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Potential Availability Waste of Food Cropas Feed in Majene West Sulawesi, Indonesia

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***Abstract*— *Animal husbandry development is an integral part of agricultural sector development. Paradigm farm livestock development is the realization of a healthy, productive and creative through a tough farm based on local resources. It is also included animal feed raw material resources. The source of agricultural-based local feed ingredients and agro-industries in Indonesia is very abundant as along as the vast agricultural land and high food crop production in Indonesia. This research was conducted in Majene, West Sulawesi. This study focused on several agricultural commodities, namely rice, corn, peanuts, green beans, cassava and sweet potatoes. This study aims were: 1). Calculate the food crop waste production; 2). Calculate the feed production concentration Index of food crop waste (FPCIFCW); 3) Calculate the carrying capacity (CCFCW) of food crop waste; 4) Calculate the feed carrying capacity index of food crop waste (FCCIFCW) in Majene. This research is a survey research. The research material was food crop waste. Determination of the study location of food crops (rice straw, corn straw, peanut straw, green bean straw, sweet potato straw and cassava leaves) was carried out in a purposive sampling. The selected districts were Ulumanda and Malunda. The result showed that the all districts were very potential in availability of food crop waste. Majene Regency has abundant production of agricultural waste. It was spread evenly, can meet livestock needs, and continuously. The production of food crops waste were159 383.6 tons dry matter, 89 313.7 tons crude protein and 53 859.9 tons total digestible nutrient.*

Keywords*—Animal feed, Food crops waste, Majene, Potential availability.

I. INTRODUCTION

Livestock is part of agriculture and other sectors which have a role in the supply of animal protein, employment, poverty alleviation, and development of regional potential. the growth and development of the livestock sub-sector is also very dependent on the growth and development of the other sectors (Naeem, et al, 2014; Ghasemi, et al, 2013; Ransom, E, et al 2012, Pighin, D, et al. 2016). The demand of livestock products, from year to year, has increased in line with the increasing income and purchasing power of the people as well as the improvement of public nutrition awareness Shimokawa, 2014). The demand of livestock products has shown in Table 1.

Table.1: Indonesian Community Protein Consumption

Type	Protein Consumption (gram/capita/year)			Protein Consumption (gram/capita/day)		
	2014	2015	2016	2014	2015	2016
Beef	26.00	417.00	417.00	0.07	1.14	1.14
Chicken	3 963.00	4 797.00	5 110.00	10.86	13.14	14.00
Milk	1 616.00	2 398.00	2 972.00	4.43	6.57	8.14
Egg	6 309.00	9 739.00	9 9796.00	17.28	266.84	273.41

Source: Livestock Statistics and Animal Health, 2017.

The high demand of livestock products is not accompanied by the growth of the livestock industry which has not been able to meet domestic needs. The data of the Directorate General of Animal Husbandry of the Ministry of Agriculture shows that the balance of beef production in 2018 was 403 668 tons. Meanwhile, domestic beef demand is predicted to reach 663 290 tons. Thus, beef needs are only fulfilled around 60.9%. The shortage of these needs are 259,662 tons where it must be imported from abroad. The balance of milk production is also much smaller than the demand figure. The inabilityof the domestic livestock industry to meet domestic needs is influenced by the following limitations i.e. 1) mastery of technology, both in the field of production and the post-harvest handling; 2) livestock capital capabilities; 3) quality of human resources; and 4) feed availability (Dahlanuddin, *et al*., 2017).Competitive livestock production systems must be based on comparative advantages with utilizing local resources including feed. The policy of developing animal feed is directed at optimizing the use of local feed raw materials to reduce the dependence of imported feed raw materials. The animal feed development policies include: a) feed concentrate policy, and b) forage feed development. Food crop waste is a fibrous feed resource that is potential and suitable for cattle and other ruminants. In many regions, food crop waste such as rice straw have not been used as sources of animal feed. Farmers tend to burn it, which means removing organic material that has the potential to become animal feed (Azis, N,A,A, et al. 2015). This condition is caused by several factors, among others; the absence of accurate data and information regarding the number and availability of feed raw materials for livestock, the results of research, related to nutritional aspects and processing technology, are still focused on limited scale research or field scale, the absence of the existence of feed raw material products that have nutritional composition, standard processing procedures that produce standard quality both physically and chemically, especially in locations that are a source of feed raw materials (Ajila, C.M, et al 2012).Majene is one of the regency in West Sulawesi that has the potential to produce food crop waste. The data of harvest area and production of several food crops in Majene are as follows: 1 718 ha of paddy with 7 610 tons of production, 2416 ha of rice field and 8 257 tons of production, 151 ha of corn field with 559 tons of production, 49 ha of peanuts field with 51 tons of production, 108 ha green beans field with 148 tons of production, 88 ha sweet potato field with production 978 tons of production and 366 ha cassava field with 7379 tons of production (Central Bureau of Statistics, 2016).

