Analysis of the carrying capacity of food crop waste as contributive of beef cattle feed related to the availability of animal protein in Gorontalo District new normal adaptation period

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Abstract. This study aims to analyze the carrying capacity of food crop waste as a contributive beef cattle feed related to the availability of animal protein in the Gorontalo District during the new normal adaptation period. This research is a descriptive study using primary and secondary data. The data obtained is then calculated the carrying capacity of food crop waste for DM, CP, and TDN. The results obtained were for the highest land carrying capacity in the Pulubala Sub-District with a total DM of 24,473.48; total CP 1.535,739,09; and total TDN 1.889,619,27. While the lowest was in the Telaga Jaya Sub-District with a total DM of 280,67; total CP 15,887,20; and total TDN 19,863,70. This shows the ability in each Sub-District of Gorontalo District to produce feed, especially in the form of forage for beef cattle in fresh or dry form, without going through processing.

1. Introduction
Ruminants have a rumen that can break down feed with microbes so that ruminants can easily adjust the feed provided. Ruminant feed is a very important product for the survival of ruminants. The availability of continuous ruminant feed is very important to pay attention to so that the livestock can grow and develop properly.

One alternative for ruminant feed can be obtained from food crop waste. Food crop waste is a waste product in the form of straw or food crop production. Food crop waste in the form of rice straw, corn straw, and soybean straw which can be used as a feed efficiency for ruminants. Straw is a plant residue and can be used as feed for ruminants because it is not difficult to find in Indonesia and is economical [1], so that this waste can meet protein and a source of fiber for ruminants [2].

Beef cattle is one of the businesses in the livestock sector that has a great opportunity to be developed [3]. One of the factors that play a big role in the success of livestock business is the availability of animal feed [4]. Beef cattle feed can use feed derived from food crop waste. Observing the potential and opportunities of food crop waste as a source of beef cattle feed, seems to be able to meet the availability of animal feed needs [5].

Based on the description above, the authors intend to provide an overview of the carrying capacity of food crop waste for dry matter (DM), crude protein (CP), and total digestible nutrients (TDN) as contributive beef cattle feed related to the availability of animal protein in Gorontalo District new normal adaptation.
2. Material and Methods

This research was conducted in 12 sub-districts in Gorontalo District from January to July 2020.

2.1. Material

The research was conducted using descriptive methods accompanied by simple statistical analysis. Data collection methods were secondary data and primary data in the form of harvested area for food crops such as rice, corn and soybeans in 19 Sub-Districts in Gorontalo District. Then the data is processed and analyzed in the form of parameters of carrying capacity of food crop waste for dry matter (DM), crude protein (CP), and total digestible nutrients (TDN).

2.2. Methods

Carrying Capacity of Food Crop Waste (CCFCW) is the ability of an area to produce feed, especially in the form of forage livestock which can accommodate several of beef cattle population in Gorontalo District which is calculated in the form of dry matter (DM), crude protein (CP), and total digestible nutrient (TDN).

Production of food crop waste such as rice, corn and soybeans are calculated based on dry matter (DM) production. The conversion value [6], can be seen as follows:

| No. | Types of Waste | Dry Matter |
|-----|----------------|------------|
| 1.  | Rice           | 5.96       |
| 2.  | Corn           | 6.00       |
| 3.  | Soybean        | 2.79       |

Furthermore, the calculation of dry matter (DM) production, crude protein (CP), and total digestible nutrients (TDN) of each food crop waste in rice, corn, and soybeans before calculating the CCFCW value [6,7] is as follows:

- **Total DM Production**
  \[\text{Total DM Production} = \text{DM Production (Ton/Ha)} \times \text{Harvested Area (Ha)}\]

- **Total CP Production**
  \[\text{Total CP Production} = \text{Total DM Production} \times \text{CP Conversion Rate} \times \%\]

- **Total TDN Production**
  \[\text{Total TDN Production} = \text{Total DM Production} \times \text{TDN Conversion Rate} \times \%\]

The value of the total production of dry matter (DM), crude protein (CP), and total digestible nutrients (TDN) is continued by calculating the Carrying Capacity of Food Crop Waste (CCFCW) for each dry matter (DM), crude protein (CP), and total digestible nutrients (TDN) in Gorontalo District:

- **CCFCW based on DM**
  \[\text{CCFCW based on DM} = \frac{\text{DM Production (Ton)}}{\text{DM Needs 1 ST (Ton/Year)}}\]

- **CCFCW based on CP**
  \[\text{CCFCW based on CP} = \frac{\text{CP Production (Ton)}}{\text{CP Needs 1 ST (Ton/Year)}}\]

- **CCFCW based on TDN**
  \[\text{CCFCW based on TDN} = \frac{\text{TDN Production (Ton)}}{\text{TDN Needs 1 ST (Ton/Year)}}\]
Calculating the carrying capacity of food crop waste used several assumptions for beef cattle feed needs. The assumption used is that one livestock unit (1 ST) of beef cattle on average requires dry matter (DM) is 6.25 kg/day [8]; crude protein (CP) is 0.66 kg/day; and total digestible nutrient (TDN) is 4.3 kg/day [9].

