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Feed Carrying Capacity Index for the Etawa Goats Breeding Area in Ampelgading District, Malang Regency, East Java, Indonesia

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Abstract**—** *This research was conducted in December 2020. The purpose of this study was to analyze the feed carrying capacity index of the Etawa (PE) goats breeding area in Ampelgading District, Malang Regency, East Java, Indonesia. The data collected is secondary data from the authorized official agency. The data were analyzed by using descriptive analysis. The results showed that Ampelgading District had a population of ruminant livestock (beef cattle, dairy cow, buffalo, goat and sheep) as many as 5.121 Animal Unit (AU) with a population of 4284 AU of PE goats. The total feed potential is 45.094.93 ton dry matter (DM)/year consisting of natural feed potential of 42,269.93 ton DM/year and agricultural by-product potential of 2.825 ton DM/year. The livestock capacity reaches 13.583 AU, so it has the development potential of 8.462 AU or the equivalent of 105.773 heads PE goats. The carrying capacity index (CCI) value of the Ampelgading District is 2,65 which is categorized as safe, meaning that it is able to fulfill the forage needs of existing ruminants in sufficient and sustainable manner while still being able to accommodate the development of livestock populations.*

Keywords**—** *Carrying capacity; feed carrying capacity index; PE Goat; Breeding Area; Malang; Indonesia.*

I. Introduction

Malang Regency is the area with the third highest ruminant livestock population in East Java by 251,158 AU (Kementrian Pertanian, 2018) with a potential feed production of 713,707.9 ton DM/year (Edi, 2020). The population of ruminant livestocks is divided into several districts in Malang Regency. The types of ruminants which are commonly farming in Malang Regency are dairy cow, beef cattle, buffalo, sheep and goat. One of the districts that contribute the highest number of ruminants, especially PE goats, is Ampelgading District. Ampelgading District has an area of 30,403 hectares with a population of 57.9 thousand people with a population growth rate of 0.91% per year (BPS Kab Malang, 2020). Ampelgading District is one of the areas in Malang Regency that has become a producer of PE goats, yet the studies that support this area are still limited.

The population of ruminant livestock (beef cattle, dairy cow, buffalo, goat and sheep) in Ampelgading District at the end of 2019 reached to 33,791.16 AU. In order to support the management of the Breeding Area, it is necessary to analyze the potential carrying capacity of the feed and the index of the carrying capacity. Provision of feed in terms of quality, quantity and sustainability of its availability is a major factor in efforts to increase livestock productivity. Inventory of land use data and food crop production can be used as a basis for breeding development because it is related to the availability of forage and to analyze the capacity of livestock that can be placed in an area (Atmiyati, 2006). Land, crops and goat breeding are an organic unit that is closely related and has a high dependence on one another. The three components are a triangular system that must function synergistically to produce optimally. Especially if productivity is expected to run in a sustainable and sustainable manner (Soedjana, 2007)

The productivity of goats is also very dependent on the quality and quantity of feed provided (Budiari and Kertawirawan, 2020). Failure to develop livestock populations in an area is usually the impact of not taking into account the carrying capacity of available feed, while feed is the largest input in the livestock system. Therefore, this study aims to determine the carrying capacity index of feed in the context of developing PE goat breeding area in Ampelgading District, Malang Regency. Feed safety status in an area is one of the most important factors and also influences the development potential and population dynamics in the successful development of PE goats.

II. Method and Material

A. Research Site

This research was conducted in Ampelgading District, Malang Regency, East Java Province, Indonesia in December 2020. The selection of Ampelgading District was carried out by purposive sampling because the number of PE goats in this region was the largest in Malang Regency. This area also had the potential for abundant forage supply. Ampelgading District itself consists of 13 villages with various feed potentials and agricultural by- products.

B. Data Collection and Analysis

The data collected in this study is secondary data. The data related to this study were obtained from a) BPS-Statistics Malang Regency, b) Animal Husbandry Service of East Java Province c) Literature study of research results published by official institutions. The data used is secondary data from the BPS-Statistics Malang Regency in 2020. The data were analyzed by using descriptive analysis. The secondary data is then processed and analyzed into information so that conclusions can be obtained.

