The Estimation of NI, NRR, and Output of Garut sheep at Breeding Center in Garut-West Java

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ABSTRACT

Sheep is one of Indonesia's most important germplasms, whose prolific capability enables it to meet the meat consumption needs of small ruminants. PT Agro Investama is a private company that operates as the largest Sheep breeding center located in Malangbong District, Garut Regency, West Java. This research aimed to estimate the output of Garut, Dorper, and its crossed breed sheep at the company. The recording data used included the number of sheep born, mortality, breeding standard operational procedure, and population structure at the beginning and end of the 2020 year. The natural increase estimation for both ram and ewes was 28.22%, while the net replacement rate was 0.36% for ram and 13.37% for ewes. The output analysis showed that culled ram and ewes were 0.36% and 13.37%, respectively. The number of remaining replacement stocks for ram was 27.85% and 14.85% for the ewes. It can be concluded that PT Agro Investama can be considered as Garut sheep producing company.

Keywords: Garut sheep, natural increase, net replacement rate, output

1. INTRODUCTION

Garut sheep are small ruminants widely spread in West Java Province and are one of the germplasm of Indonesian sheep that has excellent potential to fulfill the nation's need for animal protein. According to Heriyadi [1], as many as 54.89% of the sheep population in Indonesia are in West Java Province. The sheep population in West Java in 2016 was recorded at 10,038,828 heads, and this number expanded to 12,014083 in 2019 [2].

PT Agro Investama is a private company that operates as the largest Garut Sheep breeding center located in Malangbong District, Garut Regency, West Java. In order to maintain the balance of the Garut Sheep population in quantity and quality at PT Agro Investama, strategic effort is needed to ensure the availability of lamb meat supply as a food source. If the number of livestock output is equal to its natural increase value then population balance is attained. In order to obtain the population balance, the natural increase (NI), net replacement rate (NRR) and output estimation need to be calculated.

Increased natural value (NI) is the differentiation between natality and mortality rates in a particular area at a specific time [3]. The NRR is used to assess livestock requirements in order to maintain a balanced population in a region based on the number of offspring born [4]. Output estimation necessitates being known to determine the number of livestock that must be slaughtered or culled without changing the balance of the livestock population. The output value is determined from the number of livestock remaining for replacement and livestock that have been culled subtract with the target population increase [5]. Therefore, this research aimed to estimate the natural increase, net replacement rate, and output of Garut Sheep at the breeding center PT Agro Investama, Garut, West Java to determine the company's capability to be Garut Sheep source area.

2. MATERIAL AND METHOD

2.1 Material.

The recording data of Garut sheep collected at PT Agro Investama in Malangbong District, Garut Regency, West Java, was used in this study. The recording data used included the number of sheep born, mortality, breeding standard operational procedure, and population structure of the beginning and end of the year of 2020.

2.2 Methods.

Excel program Ver 16.52 was used for analyzing the data.

2.2.1 Average population

The following equation was used to calculate the average population [3]:

$$\overline{pop} = \frac{pop_{final} + pop_{initial}}{2} \tag{1}$$

$\overline{pop}$ = Average population
pop_f = Population at the end of the year
pop_i = Population at the beginning of the year

2.2.2 Natural Increase (NI)

The NI was estimated using the following equation [4]

$$\%natality = \frac{birth_{2020}}{\overline{pop}} \times 100 \tag{2}$$

$\%birth$ = Natality rate in 2020
$birth_{2020}$ = Total birth in 2020
$\overline{pop}$ = Average population

$$\%mortality = \frac{death_{2020}}{\overline{pop}} \times 100 \tag{3}$$

$\%mortality$ = Mortality rate in 2020
$birth_{2020}$ = Total death in 2020
$\overline{pop}$ = Average population

$$NI = \%natality - \%mortality \tag{4}$$

NI = Natural increase

2.2.3 Net Replacement Rate (NRR)

The NRR was estimated using the following equation [3]:

$$\text{Years of use of the ram/ewes} = \text{maximum breeding age (year)} - \text{first mating (year)}$$

$$\text{Replacement stock need (\%)} = \frac{\text{number of ram/ewes per population}}{\text{years of use of ram/ewes}} \times 100\%$$

$$NRR = \frac{NI}{\text{Replacement stock needed}} \times 100\% \tag{5}$$

2.2.4 Output

The output was estimated using the following equation [3]:

a. The remaining stock of ♂
$$= ♂ \, NI \, (\%) - \text{replacement ♂ stock need} \tag{6}$$

b. The remaining stock of ♀
$$= ♀ \, NI \, (\%) - \text{replacement ♀ stock need} \tag{7}$$

c. The culled ♂
$$= \text{replacement stock of ♂ (\%)} \tag{8}$$

d. The culled ♀
$$= \text{replacement stock of ♀ (\%)} \tag{9}$$

e. Total output
$$= \text{The remaining stock of ♂} + \text{The remaining stock of ♀} + \text{The culled ♂} + \text{The culled ♀} \tag{10}$$

