0.27.

The EBVs average prolific potency of the ILEG Does in 14 regions (478 data) in East Java was 1.55 $\pm$ 0.16 kg with a minimum of the prolificacy of 1.39 and a maximum prolific potency of 2.23 (Table 4).

The EBVs data (Table 4) showed that the average EBVs from lowest to highest were 1.48-1.74, with a standard deviation of 5-24% of 478 does in various breeding villages. EBVs of MAG, BP, MW, and LB (28 % of 4 regions of 14 breeding villages) were higher than the average population EBVs (1.55 heads/calving). It indicated that the mean of EBVs for prolific traits was in the medium range with a reference that the prolificacy of sheep had > 2.23 heads/doe was the high category, >1.20-1.82 heads/doe was the medium category, and <1.20 heads/doe was a low category. The breeding value research gave guidelines to improve indigenous goats' genetic quality (Al-Samarai et al., 2019). The EBV relation with the prolificacy trait was essential to improve population reproduction parameters (Abdouli et al., 2019).

Table 4. The EBVs average prolific potency of The ILEG Does

No	Region	Means	S	N	max	Min
1	MAG	1.74	0.16	47.00	2.23	1.39
2	BL	1.52	0.09	48.00	1.98	1.50
3	BP	1.56	0.16	47.00	2.11	1.39
4	MD	1.54	0.13	35.00	1.98	1.39
5	GDS	1.52	0.08	40.00	1.74	1.39
6	JW	1.49	0.11	53.00	2.11	1.39
7	SK	1.49	0.17	10.00	1.86	1.39
8	KPB	1.48	0.05	27.00	1.50	1.39
9	MW	1.68	0.20	43.00	1.98	1.39
10	LB	1.56	0.14	54.00	1.98	1.39
11	NSU	1.50	0.21	20.00	2.11	1.39
12	SP	1.54	0.11	16.00	1.86	1.39
13	SS	1.51	0.17	25.00	1.98	1.39
14	TSB	1.48	0.24	13.00	2.11	1.39
		Total of ILEG Does	478 heads			

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EBVs distribution of does prolific trait from 14 regions (MAG till TSB) in East Java (Figure 1)

Figure 1 shows that the EBV profile of breeding village centers based on boxplot analysis was divided into four shapes. The first EBV profile was the MAG, MW, and TSB regions with a Q1 value between 1.39-1.5, a Q2-Q3 value greater than 0.1, and a Q3-Q2 value greater than 0.1. The second EBV profile was the region BP, LB, MD, NSU, SK, and SS with a Q1 value between 1.39-1.5, a Q2-Q3 value greater than 0, and a Q3-Q2 value greater than 0.1. The third EBV profile was the region of BL, GDS, KPB, and SP, Q1 values between 1.39-1.5, Q2-Q3 values greater than 0, and Q3-Q2 values greater than 0.
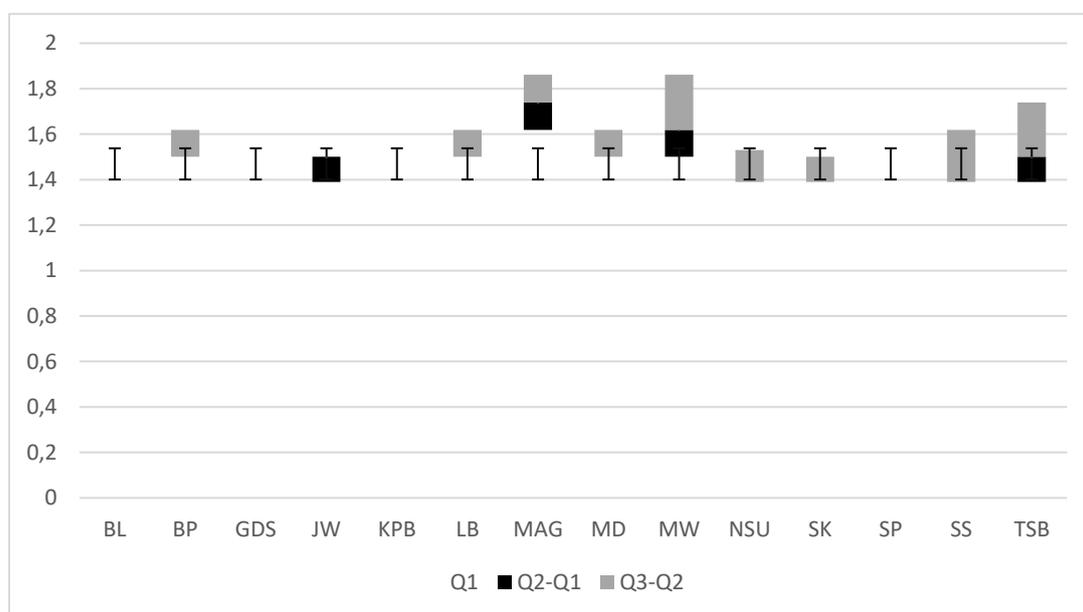
Figure 1. Profile of Does EBVs for prolific traits with Quartile (Q) in 14 regions of ILEG in East Java

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EBVs for the prolific traits reflected the prolific prediction of offspring in the optimal potency if kept in the same environment as the ancestor. It confirms previous studies that a selection of doe and buck candidates must use EBV values for subsequent breeding programs

to accelerate genetic progress in the village breeding center (Chawala et al., 2017; Gizaw et al., 2011) and to establish sustainable breeding for national scale (Aljumaah, 2019).

Conclusions

ILEG prolificacy in the present study ranged from medium to high category. The variation of a prolific trait was higher (43.98%) compared to that of the morphometry body. The prolificacy EBVs was divided into four unique pattern boxplots. The prolific variance of ILEG had great potential for a breeding program through selection or mating program.

Acknowledgement

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