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C. Parameter

1. The population of ruminant livestocks in Ampelgading District, Malang Regency. The uniformity of livestock follows Ashari et al. (1995) were; cattle 0.7 AU, buffalo 0.8 AU, sheep 0.07 AU, goat 0.08 AU
2. By-products of agricultural products potential. Calculations were following Muller (1974):
   Waste potential = (2,5 x pd x 0,70) + (6,0 x jg x 3 x 0,75) + (2,5 x kd x 0,60) + (2,5 x kt x 0,60) + (1,5 x uj x 0,80) + (1 x uk x 0,3).
   Details:
   pd= rice field area in hectare;
   jg=corn field area in hectare;
   kd=soybean field area in hectare;
   kt=peanuts field area in hectare;
   uj=sweet potato field area in hectare;
   uk=Cassava field area in hectare
3. Natural feed potential (Tanuwiria et al., 2007) :
   a) Grazing land = (0.23 x 60 ton x land area) ton DM/year
   b) Rice field = (0.77591 x land area x 0.06 x 6.083) ton DM/year
   c) Dry land (land) = (1.062 x land area x 0.09785 x 6.083) ton DM/year
   d) Forest land = (2,308 x land area x 0,05875 x 6,083) DM/year
4. Carrying capacity (AU)

$$\text{Carrying capacity (AU)} = \frac{\text{Feed Potential } (ton\frac{DM}{year})}{\text{Feed requirement 1 AU/year}} = \frac{\text{Feed Potential } (ton\frac{DM}{year})}{3.32 \text{ tons of DM/year}}$$

   The feed requirement for each AU is 9.1 kg DM/day or 3.32 ton DM/year (Ashari et al., 1995).
5. Livestock development potential (AU)
   Calculated by the approach = carrying capacity (AU) – number of real livestock (AU).
6. Area carrying capacity index (CCI) (Saputra et al., 2016)

$$CCI = \frac{\textbf{Carrying Capacity (AU)}}{\textbf{Real Livestock Population (AU)}}$$

   CCI Criteria :
   CCI ≤ 1 (very critical) ;
   CCI > 1 - 1,5 (critical);
   CCI >1,5 – 2 (vulnerable);
   CCI > 2 (safe)

III. Result And Discussion

A. Ruminant Livestocks Population in Ampelgading District

One area that supports the goat population in Malang Regency is Ampelgading District. This area is located on the slopes of Mount Semeru with good agro-climatic conditions so that the availability of forage is abundant. The total population of ruminants is 5121 AU, while the goat population in this region is 4284 AU or equivalent to 20.47% of the goat population in the Malang Regency area (BPS, 2020). The population of goats in this area is very large because people really like goats because they are easy to maintain and have good economic value. The type of goat that is kept is the Etawa crossbreed (PE). In addition to goats, other ruminant populations consist of 526 AU dairy cow, 246 AU beef cattle, 42 AU buffalo, and 24 AU sheep. The population of ruminants in Ampelgading District, Malang Regency in livestock units can be seen in Table I.

TABLE I. Ruminant Livestocks Population in Ampelgading District

Livestock Type	Population (AU)	
	Malang Regency	Ampelgading District
Dairy cow	60241	526
Beef cattle	166797	246
Buffalo	786	42
Sheep	2409	24
Goat	20924	4284
Total	251158	5121

Source: BPS data processed (2020)

B. Agricultural by-product Potential

Agricultural by-products are the by-products of the main products or residues from the main products of agricultural activities that still contain beneficial nutrients. Agricultural by-product in Ampelgading District are abundant enough so that they can be used as an alternative feed to replace forage in fulfill the nutrient needs of ruminants. There are three leading agricultural commodities such as rice, corn, and cassava with a land area of 407 ha, 437 ha, and 487 ha, respectively. So based on the area of agricultural land, it has the potential to produce by-products of 2,825 ton of DM/year. The highest by-products are in Lebakharjo Village, which is 1.511 ton of DM/year and the lowest is in Tamansari Village, which is 24.6 ton of DM/year. The distribution of agricultural by-products in Ampelgading District can be seen in Figure 1.