3. Results and Discussion

3.1. Carrying Capacity of Food Crop Waste (CCFCW) Based on Dry Matter

The carrying capacity of food crop waste based on the dry matter can be seen in Table 2 below:

| No. | Sub-District     | Total DM Production (Ton/Ha) | CCFCW - DM |
|-----|------------------|-----------------------------|------------|
| 1.  | Asparaga         | 10.817,80                   | 4.742,57   |
| 2.  | Batudaa          | 8.742,00                    | 3.832,53   |
| 3.  | Batudaa Pantai   | 3.342,00                    | 1.465,15   |
| 4.  | Bilato           | 7.512,00                    | 3.293,29   |
| 5.  | Biluhu           | 2.430,00                    | 1.065,32   |
| 6.  | Boliyohuto       | 11.524,44                   | 5.052,36   |
| 7.  | Bongomene        | 30.492,00                   | 13.367,82  |
| 8.  | Dungaliyo        | 8.308,40                    | 3.642,44   |
| 9.  | Limboto          | 15.556,32                   | 6.819,96   |
| 10. | Limboto Barat    | 18.040,88                   | 7.909,20   |
| 11. | Mootilango       | 24.648,48                   | 10.806,00  |
| 12. | Pulabala         | 55.824,00                   | 24.473,48  |
| 13. | Tabongo          | 13.043,92                   | 5.718,51   |
| 14. | Telaga           | 4.482,92                    | 1.965,33   |
| 15. | Telaga Biru      | 8.511,04                    | 3.731,28   |
| 16. | Telaga Jaya      | 640,20                      | 280,67     |
| 17. | Tibawa           | 32.673,92                   | 14.324,38  |
| 18. | Tilango          | 1.413,90                    | 619,86     |
| 19. | Tolangohula      | 15.559,16                   | 6.821,20   |

*Source: Processed data, 2020.*

Table 2 above shows that the carrying capacity of food crop waste is highest in Pulubala Sub-District and the lowest in Telaga Jaya Sub-District. That the carrying capacity of agricultural waste is the ability of an area to produce feed, especially in the form of forage, which can accommodate several of beef cattle populations in fresh or dry form, without going through processing [10].

The value of the carrying capacity of food crop waste based on the dry matter is obtained from dry matter production (ton) divided by the dry matter requirement for one livestock unit (ton/year). Where the dry matter requirement for 1 ST is 6.25 kg/day multiplied for one year (365 days), so the result is 2.281.25 kg/year or 2.28 ton/year. The plan to develop a beef cattle population is always related to the availability of animal feed for its survival [11].

3.2. Carrying Capacity of Food Crop Waste (CCFCW) Based on Crude Protein

Looking for the carrying capacity of food crop waste based on the crude protein, first the crude protein number is converted based on the dry matter as follows:
Table 3. Carrying Capacity of Food Crop Waste (CCFCW) Based on Crude Protein in Gorontalo District.

| No. | Sub-District       | Total CP Production (Ton/Ha) | DDLTP - CP       |
|-----|--------------------|-----------------------------|------------------|
| 1.  | Asparaga           | 66.133,02                   | 274.410,89       |
| 2.  | Batudaa            | 57.959,46                   | 240.495,68       |
| 3.  | Batudaa Pantai     | 22.157,46                   | 91.939,67        |
| 4.  | Bilato             | 49.804,56                   | 206.657,93       |
| 5.  | Biluhu             | 16.110,90                   | 66.850,21        |
| 6.  | Boliyohuto         | 66.346,86                   | 275.298,15       |
| 7.  | Bongomeme          | 202.161,96                  | 838.846,31       |
| 8.  | Dungaliyo          | 51.943,77                   | 215.534,32       |
| 9.  | Limboto            | 93.050,51                   | 386.101,68       |
| 10. | Limboto Barat      | 108.266,77                  | 449.239,71       |
| 11. | Mootilango         | 146.901,88                  | 609.551,36       |
| 12. | Pulabala           | 370.113,12                  | 1.535.739,09     |
| 13. | Tabongo            | 75.377,11                   | 312.768,11       |
| 14. | Telaga             | 27.162,83                   | 112.708,85       |
| 15. | Telaga Biru        | 54.358,88                   | 225.555,53       |
| 16. | Telaga Jaya        | 3.828,82                    | 15.887,20        |
| 17. | Tibawa             | 206.447,81                  | 856.629,93       |
| 18. | Tilango            | 9.419,91                    | 39.086,78        |
| 19. | Tolangohula        | 86.472,53                   | 358.807,20       |

Source: Processed data, 2020.