The aims of this study were: 1) Knowing food crop waste production; 2) Knowing the feed production concentration index of food crop waste (FPCIFCW); 3 Knowing the carrying capacity of food crop waste (CCFCW); 4. Knowing the carrying capacity index of food crop waste (CCIFCW). This study could be used as a material for consideration and reference for making decisions or policies, especially for developing livestock in Majene based on feed resources.

II. MATERIALS AND METHODS

This study was a survey research with research material was food crop waste. Determination of the research location for food crops rice straw, corn straw, peanut straw, green bean straw, sweet potato straw and cassava leaves was done in 3 stages, The first stage was the determination of the district that was carried out by purposive sampling. The selected districts are Ulumanda and Malunda. The second stage, from each selected district, was taken location by stratified random sampling, i.e. technical irrigation agricultural and non-technical irrigation agriculture. In the third stage, each level was taken again by stratified random sampling into monoculture and intercropping agriculture.

2.1 Data and Instruments

The data used consists of primary and secondary data. Primary data was obtained through direct observation in the field while secondary data was obtained from relevant agencies, namely the Office of Agriculture, Animal Husbandry and Plantation and the Central Bureau of Statistics.Primary data was obtained as follows:

a. Survey of food crop waste production. According to Syamsu (2006) sampling to find out the production of food crop waste with a size of 5m x 5m (25 m²) with 3 replications.
b. The quality of food crop waste was obtained from proximate analysis. Proximate analysis results included Dry Matter (DM), Crude Fat (CF), Crude Protein (CP), Extract Materials without Nitrogen (BETN), Crude Fiber (CF), and ash. Proximate analysis was carried out at the Animal Husbandry and Chemistry Laboratory, Department of Animal Nutrition and Food, Faculty of Animal Husbandry, Hasanuddin University.

2.2 Data analysis

Production data and quality were analyzed descriptively. Analysis of plant waste potential was calculated by the following equation:

Production of food crop waste was calculated based on fresh production, dry production, dry matter production (DM), crude protein production (CP) and production of Total Digestible Nutrient (TDN). TDN was calculated using the following equation according to Hartadi *et al*. (2017).

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$$\% \text{ TDN} = 92.464 - 3.338\,(CF) - 6.945\,(CF) - 0.726\,(BETN) + 1.115\,(CP) + 0.031\,(CF)^2 - 0.133\,(CF)^2 + 0.0036\,(CF)(BETN) + 0.207\,(CF)\,(BETN) + 0.100\,(CF)(CP) - 0.022\,(CF)^2(CP)$$

*CF (Crude Fiber), CF (Crude Fat), CP (Crude Protein), BETN (Extract Material without Nitrogen).

Based on data on harvested area (ha) in an area in a given year the following calculations are carried out (Syamsu, 2006):

a) . Total Fresh Production (tons) = fresh production (tons / ha) x harvested area (ha).
b) Dry matter total production (tons) = total fresh production (tons) x dry matter content (%).
c) Total Crude Protein Production (tons) = Total dry matter production (tons) x content crude protein (%).
d) Total TDN Production (tons) = Total dry matter production (tons) x TDN Content (%).

