The evaluation of estimated breeding value and the most probable producing ability for the basis selection of Ettawa crossbred goat (*Capra hircus* sp.) at Malang, East Java, Indonesia

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**Abstract.** Ettawa crossbred goat is Indonesia local breed goat that a dual purpose type, namely meat and milk production. The milk production is less but can improve by upgrading with other breeds like Saanen goat. The selection program is an effective way to upgrade the genetic performance of Ettawa goat. The Estimated Breeding Value (EBV) and Most Probable Producing Ability (MPPA) can be considered on the selection program. The purpose of this study was to determine the milk production different and the EBV and MPPA values of Ettawa goats. This research was carried out by survey method on goat farmers. The second lactation of milk production was stated as the data variable. The analysis of variance from nested design showed that any significant different (*P* < 0.05) in milk production between the district and very significantly different (*P* < 0.01) between sub-districts of Malang region. The highest EBV was 0.389 L from Bumiaji sub-district as well as the highest MPPA was 0.595 L from Bumiaji sub-district. So, based on the EBV and MPPA values of Ettawa crossbred goat from Bumiaji sub-district of Batu Regency could be chosen as the basis population on the breeding program of dairy milk in Malang region.

**Keywords:** Dairy milk, estimated breeding value, ettawa goat, most probable producing ability.

1. Introduction

The Goat is including one of earliest domesticated animals and based on evidence of archaeological evidence of goat were expected have been tamed at the first time in the Fertile Crescent area (approximately 10 000 yr ago) [1]. Goat farming in Indonesia has developed rapidly, not only just a people's livestock commodity but also has become an industrial-scale business where lead to prospective profits. Goats as native Indonesian commodities become very important to be one of the ways to alleviate poverty. Goats are bred for use as a source of animal protein and a source of income for humans. The benefit that can be taken from the goat is meat, milk and skin.

The one of goat breed that has been developed in Indonesia was Ettawa breed. In the past time, Ettawa goats were imported from India. Ettawa goat also referred to the Jamnapari goat. Ettawa goats
in Indonesia are crossed with native Indonesian goats namely Kacang goats to generate the Ettawa crossbred goats [2]. This crossing goat has a combination of characters between Kacang and Ettawa goats. The crossing between Ettawa and Kacang goat expected could increase the qualities of the local goats or Kacang breed.

The selection program of goat can be performed by measuring the value of the Estimated Breeding Value (BV) and Most Probably Producing Ability (MPPA). Breeding value is an indicator of the superiority of an individual animal to inherit its traits, while MPPA is a description of the potential of producing each animal in a population [3]. The measurement of EBV and MPPA that based on Ettawa goat milk production can be used as a guideline for farmers to conduct the Ettawa goat selection program.

This study is a basic study to assess the potential of Ettawa goats that will get the basis population of Ettawa crossbred goats. From the basis population, we can use for the selection of parents stock. Through the EBV and MPPA values, the breeders can be used as a reference to get the best parents stock.

2. Materials and methods

2.1. Location

Research activities were carried out in the area of Malang Raya, East Java Province (Fig. 1). The area of Malang Raya is consist of three regions, namely, Malang Regency, Malang City and Batu City. The Malang Raya area is the second largest region in East Java after the Gerbang Kertosusila (Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo, and Lamongan) regencies. Malang Raya has an area of 3 534.86 km$^2$ or equal to 353 486 ha. The latitude of Malang Raya area lies at 112° 17' 10.90" to 112° 57' 00" East Longitude and 7° 44' 55.11" to 8° 26' 35.45" South Latitude. The administrative boundaries of Malang Raya area are as follows:

i). North: Jombang, Mojokerto, and Pasuruan Regencies
ii). South: Indonesia ocean
iii). East: Lumajang and Probolinggo Regencies
iv). West: Blitar and Kediri Regencies

Most of the Malang Raya area is a mountainous region, with the contour of the area surrounded by mountains. The mountains that surround Malang Raya area consist of Arjuno, Anjasmoro, Kawi, Kelud, Bromo, Semeru and Tengger. So, besides being famous for the beautiful view of the mountains, the Malang region has a potential for agriculture and livestock activities.

![Figure 1. Map of the research area. The arrow indicates the location of sampling.](image-url)
2.2. Materials
This study used samples of Ettawa crossbred goats that have had two lactation periods as many as 63 heads from Malang Regency and Batu City. The Ettawa crossbred goats that kept by farmers in the area of Malang have the same characteristics as most Ettawa crossbred goats in Indonesia, such as having a convex face similar to Roman soldiers, floppy ears with a size longer than other Indonesian local goats and having dense hair on the neck and chest with dominant white color.

The material used in this study was the record of milk production of Ettawa crossbred goats in the 2nd lactation period. The main equipment used in this study was including counting tools, recording books, beaker glass 1 000 mL and digital camera.