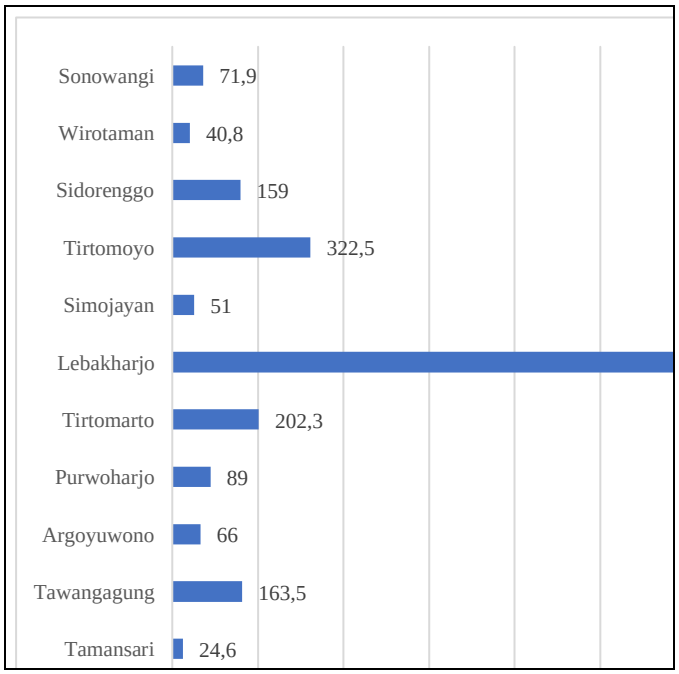

Fig. 1. Agricultural By-Product in Ampelgading District
Source: BPS data processed (2020)

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TABLE II. Nutrient content of feed ingredients from agricultural by-products

Feed Ingredients	Nutrient Content (% per 100 g)						
	Moisture	Ash	Crude Protein	Crude Fat	Crude Fiber	Calsium	Phosphor
Rice straw[1)]	14,59	5,95	9,93	6,36	9,68	0,07	0,65
Corn *Tebon*[1)]	75,20	9,40	9,24	1,37	37,45	0,55	0,20
Cornbread[1)]	11,30	4,20	8,40	2,69	13,72	0,36	0,26
Corn straw[1)]	14,11	13,20	16,22	2,55	23,50	0,46	0,41
Corn leaves[1)]	66,38	14,15	9,58	3,94	34,26	0,10	0,41
Soybean leaves[2)]	87,4	10,10	16,70	3,7	27,7	-	-
Soybean Straw[3)]	60,62	-	14,09	3,54	20,96	-	-
Green bean straw[3)]	88,07	-	15,39	3,59	26,39	-	-
Peanut root[1)]	14,16	31,10	7,45	1,17	17,46	0,43	0,17
Peanut leaves and stems[1)]	12,63	9,7	8,61	1,86	35,14	1,22	0,32
Peanut straw[1)]	16,80	12,00	19,92	1,96	29,57	1,85	0,23
Peanut shell[1)]	11,32	24,49	7,05	3,06	36,83	0,51	0,10
Sweet potato leaves[2)]	23,7	16,1	19,2	2,6	16,2	-	-
Sweet potato straw[3)]	84,79	-	3,90	1,40	21,51	-	-
Cassava stems and leaves[2)]	9,86	6,20	24,98	5,77	33,74	1,03	0,32
Cassava straw[3)]	82,59	-	3,98	1,59	33,24	-	-
Cassava leaves[4)]	75,67	7,05	33,05	5,00	14,41	1,51	0,47
Cassava peel[2)]	40,47	8,28	6,01	1,25	21,01	0,46	0,16

Sources: [1)] Balai Pengujian Mutu dan Sertifikasi Pakan Bekasi (2013), [2)] Tanuwiria (2007), [3)] Dewantari (2016), [4)] Proximate analysis results at the Animal Husbandry Service Laboratory of East Java Province

Saputra et al., (2016) stated that the use of agricultural by-products for ruminant feed is widely known because of the ability of ruminants to convert feed ingredients that contain high crude fiber into products that are beneficial for growth and reproduction. Yusriani et al., (2015) added, in the livestock crop integration model, farmers overcome the problem of animal feed availability by utilizing plant waste such as rice straw, corn straw and waste beans. The by-products can be inthe form of straw, shell or other plant parts that are not used for food needs. The nutrient content of by-products of several agricultural products is presented in Table II. Based on the quantity and quality in Figure 1 and Table II, the utilization of by-products of agricultural products in Amplegading District has great potential for the development of ruminant feed, especially PE goats. The availability of animal feed ingredients is supported by the availability and production of agricultural crops in the form of waste and its by-products, while the production of agricultural products is not only influenced by climatic conditions, but also influenced by the harvested area of the farm, labor and the number of livestock kept as well as the location of the farming area (Sari et al., 2016).

C. *Natural Feed Potential*

The potential for natural feed is calculated based on the area of rice fields, dry land, grazing fields, and forests. According to Sumanto and Juarini (2004), the carrying capacity of natural feed is the ability to provide animal feed (forage) from an administrative area. Siba et al. (2017) added that natural feed can not only be found in natural pastures but in various areas of vacant land that intentionally or unintentionally have the potential to provide natural feed. Santosa and Nurfaizin (2017) stated that the amount of feed carrying capacity depends on the amount of agricultural production of food crops and the area of plantation. The higher amount of production and area of agriculture, the higher the feed carrying capacity to support the goat population.