1.Feed Production Concentration Index of Food Crop Waste (FPCIFCW)

The FPCIFCW provided a description of the concentration of production of each food crop waste based on DM in each district. FPCIFCW was the ratio of the amount of production in a particular district to the average amount of production in the district. FPCIFCW was calculated using the following formula according to Syamsu (2006).

$$\text{FPCIFWC} = \frac{\text{Production of Food Crop Waste on District}}{\text{Average of Food Crop Waste Production on Regency}}$$

Districts with FPCIFCW ≥ 1.0 were districts that have a production advantage with high production category compared to other districts. Districts with 0.5 – 1.0 FPCIFCW were medium category and districts categories with < 0.5 FPCIFCW were a low production category.

2.Carrying Capacity of Food Crop Waste (CCFCW)

The CCFCW was the capability of a region to produce feed in the form of food crop waste without processing, and could provide feed to accommodate a number of ruminant livestock populations. Calculating CCFCW was used by several assumptions on ruminant feed requirements. The assumptions used were that one livestock unit (1 Animal Unit) ruminants requires an average DM of 6.25 kg/day, CP needs of 0.66 kg/day, and TDN needs of 4.3 kg/day (NRC, 2016). CCFCW was calculated based on the following formulas according to Syamsu (2006);

$$\text{CCFCW based on DM} = \frac{\text{Production of DM (ton/ year)}}{\text{1 AU of DM Need (tons/year)}}$$

$$\text{CCFCW based on CP} = \frac{\text{Production of CP (tons/year)}}{\text{1 AU of CP Need (tons/year)}}$$

$$\text{CCFCW based on TDN} = \frac{\text{Production of TDN (tons/year)}}{\text{1 AU of TDN Need (tons/year)}}$$

4. Carrying Capacity Index of Food Crop Waste (CCIFCW)

The CCIFCW was the ratio between availability of feed production and the number of needs of a mount of ruminants in the region. Livestock population was calculated based on Animal Unit standards (AU). Ruminant livestock unit standards: Cattle 1.00 ST, young cattle 0.60 ST and calves 0.25 ST, adult buffalo 1.15 ST, young buffalo 0.69 ST, Stallion 0.8 ST and Foal 0.5 ST. CCIFCW was calculated based on the following formula according to Syamsu (2006);

$$\text{CCIFCW based on DM} = \frac{\text{Production of DM (ton/year)}}{\text{Livestock population (AU)} \times \text{DM Need of 1 AU/year}}$$

$$\text{CCIFCW based on CP} = \frac{\text{Production of CP (ton/year)}}{\text{Livestock population (AU)} \times \text{CP Need of 1 AU/year}}$$

$$\text{CCIFCW based on TDN} = \frac{\text{Production of TDN (ton/year)}}{\text{Livestock population (AU)} \times \text{TDN Need of 1 AU/year}}$$

Based on the average CCIFCW and standard deviation (SD) values, the regions could be grouped according to three index categories, namely;

1. The low carrying capacity category was less than the average of CCIFCW value minus the SD (< average – SD).
2. The moderate carrying capacity category was the CCIFCW value which was in the range between the average of CCIFCW value minus the SD to the average value plus the SD (average – SD to average + SD).
3. The high carrying capacity category was higher than the average CCIFCW value plus SD (> average + SD).

III. RESULTS AND DISCUSSION

3.1. Production and Quality of Food Crop Waste

The amount of production and quality of food crop waste in Majene Regency was presented in Table 2. In this case, the production of food crop waste was production in the fresh form of each commodity of food crop waste, while

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the quality of food crop waste was obtained from proximate analysis.