![Figure 2. A farmer was milking Ettawa crossbred goat at Batu City of Malang region.](image)

2.3. Methods
This research was conducted by survey method with purposive sampling. The purposive sampling method is a taking sample based on the consideration of the researcher in accordance with the required sample requirements. So the data obtained is more representative by conducting research processes that are competent in their fields [4]. The reason that the study was choosing purposive sampling since the location study has a different number of Ettawa crossbred goat population and not all farmers have a record of milk production in the 2nd lactation. So it was not possible to randomly retrieve data. Data retrieval was determined based on locations that have a record of milk production in the 2nd lactation.

| Date of recording | Milk production sample in 24 h (p.) | Number of days at month (h.) | Milk production in 1 mo |
|-------------------|-----------------------------------|------------------------------|------------------------|
| 10/1              | -                                 | 31                           | -                      |
| 10/2              | -                                 | 28                           | -                      |
| 10/3              | -                                 | 31                           | -                      |
| 10/4              | -                                 | 30                           | -                      |
| 10/5              | -                                 | 31                           | -                      |
| 10/6              | -                                 | 30                           | -                      |
| Total             | -                                 | 151                          | -                      |

To calculate the EBV and MPPA values from Ettawa crossbred goats, it was needed the data records of milk production from goats. The method for collecting milk production data was taken by
the method of recording milk production by farmers based on Test Interval Method (TIM) [5], which was the recording carried out by farmers during the lactation period. The recording was done once a month within 24 h on the same date. Production every month was estimated by the multiplying the day length in one month by the amount of production for 24 h. Furthermore, milk production was calculated by adding up production each month during lactation. Milk production data was taken in liters.

The general formula for calculating milk production during lactation was to calculate using the following method:

\[ EML = di \cdot pi \]  

\[ EML = \text{Estimation of Milk Production} \]

\[ di = \text{Number of the day at month} \]

\[ pi = \text{Milk production sample in 24 h at month} \]

2.4. Data analysis

The analysis differentiation of milk production, EBV and MPPA between samples were conducted by using analysis of variance (ANOVA) that generated from the experimental design of the nested design with three levels of nesting. Furthermore, if the differences in EBV and MPPA values have very significantly different \((P > 0.01)\) or have a significant different \((0.05 < P)\) on the farms locations, then followed by the least significance difference (LSD) test to determine the differentiation in EBV and MPPA between sampling farms locations in the Malang Raya area. The ANOVA analysis was performed by SPSS ver. 16 software.

To estimate the EBV value was according to Brah [3] by using the following formula:

\[ \text{EBV absolute} = \frac{nh^2}{1 + (n - 1)k} \left( P_i - \bar{P} \right) + \bar{P} \]  

\[ \text{EBV relative} = \frac{nh^2}{1 + (n - 1)k} \left( P_i - \bar{P} \right) \]

While to estimate the MPPA value was following to Wilcox [6] by using the following formula:

\[ \text{MPPA absolute} = \frac{nr}{1 + (n - 1)k} \left( P_i - \bar{P} \right) + \bar{P} \]

\[ \text{MPPA relative} = \frac{nr}{1 + (n - 1)k} \left( P_i - \bar{P} \right) \]

where:

\( n \) = number of milk production observed

\( r \) = repeatability of milk production

\( h^2 \) = heritability

\( P_i \) = average of milk production of cow observed

\( \bar{P} \) = average of population milk production

3. Results and discussions

3.1. Milk production between the sampling region

The differences in milk production between samples regions suspected due to the differences in the genetic quality of Ettawa goats in each area population. The goat samples from Malang regency has lower production than Batu city and Singsosari have the lowest milk production compared to others. It was presumably caused by the differences in the genetic quality of Ettawa crossbred goats in each sample area population. The low genetic quality will cause low productivity of livestock because there are a genetic correlation as well as a phenotypic correlation of livestock [7].
Similarly, the differences between livestock maintenance management could make in variation of animal production. The dairy farmers from Singosari usually only once a day on goat milking, while the other sample areas are twice a day. So, this could be caused decreased in milk yield.

**Table 2.** The milk production of Ettawa crossbred goats on 2\textsuperscript{nd} lactation period (liter)

| Source of variance | Malang regency | Batu city |
|--------------------|----------------|-----------|
|                    | Ampelgading sub district | Lawang sub district | Singosari sub district | Bumiaji sub district | Junrejo sub district | Pesanggrahan sub district |
| Sub total          | 1 887.50        | 936.20    | 490.75     | 2 544.35    | 1 072.10      | 724.80    |
| Total              | 3 314.45        |           |            |             |               |           |

From the analysis of variance showed that the milk production of Ettawa crossbred goat milk in the second lactation between districts/cities has a significant difference ($P < 0.05$) while milk production between sub-districts was a very significant difference ($P < 0.01$).