BPS (2020) stated that the land area of Ampelgading District was 30.403 hectares. The details of the land were used as settlements of 14.998 ha; rice fields 407 ha; dry land/garden 11,793 ha; plantation area 2,487 ha; forest 460 ha and another 258 ha. The potential of natural feed in Ampelgading District can be seen in Table III. The highest potential of natural feed dry matter is produced by grazing land, which is 34.320,60 ton DM/year. The total potential of natural feed dry matter in Ampelgading District in a year can reach to 42.269,93 ton DM/year. The level of availability of forage fodder in an area is one of the most important factors and also influences population dynamics in the success of livestock development. The availability of large land in Ampelgading District strongly supports the provision of goat feed, either by cultivating or the availability of natural feed and agricultural by-product.

TABLE III. Natural Feed Potential of Ampelgading Regency

Land Type	Width (Ha)	Natural Feed Potential (ton DM/year)
Grazing land	2.487	34.320,60
Rice Field	407	115,26
Dry land	11.793	7.454,65
Forest Land	460	379,42
Total		42.269,93

Source: BPS data processed (2020)

D. *Carrying Capacity and Potential for Ruminant Livestock Development*

Livestock capacity is the ability of an administrative area to be able to accommodate the needs of animal feed at a certain time, in the form of natural feed and agricultural products without processing. Furthermore, it is explained that the carrying capacity of the region can be interpreted as the ability of an area to be able to accommodate and hold pressure/damage due to human activities in fulfill their needs while maintaining the balance of their ecosystem (Umela and Bulontio, 2016). The capacity of livestock is calculated by looking at the population in an area compared to the potential for feed produced in that area within a certain period of time. Based on the results of the analysis of the potential for

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agricultural by-products in Ampelgading District, it is 2.825 ton DM/year while the potential for natural feed is 42,269.93 ton DM/year. The total potential of feed ingredients owned by Ampelgading District is 45,094.93 ton DM/year. The capacity and potential for livestock development in Ampelgading District can be seen in Table IV.

TABLE IV. Capacity and potential for ruminants development in Ampelgading District

Feed production (ton DM/year)	Population (AU)	Dry matter requirement (ton DM/AU/year)	Carrying Capacity (AU)	Development Potential (AU)	Carrying Capacity Index
45.094,93	5.121	3,32	13.583	8.462	2,65

Source: BPS data processed (2020)

By considering the potential of feed based on agricultural by-products and production of natural feed as well as livestock population, it can be seen that the capacity of ruminants in Amplegading District reaches 13.583 AU. The existing population of ruminants is 5.121 AU, so there is a potential for ruminant livestock development of 8.462 AU. The value of this development potential can be interpreted that the Amplegading District has feed resources that have not been utilized optimally. If the value of this development potential is used as a whole for PE goats, the population that can be added is 105.773 heads PE goats.

E. Carrying Capacity Index (CCI)

The carrying capacity index is an approach to assessing the development of a region. The CCI number is also used to determine the level of animal feed security in an area to support the life of livestock in the area (Triyanto et al., 2018). The results of the CCI calculation in Ampelgading District are 2,65, indicating the criteria for safe status (CCI>2). This means that the availability of feed resources is functionally sufficient to efficiently meet the needs of the environment (Sumanto and Juarini, 2004). This shows that Ampelgading District has the ability to fulfill the existing feed needs of ruminants in an adequate and sustainable manner while still being able to accommodate population development. According to Wantasen et al. (2016) the continuous availability of feed over time will provide stability in the business and more profit value for farmers.

IV. CONCLUSSION

The results showed that Ampelgading District had a population of ruminants (beef cattle, dairy cow, buffalo, goat, and sheep) of 5.121 AU with a population of 4284 AU of PE goats. The total feed potential is 45.094.93 ton DM/year consisting of natural feed potential of 42.269.93 ton DM/year and agricultural by-product potential of 2.825 ton DM/year. The livestock capacity reaches 13,583 AU, so it has the potential for development of 8,462 AU or the equivalent of 105.773 heads PE goats. The carrying capacity index value of the Ampelgading District is 2.65, which means it is safe, meaning it fulfill the feed needs of existing ruminants in sufficient and sustainable manner while still being able to accommodate population development.

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