Table.2: Production and Quality of Food Crop Waste

Description	Food Crop Waste					
	RS*	CS*	PS*	GBS*	CL*	SP*
Total Fresh production (ton)	103 633.20	9 135.00	3 129.00	767.00	5 115.00	3 649.0
Total Dry Matter	93 062.60	59 207.00	2 730.57	682.00	4 593.27	1 399.13
Crude Protein	4.71	8.58	21.01	16.12	23.98	10.56
Crude Fat	3.01	1.95	4.66	3.92	2.87	3.44
Crude Fiber	33.18	37.49	15.01	20.92	21.85	23.76
BETN	38.91	39.10	49.96	45.92	44.60	47.91
TDN	41.94	48.17	85.75	66.78	69.06	60.64
Ash	20.19	12.88	9.36	13.12	6.70	14.33

*RS = Rice Straw, CS = Corn Straw, PS = Peanut Straw, GBS = Green Bean Straw, CL= Cassava Leaves, SP = Sweet Potato

Table 2 shown some of the nutritional content of corn straw. It was similar to Hartadi *et al.* (2017) i.e. 8.8% ash, 7.0% crude protein, 1.7% crude fat, 33.8% crude fiber, 48.6% BETN and 52% TDN. In the other hand, the nutrient content of cassava leaves was greater than stated of Hartadi *et al.* (2017), i.e. ash 6.9%, crude protein 17.3%, crude fat 7.9%, crude fiber 22.9%, BETN 45.5% and 59.03% TDN. Nutrient content of food crop waste was generally influenced by plant age, climate, and fertilization. According to Hartadi *et al.*, (2017) the maturity and cutting limits affect the nutritional content of food crops. The nutritional content of food crop waste was a weakness for the strategy of developing the utilization of food crop waste as animal feed in Majene Regency.

3.2. Feed Production Concentration Index (FPCI) Food Crop Waste.

The production of food crop waste in Majene Regency shown in Table 3. Production of food crop waste based on the type of commodity in Majene shown in Appendix 1. Based on Table 3, the total dry matter production of food crops in Majene was 159 383.65 tons. Ulumanda District has a dry material production of food crop waste which was greater than the other districts. The amount of dry matter production in Ulumanda District was related to the area of rice field that was owned. The high production of food crop waste was a power for the development of the utilization of waste as an animal feed.

Table.3: Production of Food Crop Waste in Majene Regency (ton/harvest season)

Districts	Dry Matter*	Crude Protein*	Total Digestible Nutrien*
Banggae	1 098.2	249.3	749.9
Banggae Timur	4 081.7	3 116.6	2 104.2
Pamboang	5 835.5	643.3	1 107.4
Sendana	30 557.0	18 507.6	13 694.9
Tammerodo	12 033.1	7 846.1	5 833.6
Tubo	4 799.8	2 711.7	2 228.0
Malunda	42 927.0	24 281.7	19 489.3
Ulumanda	58 051.0	31 957.0	8 652.2
Total	159 383.6	89 313.7	53 859.9
Average	19 922.9	11 164.2	6 732.4

*summation of rice straw, corn straw, peanut straw, straw green beans, cassava leaves and sweet potato leaves.

Based on Table 3, it could be seen that the largest crude protein production was in 3 districts, namely; Ulumanda, Malunda and Sendana. The high production of crude protein in the 3 districts was closely related to the number of production of cassava leaves and peanut straw in that region. The proximate analysis results showed that the cassava leaves and peanut straw had a higher crude protein content than the other 5 types of food crop waste. So that, the cassava leaves could influence the amount of crude protein production of food crop waste in Majene Regency. Cassava is multipurpose crop for food feed and industrial raw materials. Cassava leaf, an important by-product of cassava industry, is rich in protein, mineral and flavonoids, Qiufei WU et al (2017). The commodities which have dry matter production and high crude protein content will produce high crude protein production as well.

