Estimation output of Aceh cattle in livestock breeding and forage center of Indrapuri

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Abstract. Livestock Breeding and Forage Center (BPTU-HPT) Indrapuri is a technical implementation unit tasked with carrying out cattle breeding, especially the Aceh cattle. The objective of this study is to determine the estimated Aceh cattle output in BPTU-HPT Indrapuri, Aceh. Recording data covering the structure of the population, death and birth of cattle, expenditure, and income data in 2019 were used in this study. The results indicated that value of natural increase (NI) was 19.08%. Male cattle population exceeded 140.08% of the male breeding stock. Similarly, the female population also was over the population’s female breeding stock (73.03%) with male and female net replacement rate (NRR) of 240.08% and 173.33%, respectively. Output estimation of Aceh cattle was 19.08% of population number. The calling rate of female cattle (5.58%) was almost twice compare to male Aceh cattle (3.92%). Meanwhile, male replacement stock remains at 5.49%, and female replacement remains at 4.09% of the total Aceh cattle population. In conclusion, Livestock Breeding and Forage Center (BPTU-HPT) Indrapuri is suitable as a source of Aceh cattle breeds, albeit it needs to be increased by natural increase through increasing birth rate and reducing death rate with better management so that it can be sustainable.

1. Introduction
Livestock Breeding and Forage Center (BPTU-HPT) Indrapuri is a technical implementation unit Ministry of Agriculture which has the role to provide Aceh cattle. Aceh cattle are a small type of cattle arise specifically in the Aceh region [1] and has been established as one of Indonesia’s local cattle families through Minister of Agriculture Decree Number 2907/Kpts/OT.140/6/2011. Aceh cattle can be raised in the tropics because they have resistance to poor environments including the crisis of feed, water and high-fiber feed, parasitic diseases, hot temperatures and traditional extensive maintenance systems [2]. However, the low quality of breeding stock due to inbreeding and unplanned crossbreeding programs are the key problems in the production of Aceh cattle [3]. One way to preserve the genetic quality of the livestock in the region as a source of breeding stock is to measure the amount of production that can be released, which is equal to the number and quality of the breeding stock that has been raised as a replacement of the catlle [4]. The production of Aceh cattle controlled by BPTU-HPT Indrapuri has
not yet been optimum as the old cattle which should be culled are still in the herd. Therefore, it is important to assess their output estimates.

Livestock output estimation in the population can be calculated on the basis of their natural increase parameter, their ability to provide livestock replacement for their own population or net replacement rate (NRR), as well as their ability to eliminate remaining replaced cattle and culling cattle or their output. Thus, the goal of this study is to estimate the output production of Aceh cattle at BPTU-HPT Indrapuri in order to decide the direction of development policies for Aceh cattle.

2. Materials and method

This study was conducted in Livestock Breeding and Forage Center (BPTU-HPT) Indrapuri, Aceh Province. To achieve the objective of this study, data were recorded at two points: January and December, including population structure, mortality, birth rate, livestock input and output data over the study period. Observed variables as follows; 1) composition and structure of the population 2) mutation records, 3) mortality records, 4) natural increase, 5) net replacement rate value and 6) output value of Aceh cattle.

Data Analysis. Quantitative data were calculated on the basis of equation as follows:
The average number of cattle samples per year:

\[ P_t = \frac{P_{aw} + P_{ak}}{2} \]

Where:
- \( P_t \) = average number of cattle samples per year
- \( P_{aw} \) = number of cattle at the beginning of year or one year prior to study
- \( P_{ak} \) = number of cattle at the end of the year of study period

In order to calculate the natural increase, the birth rate and the population mortality rate need to be determined in the first place [5].

