Potential of food crop waste as one of beef cattle feed sources to support meat self-sufficiency in Gorontalo District during the new normal period

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Abstract. This study aims to determine the potential of food crop waste as one of beef cattle feed sources to support meat self-sufficiency in the Gorontalo District during the new normal period. This research is a descriptive study using primary and secondary data. The data obtained is then calculated for the analysis of livestock performance to see the growth rate of beef production and the analysis of the concentration index for agricultural waste feed production in the Gorontalo District. The results obtained indicate that the growth rate of beef production in the Gorontalo District is \( \ln(y) = 13.50 + 0.12 \ t \) so that the growth rate increases by 12%. Furthermore, the FPCI value in the Gorontalo District is still in the low category in 12 Sub-Districts, the medium category in 4 Sub-Districts, and the high category in 3 Sub-Districts. This shows that the availability of beef cattle feed is not fully fulfilled if it only relies on existing food crop waste even though there is a growth in meat production in the Gorontalo District.

1. Introduction
Beef cattle is one of the ruminant livestock in Gorontalo Province which is mostly maintained and developed in Gorontalo District. The population of beef cattle in Gorontalo District has always increased every year. The number of beef cattle in 2019 is 92,774 heads [1]. This shows an increase in the number of beef cattle population from previous years, so that its development is very supportive of the economy and becomes an opportunity for people in Gorontalo District to develop a beef cattle business. The existence of beef cattle in Gorontalo District is considered to have a big contribution as a supplier of beef cattle to support beef self-sufficiency in Gorontalo Province. Government efforts to encourage the growth of meat self-sufficiency [2], of course there will be some challenges [3]. The graph of beef cattle population growth certainly needs to be balanced with the availability of feed which plays an important role in determining the sustainability of beef cattle farming to support meat self-sufficiency [4].

Waste is the residual waste from a production process. Agricultural waste is divided into two groups, namely post-harvest waste and industrial waste from processing [5]. Food crop waste is produced from commodities that are cultivated and have great potential as beef cattle feed. Post-harvest agricultural waste originating from food crop waste in the form of rice straw, corn, and soybeans is an easy and inexpensive alternative for beef cattle breeders in utilizing their waste products as animal feed.
Beef cattle business is mostly cultivated through the fattening model and the mother child model [6]. The ability of beef cattle to convert feed derived from agricultural waste into components needed for growth and reproduction in beef cattle [7]. The development of beef cattle business needs to be supported by various factors, one of which is feed. The availability of agricultural waste originating from food crop waste products is influenced by cropping patterns and the area of harvest of food crops in an area [8].

Utilization of food crop waste such as rice, corn, and soybeans has potential as beef cattle feed. Based on the description above, the authors will identify and analyze the potential of food crop waste as one of beef cattle feed sources to support meat self-sufficiency in the Gorontalo District during the New Normal period.

2. Material and Methods
This research was conducted in all sub-districts in Gorontalo District in January-July 2020.

2.1. Material
This research is a descriptive study where the data used in this study are primary data and secondary data. The variables observed were beef production and harvested area for food crops such as rice, maize and soybeans in 19 Sub-Districts in Gorontalo District.

2.2. Methods
Analysis of the performance of beef cattle in the last 3 years for Gorontalo District (2017 - 2019) by calculating the growth rate of beef production. The development model for the growth rate of beef production uses a simple linear regression model in the form of the equation [9].

\[
\ln (y) = a + bt
\]

Information:
- \( y \) = Livestock performance, namely the amount of beef production
- \( a \) = Constant
- \( b \) = Direction coefficient
- \( t \) = Period of year

The Feed Production Concentration Index (FPCI) provides an overview of the production concentration of each food crop waste based on dry matter production in Gorontalo District. The calculation of FPCI uses the conversion value for food crop waste [10] as follows:

**Table 1.** The conversion value of food crop waste production in rice, corn and soybeans

| No. | Types of waste | Fresh | Dry matter |
|-----|----------------|-------|------------|
| 1.  | Rice           | 11,89 | 5,96       |
| 2.  | Corn           | 9,74  | 6,00       |
| 3.  | Soybeans       | 4,34  | 2,79       |

Furthermore, calculations are carried out to calculate the Feed Production Concentration Index (FPCI) using the following formula [11]:

\[
\text{FPCI} = \frac{\text{Production of Food Crop Waste in each Sub-District of Gorontalo District}}{\text{Average Production of Food Crop Waste in Gorontalo District}}
\]

The criteria used for the Feed Production Concentration Index (FPCI) are high production categories > 2, medium > 1 - 2 and low <1.
3. Results and Discussion