The total digestible nutrient (TDN) of Majene Regency was 53 859.9 tons. TDN production was spread in every district. Malunda was the largest district producing the TDN and Banggae was the smallest district producing the TDN. TDN production was closely related to the production of dry matter. TDN production was also related to the percentage TDN of feed ingredients. The commodities which have dry material production and a high percentage of TDN will produce high TDN production.

The concentration index of food crop waste production was presented in Figure 1. The concentration index of food crop waste production shown an illustration of the concentration of production of each food crop waste based on dry matter in each district.

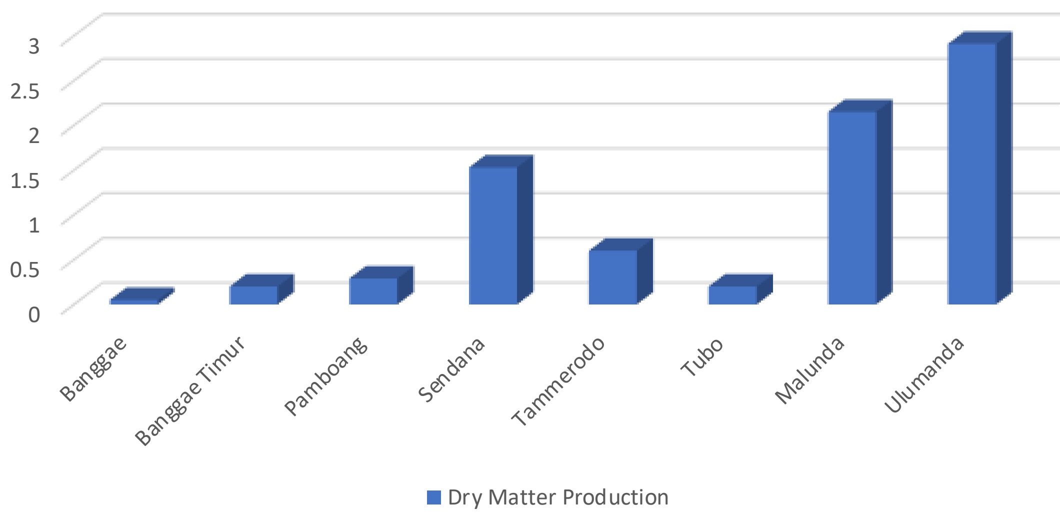

Fig.1: The concentration index of food crop waste production

The concentration index of food crop waste production showed that there are three districts which were the concentration of feed production in Majene, namely; Ulumanda, Malunda, and Sendana. The three districts were located in the southern region of Majene. This condition was in line with the mapping of the region and the direction of the development of the southern region as a center for agricultural food crops in Majene. One district categorized as medium production category was Tammerodo, and 4 districts categorized as low production, namely; Banggae, Banggae Timur, Pamboang and Tubo. This feed concentration index could be used as a consideration of the concentration of utilization of food crop waste as animal feed in terms of production (Syamsu, 2015).

Carrying Capacity of Food Crop Waste (CCFCW)

The CCFCW was the ability of a region to produce feed in the form of food crop waste without going through processing, and could provided feed to accommodate a number of ruminant livestock populations. Calculating CCFCW was used by several assumptions on ruminant feed requirements. The assumptions used were that one Animal Unit (1 AU) ruminants requires an average DM of 6.25 kg/day, needs CP of 0.66 kg/day, and needs of TDN of 4.3 kg/day (NRC 2016).

Figure 2 showed that the number of livestock which could be accommodated by the availability of dry feed ingredients in Majene was 69 854.5 AU. The animals were spread throughout the district. In accordance with the production of feed ingredients showed in Figure 2, Ulumanda has a relatively higher capacity compared to other districts in Majene Regency. The number of livestock that could be accommodated by Majene, based on crude protein needs, was 372 318.1 AU, meanwhile, based on TDN was 28 114.1 AU.