Natural increase (%) = percentage of birth a year - percentage of mortality a year

Where:

\[ \text{Percentage of birth} = \frac{\text{number of birth each year}}{\text{average population a year}} \times 100\% \]

\[ \text{Percentage of Mortality} = \frac{\text{number of death each year}}{\text{average population a year}} \times 100\% \]

The net replacement rate value can be determined on the basis of a comparison between the candidate for replacement cattle and their demand for replacement cattle multiplied by 100 per cent per year [4].

\[ \text{NRR} (\%) = \frac{\text{Natural increase}}{\text{number of replacement cattle needed}} \times 100\% \]

Number of replacement needed(%) = \( \frac{\text{Number of population longest utilization period (year)}}{\text{Number of population longest utilization period (year)}} \times 100\% \)

The output is calculated on the basis the number of rejected cattle each year and the remaining of replaced cattle. Total output = remaining of the replaced bull (percent) + remaining of the replaced female (percent) + the removed bull (percent) + the removed female (percent).

3. Result and discussion

3.1. Composition and structure of Aceh cattle population

The population of Aceh in BPTU-HPT Indrapuri was 959 in 2019 with a male adult population of 19.60 per cent and a female adult population of 44.63 per cent as shown in table 1.
Table 1. Population structure of Aceh cattle at BPTU-HPT Indrapuri in 2019.

| Composition     | Quantity (head) | Animal Unit (AU) | Percentage (%) |
|-----------------|-----------------|------------------|----------------|
| Male adult      | 188             | 188.00           | 19.60          |
| Female Adult    | 428             | 428.00           | 44.63          |
| Young male      | 92              | 54.90            | 9.54           |
| Young female    | 81              | 48.30            | 8.39           |
| Male calf       | 87              | 21.75            | 9.07           |
| Female calf     | 84              | 21.00            | 8.76           |
| Total population| 959             | 761.95           | 100.00         |

3.2. Livestock mutation

The percentage of difference over a population between input and output livestock may be used as a benchmark to determine if this area is a producer of cattle [6]. BPTU-HPT Indrapuri cattle mutation includes direct sales or grants of feeder or breeding stock to farmers, government agencies, and direct sales of culled cattle. Livestock mutation categories are including breed stock, feeder stock and culled cattle. Table 2 shows the mutation record. In this table, breeding stock data refers to cattle that have an Indonesian National Quality Certificate (SNI) from the Ministry of Agriculture's. It is shown that there were 16 culled cattle that had to be removed from the population, most of which had suffered serious injury and were sent to the slaughterhouse. In addition, from 2019 to the present, there is no additional (input) cattle population in BPTU-HPT Indrapuri. The replacement stock originated only from internal BPTU-HPT Indrapuri. Therefore, the number of cattle emerging was also greater than the number of cattle entered as shown in table 2.

Table 2. Livestock mutation at BPTU-HPT Indrapuri in 2019.

| Variable          | Category       | Breed Stock (head) | Feeder stock (head) | Culled cattle (head) | Total (head) |
|-------------------|----------------|-------------------|---------------------|----------------------|--------------|
| Livestock in      |                | 0                 | 0                   | 0                    | 0            |
| Livestock out     | Adult male     | 19                | 99                  | 3                    | 121          |
|                   | Adult female   | 5                 | 11                  | 10                   | 26           |
|                   | Young male     | 0                 | 0                   | 1                    | 1            |
|                   | Young female   | 0                 | 1                   | 2                    | 3            |
|                   | Male calf      | 0                 | 0                   | 0                    | 0            |
|                   | Female calf    | 0                 | 0                   | 0                    | 0            |
|                   | Number of livestock out | 24 | 111 | 16 | 151                   |
| Percentage of livestock out |             | 15.89            | 73.51               | 10.60                | 100.00       |