3.1. Animal Performance

Beef cattle performance analysis by calculating the growth rate of meat production. The relationship between the year period and the amount of meat production can be seen in Figure 1 as follows:

![Figure 1. The growth rate of beef production in Gorontalo District](image)

Based on Figure 1 above, it can be seen that the increase in the amount of beef production follows the livestock diversity equation, namely \( \ln(y) = 13.50 + 0.12t \) so that the growth rate increases by 12%. This shows that the amount of beef production each year increases from the first year to the last year (2017-2019). The fulfillment of national meat consumption needs is obtained from beef/buffalo, goat/lamb, pork, poultry and other livestock [12]. Especially for beef, it contributes 23% to the national meat demand and is expected to continue to increase in line with population growth.

3.2. Feed Production Concentration Index (FPCI)

The harvested area for food crops (Ha) such as rice, corn, and soybeans in Gorontalo District can be seen as follows:

| No. | Sub-District | Harvested area (Ha) | Total (Ha) |
|-----|--------------|---------------------|------------|
|     |              | Rice | Corn | Soybean |          |
| 1.  | Asparaga     | 605  | 1.202 | -       | 1.807    |
| 2.  | Batudaa      | -    | 1.457 | -       | 1.457    |
| 3.  | Batudaa Pantai | -  | 557  | -       | 557      |
| 4.  | Bilato       | -    | 1.252 | -       | 1.252    |
| 5.  | Biluhu       | -    | 405  | -       | 405      |
| 6.  | Boliyohuto   | 1.089 | 839  | -       | 1.928    |
| 7.  | Bongomeme    | -    | 5.082 | -       | 5.082    |
| 8.  | Dungaliyo    | 340  | 1.047 | -       | 1.387    |
| 9.  | Limboto      | 1.092 | 1.508 | -       | 2.600    |
| 10. | Limboto Barat | 1.228 | 1.787 | -       | 3.015    |
| 11. | Mootilango   | 1.788 | 2.332 | -       | 4.120    |
| 12. | Pulabala     | -    | 9.304 | -       | 9.304    |
| 13. | Tabongo      | 1.202 | 980  | -       | 2.182    |
| 14. | Telaga       | 277  | 472  | -       | 749      |
Based on the data above, it shows that the harvested area for maize is higher than the harvested area for other food crops. This shows that people in Gorontalo District use more of their land for the agricultural sector in terms of corn crops. So that the provision of feed for livestock is dominated by corn straw. That the beef cattle business system can be integrated with feed sources [13]. The availability of feed sources can be integrated between land resources and locally generated waste [14]. This is reinforced by the climate, topography, agroecosystem and ecology that Indonesia has so that it can provide feed for beef cattle [15].

Forage for livestock consists of natural forages such as field grass and forage agricultural waste originating from food crop waste such as rice straw, corn, soybeans, and beans [16]. The availability of agricultural waste originating from food crop waste greatly affects the pattern of food crops in the area [17].

Furthermore, from the harvested area of food crop, we can know the dry matter weight of each type of agricultural waste produced from the agricultural sector based on the dry matter conversion rate [10] for each food crop variety as shown in the following table:

**Table 3. Production of dry matter food crops (Ha) in Gorontalo District**

| No. | Sub-District | Production of dry matter (Ton/Ha) | Total |
|-----|--------------|----------------------------------|-------|
|     |              | Rice    | Corn   | Soybean |       |
| 1.  | Asparaga     | 3.605,80| 7.212,00| -       | 10.817,80 |
| 2.  | Batudaa      | -       | 8.742,00| -       | 8.742,00 |
| 3.  | Batudaa Pantai| -      | 3.342,00| -       | 3.342,00 |
| 4.  | Bilato       | -       | 7.512,00| -       | 7.512,00 |
| 5.  | Biluhu       | -       | 2.430,00| -       | 2.430,00 |
| 6.  | Boliyohuto   | 6.490,44| 5.034,00| -       | 11.524,44 |
| 7.  | Bongomeme    | -       | 30.492,00| -       | 30.492,00 |
| 8.  | Dungaliyo    | 2.026,40| 6.282,00| -       | 8.308,00 |
| 9.  | Limboto      | 6.508,32| 9.048,00| -       | 15.556,32 |
| 10. | Limboto Barat| 7.318,88| 10.722,00| -       | 18.040,88 |
| 11. | Moootilango  | 10.656,48| 13.992,00| -       | 24.648,48 |
| 12. | Pulabala     | -       | 55.824,00| -       | 55.824,00 |
| 13. | Tabongo      | 7.163,92| 5.880,00| -       | 13.043,92 |
| 14. | Telaga       | 1.650,92| 2.832,00| -       | 4.482,92 |
| 15. | Telaga Biru  | 1.335,04| 7.176,00| -       | 8.511,04 |
| 16. | Telaga Jaya  | 268,20  | 372,00  | -       | 640,20 |
| 17. | Tibawa       | 6.567,92| 26.106,00| -       | 32.673,92 |
| 18. | Tilango      | -       | 1.386,00| 287,90  | 1.413,90 |
| 19. | Tolangohula  | 10.823,36| 4.680,00| 55,80   | 15.559,16 |
|     | Amount       | 64.415,68| 209.064,00| 83,70   | 273.563,38 |