Table 3 shows the value of the carrying capacity of food crop waste based on crude protein, the highest in the Pulubala Sub-District, and the lowest in the Telaga Jaya Sub-District. Stated that the availability of protein in beef rations is very important because protein is a major component of body organs, enzymes, hormone transport substances, and so on [12]. Research on the carrying capacity of CP was also conducted [13], who reported that the carrying capacity of feed CP in West Halmahera Regency reached 9.185.515,15 ST.

Assessment of the carrying capacity of food crop waste based on crude protein is obtained from crude protein production (ton) divided by crude protein requirement for 1 ST (ton/year). Where the crude protein requirement for 1 ST is 0,66 kg/day multiplied for one year (365 days), so the result is 240,90 kg/year or 0,24 ton/year. An area is said to be capable if the animal feed available in the area is greater than the need for livestock [14].

3.3. Carrying Capacity of Food Crop Waste (CCFCW) Based on TDN

The carrying capacity of food crops waste (CCFCW) based on the total digestible nutrient (TDN), first converted to the total digestible nutrient (TDN) figure based on the dry matter production shown in Table 4, which is as follows:
Table 4. Carrying Capacity of Food Crop Waste (CCFCW) Based on Total Digestible Nutrient (TDN) in Gorontalo District.

| No. | Sub-District  | Total TDN Production (Ton/Ha) | DDLTP - TDN |
|-----|---------------|-------------------------------|-------------|
| 1.  | Asparaga      | 536.420.05                   | 341,886.59  |
| 2.  | Batudaa       | 464.287.62                   | 295,913.08  |
| 3.  | Batudaa Pantai| 177.493.62                   | 113,125.32  |
| 4.  | Bilato        | 398.962.32                   | 254,278.09  |
| 5.  | Biluhu        | 129.057.30                   | 82,254.49   |
| 6.  | Boliyohuto    | 543.459.06                   | 346,372.89  |
| 7.  | Bongomeme     | 1,619.430.12                 | 1,032,141.57|
| 8.  | Dungaliyo     | 419.840.08                   | 267,584.50  |
| 9.  | Limboto       | 757.403.21                   | 482,729.90  |
| 10. | Limboto Barat | 880.790.58                   | 561,370.67  |
| 11. | Mootilango    | 1,196.441.78                 | 762,550.53  |
| 12. | Pulabala      | 2,964.812.64                 | 1,889,619.27|
| 13. | Tabongo       | 617.039.96                   | 393,269.57  |
| 14. | Telaga        | 220.637.66                   | 140,623.11  |
| 15. | Telaga Biru   | 437.909.96                   | 279,101.31  |
| 16. | Telaga Jaya   | 31.166.15                    | 19,863.70   |
| 17. | Tibawa        | 1,665.888.98                 | 1,061,752.06|
| 18. | Tilango       | 75.136.31                    | 47,888.02   |
| 19. | Tolangohula   | 712.032.24                   | 453,812.77  |

Source: Processed data, 2020.

Based on Table 4 above, it can be seen that the carrying capacity of food crop waste based on the TDN is the highest in Pulubala Sub-District and the lowest in Telaga Jaya Sub-District. The carrying capacity of food crop waste based on TDN is obtained from TDN production (ton) divided by TDN needs for 1 ST (ton/year). Where the TDN requirement for 1 ST is 4.3 kg/day multiplied for one year (365 days), so the result is 1.569 kg/year or 1.57 ton/year. The need for beef cattle feed consumption based on the dry matter can also be seen through the need for total digestible nutrients (TDN) that can be digested by the livestock [15]. The growth of food crops can increase economic growth [16], so that food crop waste can be integrated with beef cattle to support the availability of feed. Beef cattle is one of the livestock commodities that has the potential to be developed to support the availability of animal protein in Gorontalo District.

4. Conclusion
The highest land carrying capacity is in Pulubala Sub-District with a total DM of 24,473.48; total CP 1,535.739.09; and total TDN 1,889,619.27. While the lowest was in Telaga Jaya Sub-District with a total DM of 280.67; total CP 15,887.20; and total TDN 19,863.70. This shows the ability in each Sub-District of Gorontalo District to produce feed, especially in the form of forage for beef cattle in fresh or dry form, without going through processing.
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