3.3. Natural increase

Natural increase is defined by the difference between birth rate and the one-year mortality rate [5]. Analyzing the parents' population over the total population may be used to assess the type of natural increase. The categories can be classified into three classes: high, medium and low to which these natural increase categorizations can be applied only in particular population and period of time [7]. High Natural increase value is between 29.77% to 44.63%, whereas the medium is between 14.88% to 29.76%, and the low natural increase is between 0% to 14.87%. The NI of Aceh cattle in Indrapuri could be categorized as medium (19.08% NI value) as mentioned in Table 3. This result was much lower than that Madura cattle in Sapudi Island, which having NI value of 27.96% [8], PO cattle in Kebumen, Central Java Province by 40.78% of NI value [7], beef cattle in Banyuasin, South Sumatera Province by
24.39% [9], beef cattle in Pesisir Selatan, Western Sumatera of 29.46% [10]. In addition, Bali Cattle have had a marginally higher NI value of 21.72% [11], 21.77% [12] and 25.30% [13] in Timor Tengah Utara, Bali Province and Southeast Sulawesi Province, respectively. Conversely, this result is significantly higher than the NI value of beef cattle in North Pamoa, Poso District by 12.13% and a slightly higher to NI of Bali Cattle in Yapen, Papua Province of 18.18% [14].

Table 3. Natural increase of Aceh cattle at BPTU-HPT Indrapuri in 2019.

| Variable                  | Quantity (head) | % to average population | % to parents |
|---------------------------|----------------|-------------------------|--------------|
| Early population          | 943            | 44.63                   |              |
| End-year population       | 975            | 52.10                   |              |
| Average population        | 959            | 23.25                   | 52.10        |
| Parent population         | 428            | 44.63                   |              |
| Total of birth            | 223            | 23.25                   | 52.10        |
| Male                      | 110            | 11.47                   | 25.70        |
| Female                    | 113            | 11.78                   | 26.40        |
| Livestock deaths          | 40             | 4.17                    |              |
| Natural increase (NI)     | 183            | 19.08                   |              |
| Natural increase male (NI)| 90             | 9.41                    |              |
| Natural increase female (NI)| 93       | 9.67                    |              |

This study claims that this NI value is influenced by high death rate over population [15], that the number of deaths is affected by the NI value, where the higher death rate results in lower NI value, and vice versa. Low NI value will be affected by the demand for replacement stock and the number of cattle that can be released [16]. NI has a correlation with population growth, where higher NI value means that there is a high number of productive female adults in a good handling and management. NI values are said to be optimum or ideal when high birth rates are accounted for by low mortality rates [6].

Death percentage was calculated from the number of deaths divided by the average population and multiplied by 100%. Death rate in 2019 at Indrapuri was 4.17%, of which 1.04% of them was adults, 0.73% were young cattle and the rest 2.4% of them were the calf, as shown in Table 4. The number of death was exceeding the main performance indicator defined by Directorate of Animal Breeding and Production decree number 25006/TU.020/F2.2/07/2019, where death rate of cattle should be ≤ 3% from total population a year. Additionally, the number of deaths in Indrapuri was much higher compared to PO in Kebumen, Central Java Province by 0.12% [7], Madura cattle in Sapudi island conservation by 2.23% [8], beef cattle in Pesisir Selatan, Western Sumatera by 0.68% [10], beef cattle in Pamoa Utara, Poso District 2.7% [16], and Bali cattle in Yapen Islands, Papua Province by 1.33% [14].

Dietary deficiency was the leading cause of death in 2019 by 32.5% from total deaths, followed by tympani 22.5%, gastrointestinal obstruction by corpora aliena 17.5%, trauma/accident 15%, pneumonia 5%, diarrhea 2.5%, heat stress 2.5% and complication 2.5%. Calf mortality was higher by 2.4% mostly due to dietary deficiency by 34.78% and tympani by 30.43%. This dietary deficiency was mainly due to the overcapacity of cage which makes some cattle unable to compete for feed. In order to combat dietary deficiency, the consistency and quantity of forage feed must be improved by the introduction of minerals. Additionally, to avoid fighting over food, livestock must be separated from other adult livestock.