**Table 3.** Analysis of variance (ANOVA) of Ettawa crossbred goat milk production

| Source of variance | df | ss       | ms       | $F_{cal}$ | $F_{tab}$ |
|--------------------|----|----------|----------|-----------|-----------|
|                    |    |          |          |           | 0.05      | 0.01      |
| Between district/city | 1  | 42 669.53 | 42 669.53 | 4.03*     | 4.01      | 7.10      |
| Between sub district   | 5  | 42 359.60 | 10 589.9 | 9.34**    | 2.53      | 3.67      |
| Error                | 57 | 64 626.87 | 1 133.81 |           |           |           |
| Total                | 63 | 149 655.99|          |           |           |           |

When the research is continued with Least Significance Different (LSD) test (table not shown), so Singosari district of Malang Regency was any different milk production with other because of the lowest production and Bumiaji district of Batu City was any different with other because of this district was the highest production compare to other, even between regencies/cities. The highest production of Ettawa goat milk from Bumiaji sub-district presumably that the dairy farmers from this sub-district have a better on dairy goat raising and good quality feed control on dairy goats management.

The selected Ettawa crossbred goat namely Etawah Senduro is conserved by the farmer at Lumajang district, East Java Province. The Etawah Senduro goat has milk production around 0.8 L d\textsuperscript{-1} to 1.8 L d\textsuperscript{-1} [11]. This is not different from last study that the average production of Ettawa goat was 0.8 L d\textsuperscript{-1}. This performance is still lower than other goat breeds like Saanen (France) that can produce milk up to 2.5 L d\textsuperscript{-1} [12]. Hence, the continuous selection is still needed for improving Indonesia Ettawa goat.

3.2. Estimated Breeding Value (EBV) of Ettawa dairy goats

The determined of EBV value of Ettawa goats was based on milk production in the 2\textsuperscript{nd} lactation. The EBV score of goats that have positive value was only 42 % or 26 goats. This result was small because it was below than 50 %. Table 3 showed the EBV score of Ettawa crossbred goats at sampling locations.
Table 4. The Estimated Breeding Value (EBV) of Ettawa crossbred goats of Malang region

| No | Malang Regency |       |       |       |       |       |
|----|----------------|-------|-------|-------|-------|-------|
|    | Ampelgading    | Lawang| Singosari| Bumiaji| Junrejo| Pesanggrahan |
| 1  | -0.003         | -0.059| -0.171 | -0.059| +0.221| -0.003 |
| 2  | -0.171         | -0.171| -0.227 | +0.389| +0.333| -0.003 |
| 3  | -0.115         | -0.059| -0.115 | +0.109| -0.003| +0.109 |
| 4  | +0.109         | -0.171| -0.283 | +0.165| +0.053| +0.109 |
| 5  | +0.109         | -0.003| -0.311 | -0.115| +0.053| -0.171 |
| 6  | -0.059         | -0.003| -0.339 | +0.389| -0.003| -0.059 |
| 7  | +0.109         | -0.059| -0.339 | +0.361| +0.165|       |
| 8  | +0.109         | -0.171| -0.283 | +0.165|       |       |
| 9  | +0.109         | +0.109| -0.283 | +0.165|       |       |
| 10 | -0.171         |       | -0.339 | +0.221|       |       |
| 11 | +0.109         |       |       | -0.003|       |       |
| 12 | -0.003         |       |       | -0.115|       |       |
| 13 | +0.109         |       |       | +0.221|       |       |
| 14 | -0.003         |       |       | +0.221|       |       |
| 15 | -0.003         |       |       | +0.221|       |       |
| 16 |               |       |       | -0.115|       |       |
|    | Average        | +0.016| -0.065| -0.269| +0.138| +0.117| -0.003|

Notes:
- \( P \) : 0.805
- \( h^2 \) : 0.40 (Warmadewi) \([8]\)
- \( r \) : 0.70 (Warmadewi) \([8]\)

Ettawa goat that has a positive EBV value means that the amount of milk production above the average of the population. The goat with positive EBV possible to crossbred with other goats that have the low genetic performance for the benefit of genetic quality improvement. According to Hartati \([9]\) that genetic quality improvement can be done through selection activities in a population that has a high genetic diversity, so that selection will be easier to obtain the desired traits. The reason that animal selection is based on an animal has a positive EBV value for genetic improvement because 50% of the genetic superiority of parents is inherited to their offspring. This means that an individual who has a high EBV score will inherit half of their superior traits to their kid/offspring.

On the contrary, according to Widyandari \([8]\), if females with high score of EBV are mated with males who are not superior, it will produce offspring who have lower breeding values than their mothers. The less accurate of goat selection was suspected due to a limited number of Ettawa goat with a good quality and animal culling was not implemented regularly because farmers still expected that milk production could be provided with the increasing demand for goat milk. It will lead to a decrease in the quality of Ettawa goats in Malang region.