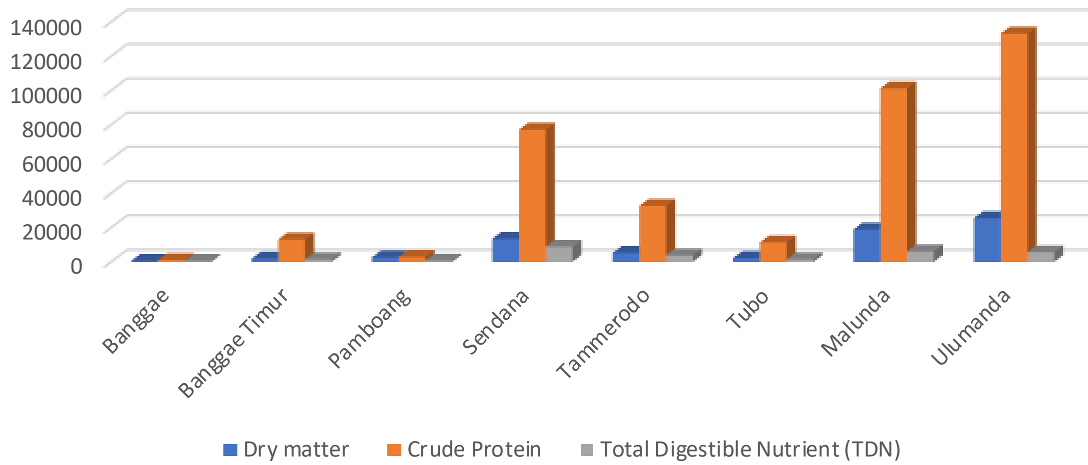

Fig.2: Feed Support Capacity of Majene District Food Crops Based on Livestock Units.

1. Carrying Capacity Indeks of Food Crop Waste (CCIFCW)

The CCIFCW as animal feed was the ratio between available feed production and the number of needs of a number of ruminant livestock populations in the region. The CCIFCW as animal feed was illustrated in Table 4.

Table.4: Carrying Capacity Index of Food Crop Waste of Majene Regency

Districts	Dry Matter		Crude Protein		Total Digestible Nutrien	
	Indeks	Category	Indeks	Category	Indeks	Category
Banggae	0.70	1	1.67	1	0.77	2
Banggae Timur	1.44	1	10.10	1	1.09	2
Pamboang	0.83	1	0.87	1	0.23	1
Sendana	2.29	2	13.20	2	1.50	2
Tammerodo	9.32	3	57.78	3	6.60	3
Tubo	1.76	1	9.44	1	1119.00	2
Malunda	5.85	2	31.48	3	3.88	3
Ulumanda	57.74	3	301.93	3	1257.00	3

Table 4 shown that the Tammerodo and Ulumanda has a high category CCIFCW. The index value possessed by the two districts illustrated that the region has a high feed carrying capacity so it was highly recommended to increase the number of livestock. Malunda district was a district with high crude protein CCIFCW and TDN, however the CP production was in the moderate category. This was due to the high livestock population in that district. There was one district was categorized as medium CCIFCW, namely Sendana, meanwhile, four districts was categorized as low CCIFCW, namely Banggae, Banggae Timur, Pamboang and Tubo. This explained that the production of food crop waste in Banggae, Banggae Timur, Pamboang and Tubo could not meet the needs of livestock which farmed in that region. This inability occured in dry matter, crude protein and TDN productions. The low value of the CCIFCW of the district was due to the low production of food crop waste which was also related to the number of livestock populations that farmed in the region. It could be seen in Table 4 that Sendana, Pamboang and East Banggae were districts that have relatively more livestock populations.

IV. CONCLUSION

Based on this study, it could be concluded that Majene Regency was very potential in the availability of food crop waste. Majene has abundant of agricultural waste production. It was spread relatively evenly, could meet livestock needs, and was sustainable. Production of food crops waste were 159 383.6 tons DM, 89 313.7 tons CP, and 53 859.9 tons TDN. Four of the eight districts that has a feed concentration index with medium to high production

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categories. Four districts belong to the category of moderate carrying capacity.

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