3. RESULT AND DISCUSSION

The population structure of Garut sheep in 2020 is shown in Table 1. The average population was 1713.5 heads, with 53.49% of the population is the ewes, 17.22% yearling ram, 10.42% yearling ewes, 10.18% male lamb, 7.29% female lamb, and 1.46% of ram. This indicates the ratio of ewes to the ram was much larger because of the company's core business for breeding purposes aimed to produce lamb.

Table 1. Population structure of Garut Sheep at PT Agro Investama in 2020.

Item	Population			
	Beginning of the year (head)	End of year (head)	Average (head)	Average (%)
Ram	29	21	25	1.46
Ewes	825	1008	916.5	53.49
Yearling ram	262	328	295	17.22
Yearling ewes	55	302	178.5	10.42
Male lamb	228	121	174.5	10.18
Female lamb	205	43	124	7.24
total	1604	1823	1713.5	100.00

Table 2. Total birth and mortality of Garut Sheep at PT Agro Investama in 2020.

Item	Number (head)	Percentage to average population (%)
Birth		
Male lamb	707	41.26
Female lamb	707	41.26
Mortality	447	26.09

The Natural increase category was determined by examining the percentage of ewes to total population, which was then classified into three categories: high, medium, and low. The highest NI value can be obtained if all the ewes in the population produce a lamb with a zero-mortality rate. The NI value of the Garut sheep at PT Agro Investama in 2020 was 56.43% and categorized as high (low: 0-17.83%; medium: 17.83-35.66%; high: 35.66-53.49%). The NI value was higher than the percentage of ewes to the total population because the sheep are multiparous, producing more than one lamb per gestation. Natural increase directly impacts population growth; a high NI value indicates that there are a large number of ewes in the area that are well handled and managed. The high NI value is followed by a high birth rate and low mortality rate and should be calculated each year [6].

The purpose of estimating NRR value was to determine the ability of an area to provide replacement stock in a certain period by considering two aspects; the availability and the need for replacement stock. The NRR value was estimated by comparing the number of yearling ewes as replacement candidates with the need for replacement stock per year multiplied by 100%. According to Samberi [7], the NRR value determines whether the number of lamb births can fulfill the need for replacement stock to balance the population. If the NRR value is <100%, then the need for replacement stock is not met. In contrast, if the NRR value is >100%, then the need for replacement stock is fulfilled. The NRR value in 2020 was 12280.71% for the ram and 211.02% for the ewes, indicating that PT Agro Investama has met the requirement as a source area of Garut Sheep seed stock.

The output value was estimated from the sum of the remaining livestock population used for both male and female replacement and with culled population both male and female. The number of ram and ewes culled was determined by the length of time used in the breeding or rearing program, starting from the first mating of the sheep. The number of livestock that can be removed from certain location to be shipped or slaughtered without affecting the population balance is known as the output of livestock in an area [8]. The most ideal livestock population output value is the same as its NI value. There will be an increase in population if the value of livestock output is lower than the NI value. However, population depletion would occur if the output value is higher than the NI value. The output estimated of Garut sheep at PT Agro Investama in 2020 was 28.22% in both male and female, and it is equal to the NI value.

Table 3. Total birth and mortality of Garut Sheep at PT Agro Investama in 2020.

Estimation	In Head	In Percentage
Natural increase (NI)	967.00	56.43
Male NI	483.5	28.22
Female NI	483.5	28.22
Net replacement rate (NRR)		
Male NRR		12280.71
Female NRR		211.02
Output	967.00	56.43
Male	483.5	28.22
Female	483.5	28.22

4. CONCLUSION

The NI value of the Garut Sheep was 56.43% and categorized as high, with a 12290.71% net replacement rate for the male and 211.02% for the female sheep, far exceeding the replacement stock needed. The output of Garut sheep was 56.43%, with 28.22% for both male and female sheep in the year 2020, which indicated that PT Agro Investama has a balance population and can be considered as Garut Sheep source area.

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