Table 4. Livestock death at BPTU-HPT Indrapuri in 2019

| Cattle Composition | Quantity (head) | % to average population | % to livestock composition |
|--------------------|----------------|-------------------------|----------------------------|
| Adults             | 10             | 1.04                    | 1.62                       |
| Young              | 7              | 0.73                    | 4.07                       |
| Calf               | 23             | 2.40                    | 13.45                      |
| Total Deaths       | 40             | 4.17                    |                            |
3.4. Net Replacement Rate (NRR)
The estimation of NRR is used to measure the ability of a specific area to supply livestock replacement demand over a period of time. This value was used to evaluate whether number of births can be overcome the livestock replacement demand to maintain a constant population. If NRR < 100%, then the demand for replacement cattle is not fulfilled, vice versa [4]. Replacement stock of prospective bulls and breed stock candidates came from the BPTU-HPT Indrapuri itself, which did not brought cattle from outside. Thus, in order to calculate the livestock breeds and supplies required, it is important to decide how long the livestock will be used for breeding, natural increase and livestock population [17]. Male cattle firstly mated between 2 to 3 years of age and female cattle between 1.5 to 2 years. Male and females are used for breeding purposes for 5 and 8 years respectively. The NRR value for males was found to be 240.08% and females to be 173.33% as mentioned in Table 5. Based on this value, it is can be claimed that Aceh cattle in BPTU-HPT Indrapuri can meet the demand for livestock replacement. The surpluses in livestock replacement were supplied by 140.08% for males and 73.33% female cattle. This result was much higher compared to NRR value for males and females in Madura cattle at Sapudi Island by 96.18% and 126.41% [8], PO cattle in Kebumen, Central Java Province by 53.94% and 123.99% [7], Beef cattle in Pesisir Selatan, Western Sumatera Province by 87.68% and 121.03% for male and female respectively [10]. However, research by [14] found that the NRR value for Bali cattle in Yapen Island, Papua Province was 234.28% for males and 189.59% for females.

| Table 5. Net replacement rate Aceh cattle at BPTU-HPT Indrapuri in 2019. |
|-----------------------------|-----------------------------|
| Variable                                   | Quantity (head) | Percentage (%) |
| Male                                      |                |                |
| Male replacement demand                   | 38             | 3.92            |
| Livestock replacement availability = NI   | 90             | 9.41            |
| Male cattle net replacement rate           | 240.08         |                |
| Female                                    |                |                |
| Female replacement demand                 | 54             | 5.58            |
| Livestock replacement availability = NI   | 93             | 9.67            |
| Female cattle net replacement rate         | 173.33         |                |

3.5. Output
Beef cattle output in an area is the number of beef cattle which may be transported to other areas or slaughtered from a certain area without disrupting the balance of the livestock population [5]. This output can be estimated based on the availability of existing beef cattle productivity [18]. The output also shows the ability of an area to produce beef cattle [19]. Output estimation of Aceh Cattle at BPTU-HPT Indrapuri can be seen in table 6. The number of outputs is influenced by its natural increase, because the output is estimated based on difference between natural increase and livestock replacement demand in a year period [15]. Therefore, improving natural increase value is needed to escalate its output value. [7] found out that if there is a condition when output value is equals to NI value, which is means that there is a population balance. It can be assumed that the most optimal value of livestock population output is the same as the NI value. If the value of livestock output is lower than the value of NI, there will be an increase in population, and if the value of output is higher than the value of NI, there will be a depletion in population.

| Table 6. Aceh cattle output at BPTU-HPT Indrapuri in 2019 |
|-----------------------------|-----------------------------|
| Variable                                   | Quantity (head) | Percentage (%) |
| Culled cattle                              |                |                |
| Male                                      | 37.60          | 3.92            |
| Female                                    | 53.50          | 5.58            |
| Remaining cattle as replacement             |                |                |
| Male                                      | 52.67          | 5.49            |
| Female                                    | 39.23          | 4.09            |
| Total output                               | 183            | 19.08           |
4. Conclusion

It can be inferred from the findings and discussions that the BPTU-HPT Indrapuri is sufficient as a source of Aceh cattle breeds, but its natural increase needs to be increased by escalate the birth rate as well as reduce the percentage of livestock deaths through better management system to ensure its sustainability.

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