3.3. Most Probable Producing Ability (MPPA) of Ettawa crossbred goats

Based on the Most Probable Producing Ability (MPPA) value showed that the population has an MPPA average value of 42% or 26 of 63 individuals. It showed that in this study individuals who have positive breeding values also have positive MPPA values, so it could be seen that these individuals have the ability to pass its traits also to the offspring, especially in good ability on milk production. Table 4 below showed the MPPA score of Ettawa goat from Malang region.
Table 5. The Most Probable Producing Ability (MPPA) score of Ettawa crossbred goats.

| No. | Malang Regency | Batu City |
|-----|----------------|-----------|
|     | Ampelgading    | Lawang    | Singosari | Bumiaji | Jenrejo | Pesanggrahan |
| 1   | -0.004         | -0.090    | -0.261    | -0.090 | +0.339  | -0.004       |
| 2   | -0.261         | -0.261    | -0.347    | +0.596 | +0.510  | -0.004       |
| 3   | -0.176         | -0.090    | -0.176    | +0.167 | -0.004  | +0.167       |
| 4   | +0.167         | -0.261    | -0.433    | +0.253 | +0.082  | +0.167       |
| 5   | +0.167         | -0.004    | -0.476    | -0.176 | +0.082  | -0.261       |
| 6   | -0.090         | -0.004    | -0.518    | +0.596 | -0.004  | -0.090       |
| 7   | +0.167         | -0.090    | -0.518    | +0.553 | +0.253  | +0.253       |
| 8   | +0.167         | -0.261    | -0.433    | +0.253 |         |             |
| 9   | +0.167         | +0.167    | -0.433    | +0.253 |         |             |
| 10  | -0.261         |          | -0.518    | +0.339 |         |             |
| 11  | +0.167         |          |          | -0.004 |         |             |
| 12  | -0.004         |          |          | -0.176 |         |             |
| 13  | +0.167         |          |          | +0.339 |         |             |
| 14  | -0.004         |          |          | +0.339 |         |             |
| 15  | -0.004         |          |          | +0.339 |         |             |
| 16  |          |          |          | -0.176 |         |             |
|     | Average        | +0.0243   | -0.0993   | -0.4113 | +0.2128 | +0.1797     | -0.0042     |

Notes:
P: 0.805
h²: 0.40 (Warmadewi) [8]
r: 0.70 (Warmadewi) [8]

Based on Warwick formula in Warmadewi [8] the higher individual on milk production and its population and repeatability value as well as, so the higher score of the MPPA could be obtained. Individuals with high MPPA score in milk production predicted inherited offspring with high milk production and high MPPA also. The MPPA score could be calculated relatively, so it could show positive and negative results. A positive value indicates that a dairy cattle at the next lactation period able to repeat their milk production and the milk production average higher than their population. Contrary, the negative value of MPPA indicates that milk production less than the average of their population. The superior cattle will have a high EBV and MPPA score compared to their population. By determined that two indicators, an evaluation of livestock that has high production will be obtained and the ability to pass on these traits is also high [10]. In this study showed that at Malang region has found many cattle had no positive MPPA score. For example, Lawang sub-district was almost the goats owned have a negative MPPA score, and extremely at Singosari sub-district all of the samples have a negative MPPA score. In this study, Ettawa crossbred goats that have negative MPPA also have negative EBV. So, improving animal raising management and feed quality control are considered to implement precisely which finally able to increase the EBV and MPPA score. According to Fayuma [10], several environmental factors both internal such as lactation, the age of mating, the frequency of milking and empty periods and external factors such as the condition of the animal housing environment, the year of mating and the mating season can contribute to variations in milk production in one lactation period. This situation will impact on the diversity of milk production that caused by
genetic diversity performance. Based on that reason, the proper raising management is able to influence on milk production where can be affect to the higher MPPA score also.

The dairy goats that have positive EBV and MPPA score are effectively to be selected in the animal selection program to improve the genetic quality and milk production capacity. In dairy goat farms, the high rank of milk production or MPPA score is effective to determine the animal choice to continue milk production and also could be used as animal prominent maternal or to determine animal which need to be culled. So, only by providing the high level of EBV and MPPA score is expected to increase the average milk production of Ettawa crossbred goat in the future.

4. Conclusions
From the results of this preliminary study which showed that EBV and MPPA score of Ettawa goats in Malang region below than 50 %, its meaning that generally, the genetic quality of goats was still poor in the ability to pass on their genetic characters and the ability to repeat their productivity. Hence, it is necessary to immediately conduct of the genetic grading up of the Ettawa goats in Malang region by optimizing the Ettawa goats that have positive EBV and MPPA scores and high rankings compare to their population for selection and parentage activity.

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