*Source: Processed data, 2020.*
In Table 3 above, it can be seen that the dry matter is mostly obtained from Pulubala Sub-District while the least dry matter is in Telaga Jaya Sub-District. The dry matter value shows that the amount of harvest production in each Sub-District in Gorontalo District is different. This is also due to the variable harvest area in each Sub-District so that the dry matter yield for each food crop variety is also different. The feed given to beef cattle must match the nutritional needs of the beef cattle [6]. The need for one adult cow is 2.28 tonnes BK/year or 6.25 kg BK/day and stated that the consumption requirement is 3-4% based on the body weight of beef cattle [18].

By-products and crop waste are the key to a sustainable livestock-agriculture integration system [19]. Feeding beef cattle is carried out twice a day. Forage or agricultural waste such as straw is given to beef cattle twice a day in the morning and evening as much as 30-40 kg/head/day [20].

For the amount of dry matter for food crops above, then we can then find out the value of the Feed Production Concentration Index (FPCI). FPCI provides an overview of the production concentration of each food crop waste based on dry matter production in each region (Sub-District) in Gorontalo District. The criteria used were high > 2, medium > 1-2, and low 0-1 production categories. FPCI is the production of food crop waste in each district divided by the average production of food crop waste in Gorontalo District. The following can be seen in Table 4 below:

**Table 4. Value of Feed Production Concentration Index (FPCI) in Gorontalo District**

| No. | Sub-District  | FPCI | Category |
|-----|---------------|------|----------|
| 1.  | Asparaga      | 0.75 | Low      |
| 2.  | Batudaa       | 0.61 | Low      |
| 3.  | Batudaa Pantai| 0.23 | Low      |
| 4.  | Bilato        | 0.52 | Low      |
| 5.  | Biluhu        | 0.17 | Low      |
| 6.  | Boliyohuto    | 0.80 | Low      |
| 7.  | Bongomeme     | 2.12 | High     |
| 8.  | Dungaliyo     | 0.58 | Low      |
| 9.  | Limboto       | 1.08 | Medium   |
| 10. | Limboto Barat | 1.25 | Medium   |
| 11. | Mootilango    | 1.71 | Medium   |
| 12. | Pulabala      | 3.88 | High     |
| 13. | Tabongo       | 0.91 | Low      |
| 14. | Telaga        | 0.31 | Low      |
| 15. | Telaga Biru   | 0.59 | Low      |
| 16. | Telaga Jaya   | 0.04 | Low      |
| 17. | Tibawa        | 2.27 | High     |
| 18. | Tilango       | 0.10 | Low      |
| 19. | Tolangohula   | 1.08 | Medium   |

*Source: Processed data, 2020.*

From Table 4 above, it shows that the value of the concentration of forage production in Gorontalo District is still low on average in 12 Sub-Districts, medium category in 4 Sub-Districts, and high category in 3 Sub-Districts. This shows that the availability of beef cattle feed is not fully fulfilled if it only relies on food crop waste in Gorontalo District. The agricultural and agro-industrial waste has considerable potential as a source of ruminant animal feed [21].

Agricultural waste is commonly used as an alternative for beef cattle feed because beef cattle are able to convert crude fiber content into content that is useful for body weight growth and reproduction.
Food crop waste as an alternative for beef cattle feed is one of the solutions in overcoming the availability of feed [22].

4. Conclusion
The growth rate of beef production in Gorontalo District is \( \text{In (y)} = 13.50 + 0.12t \) so that the growth rate increases by 12%. Furthermore, the average FPCI score in Gorontalo District is still in the low category in 12 Sub-Districts, the medium category in 4 Sub-Districts, and the high category in 3 Sub-Districts. This shows that the availability of beef cattle feed is not fully fulfilled if it only relies on existing food crop waste even though there is a growth in meat production in Gorontalo District.

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