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### Review and Short Length Article:

## Analysis of Feed Carrying Capacity for Ruminant Livestock in Madura Island, Indonesia

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**Abstract.** A region is considered self-sustainable when the feed provision is adequate for all livestock demands. Livestock is fed in order to supply nutrient needs for maintenance, growth, and reproduction purposes. This study aimed to determine whether Madura Island in Indonesia is able to independently provide sufficient forage for its ruminant livestock. A Carrying Capacity Index (CCI) in four regions of Madura Island was determined and then, the capacity to sustain additional ruminant livestock was calculated. The results showed that Sumenep and Pamekasan with average values of 454306 and 90663 BKC had the highest and lowest potentials for the supply of fresh forage, respectively. Sumenep also had the best carrying capacity of all the analyzed regions, supporting up to 231879 ST ruminants. Also, the results suggest that Madura Island was already at overcapacity with the livestock population that exceeds the region's capability to provide feed from fresh or waste agricultural products.

**Key words:** Feed carrying capacity, Ruminant livestock, Madura Island, Overcapacity

## Introduction

Livestock development in a region is closely related to feeding provision as the most common constraint faced by breeders is lack of feed for their livestock. Failure in increasing the livestock population in a region is often caused by a miscalculation of the region's feed carrying capacity. Feed is one of the most important factors in livestock development (Beigh *et al.*, 2017)

One of the most popular fodders for livestock in the region is King Grass (*Pennisetum purpureum*). In a suitable environment, King Grass can produce 1.076 tons of fodder and 525 tons of green forage per acre every year. But breeders can only provide up to 500 tons of feed and 250 tons of green forage. In reality, the green forage provision of the breeders still poses the main problem, especially in the dry season (Nampanzira *et al.*, 2015).

Ruminant livestock is able to utilize the feed, especially green forage including agricultural waste. In order to develop the ruminant livestock in a certain region, the utilization of agricultural waste is important as the provision from grass and green forage is limited (Scasta *et al.*, 2016). Agricultural waste production such as maize hay, paddy hay, and legume hay depends on the planting pattern of particular region (Yanti and Yayota, 2017). Maize hay, paddy hay, legume hay, cassava leaves, and sweet potato leaves have the potential to be used as feed for ruminant livestock (Hammond *et al.*, 2014). These agricultural wastes can provide fiber and essential protein for the livestock. In general, agricultural wastes are mostly abundant during harvesting season and their utilization needs technology in order

to increase their nutritional value (carbohydrate and protein) as well as achieving autonomous provision throughout the year (Gado *et al.*, 2017)

Livestock consume feed in order to supply nutrient needs for maintenance, growth, and reproduction purposes. Consumed feed undergoes physical and chemical changes inside the animal system by the actions of enzymes.

## Materials and Methods

Data were collected from the Badan Pusat Statistik (BPS) (Indonesia Central Statistics Agency) East Java branch in 2015 to measure the region carrying capacity. Bappeda (Indonesia Regional Development Planning Agency) East Java branch provided data related to livestock by phone and during visits to the office in person. Most of the data were provided by Dinas Peternakan Propinsi Jawa Timur (East Java Province Animal Husbandry Department): disease data, livestock health, feed function, breeding function, cultivation function, administrative, and population.

### a) Livestock population to animal unit conversion

Livestock conversion to the animal unit was calculated according to the formula given by Ashari *et al.* (1996).

### b) Feed potential analysis

The feed potential analysis was calculated according to Ashari *et al.* (1996). Total feed potential is the sum of waste feed potential and fresh feed potential.

### CCI (Carrying capacity index) analysis

CCI analysis is used to determine the ratio between total feed provision and feed demand and was calculated as per by Ashari *et al.* (1996):

$$\text{Carrying Capacity Index} = \frac{\text{Waste feed potential} + \text{Fresh feed potential}}{\text{Feed demand}} \quad (1)$$

### c) Region capacity analysis

Region capacity can be determined using the following formula (Ashari *et al.*, 1996):

$$\text{Area capacity} = \frac{\text{Carrying capacity index}}{4} \times \text{Livestock population (ST)} \quad (2)$$

The conclusion was drawn based on the region carrying capacity to determine the status whether the region is capable of providing additional feed for livestock or is already at overcapacity and requires alternative treatment. If the region capacity is higher than the livestock population, breeders can increase the number of their livestock. However, if the region capacity is lower than the livestock population, it is considered as overcapacity and an alternative feed source is required in order to meet the feed demand. Additional livestock capacity was conducted in all regions to determine whether one region is capable

of supporting additional livestock. It was calculated by subtracting the livestock population from the region carrying capacity.

## Results

The ruminant livestock population (260960 ST), agricultural waste feed potential (603646 BKC) and fresh feed potential (454306 BKC) were the highest in Sumenep while the lowest (113148 ST, 270026 BKC and 90663 BKC, respectively) was in Pamekasan (Table 1).

**Table 1.** Population analysis (ST) and feed potency analysis in 4 regions of Madura Island

Location	Population (ST)	Agricultural Waste Feed Potential (BKC)	Fresh Feed Potential (BKC)
Bangkalan	143199	411629	142499
Pamekasan	113148	270026	90663
Sampang	150680	414165	138576
Sumenep	260960	603646	454306

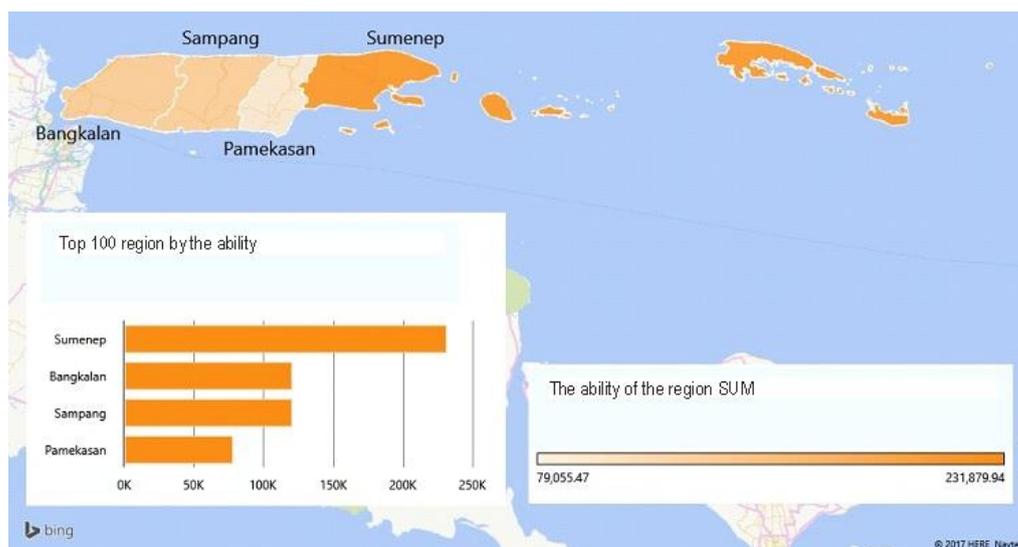
Every region had less than 4 CCI. Sumenep had the highest CCI (3.55) and Pamekasan had the lowest CCI (2.79) (Table 2). Also, Sumenep had the best carrying capacity of all the analyzed regions, supporting up to 231879 ST ruminants. The region with the worst carrying capacity was Pamekasan, which was only capable of supporting 79055 ST

ruminants less than half of the Sumenep capability (Table 2 and Fig. 1).

The result of additional livestock capacity showed that every analyzed region was at overcapacity, which means that for each region, it is not advisable to add more livestock as it already exceeds its ability to provide feed for its livestock (Fig. 2).

**Table 2.** Carrying capacity index, region carrying capacity, and additional livestock capacity in four regions of Madura Island

Location	CCI	Region carrying capacity (ST)	Livestock Addition Capacity
Bangkalan	3.392	121452.89	-21746.67
Pamekasan	2.794	79055.47	-34093.49
Sampang	3.216	121148.94	-29531.71
Sumenep	3.554	231879.94	-29080.24



**Fig. 1.** Ability of the region map for livestock feed



**Fig. 2.** Map of Capacity livestock addition for feeding

**Discussion**

The results of this study are surprising to the current understanding that Madura has abundant feed for ruminant livestock even though there was never any scientific investigation conducted in the aspect. As well, the government is suggested to create a policy regarding this under capacity in Madura Island such as organizing the transport of feed from high feed provision potential regions to Madura Island or creating a specialized region to provide feed. The transportation method cannot be sustained for a long time as it diminishes the ability of Madura Island to be independent in terms

of livestock feed provision. The specialized region creation is the most reasonable solution to overcome the overcapacity problem as well as providing independence to Madura Island in livestock feed provision.

**Conclusion**

Madura Island is well known as a livestock breeding region with its enormous ruminant livestock population, especially cattle; however, the enormous population is not supported by livestock feed provisions. The government needs to increase feed production locally to create

an independent breeding region in Madura Island.

### Conflict of interest

All authors declared no competing interest.

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## ارزیابی ظرفیت چرای مرتع برای دام‌های اهلی (گاو و گوسفند) در جزیره مادورا اندونزی

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**چکیده.** ناحیه مورد بررسی به دلیل خودپایداری در تامین علوفه کافی برای همه دام‌های اهلی مورد توجه قرار گرفته است. برای نگهداری و تولید محصولات دامی، تامین مواد غذایی مورد نیاز دام‌های اهلی مد نظر قرار دارد. هدف از این مطالعه بررسی توانایی جزیره مادورا در کشور اندونزی برای تهیه علوفه کافی مورد نیاز گاو و گوسفند بود. شاخص ظرفیت برداشت در چهار ناحیه جزیره تعیین شد و سپس ظرفیت برداشت پایدار دام‌های اهلی محاسبه شد. نتایج نشان داد که دو ناحیه سومنپ و پامکاسان با متوسط ارزش ۴۵۴۳۰۶ و ۹۰۶۶۳ واحد اندازه‌گیری منطقه به ترتیب بیشترین و کمترین پتانسیل عرضه علوفه تازه را داشتند. همچنین سومنپ بهترین ظرفیت برداشت نسبت به تمامی مناطقی که آنالیز شدند داشت که می‌توان اشاره به تغذیه بیش از ۲۳۱۸۷۹ واحد دامی در منطقه کرد. با توجه به نتایج این تحقیق پیشنهاد می‌شود از آنجا که در جزیره مادورا بیش از ظرفیت چرا جمعیت دام‌های اهلی (گاو و گوسفند) وجود دارد لذا انتظار می‌رود برای تهیه علوفه دام‌های مازاد از پس ماند محصولات کشاورزی استفاده شود.

**کلمات کلیدی:** ظرفیت علوفه دهی، دام‌های اهلی گاو و گوسفند، جزیره مادورا، بیش از ظرفیت