Toward Sustainable Feeding Systems of Madura Cattle: A Case Study in Bangkalan Regency

Kusmartono Kusmartono(✉), Mashudi Mashudi, and Poespitasari Hazanah Ndaru

Faculty of Animal Science, Universitas Brawijaya, 65145 Malang, Indonesia
kusmartono_ansi@ub.ac.id

Abstract. The term "Sustainable farming (SF)" relates to a general approach, a broad production system using methods that involve society (farmers), environment, and economy. This concept aims to support health and well-being of the society and to work with nature, while still aiming for being profitable businesses, as well as offers a solution to the problems caused by the way most of the production system is practised today. The paper presented in this conference was partly based on a study being done in Bangkalan regency focussing on beef cattle feeding systems currently practised by local farmers and ways to increase their growth rates by optimising the use of local feed resources. Current systems of production are often not profitable and growth rates of Madura cattle under village production systems are low (ranging from 0.2–0.4 kg/d) in which case farmers often feed for daily cost or availability and the level of feeding may be lower than required to meet production targets and there is a production and financial penalty for this approach. Natural grasses or rice straw being dominant types of feed given all over the year with a very minimum input of supplements. Thus, there is a great opportunity to increase beef cattle productivity (annual LWG) with a resultant increase in income for the farmers. There are two strategies to achieve that target 1) continue with low input systems but improve the availability of feeds and supplementing them with low amounts of ingredients with a high ME content or 2) shift to feeding high amounts of Least Cost formulated rations which will promote high LWG. To do this, feed inventory activities were conducted in 18 sub-districts in Bangkalan regency to investigate potential local feeds available for beef cattle both in quantity (DM yield/year) and quality (chemical composition and digestibility) and propose most suitable feeding systems that may lower local fluctuations in availability of ingredients, and warrant a sustainable feeding system.

Keywords: beef cattle diet · local feed resource use · sustainability

1 Introduction

The term "Sustainable farming (SF)" describes a general approach, a broad production system using methods that involve society (farmers), environment, and economy. This concept aims to support health and well-being of the society and to work with nature, while still aiming for being profitable businesses, as well as offers a solution to the

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problems caused by the way most of the production system is practised today. Sustainable farming should consist of a method that is environmentally friendly and allows the livestock production without causing any damage to human or natural systems, prevent adverse effects to livestock, biodiversity, surrounding or downstream resources, as well as to those working or living on the farm or in neighboring areas.

In context of beef cattle production system, sustainable farming provides a potential solution which enables farmers to make the most efficient use of local feed resources by implementing a robust technique on beef cattle farming that is economically viable and simple. The sustainability of feed supply for supporting beef cattle industry is crucial and considered the key to meet current and future demand of beef production. As a strategic commodity that strongly supports the farmers' income to fulfill the family expenditures, it is important that a much better farming practices of beef cattle by optimising the use of potential local feed resources need to be proposed on day-to-day farm operation.

Madura cattle is one of native beef cattle in Indonesia which has good adaptation to low quality feed, hot environment and highly resistency to environmental stress and diseases. They have been farmed long time ago and scattered all over the regencies in Madura island with the total population reported 1.070.956 heads in 2021 [1]. Bangkalan is one of regencies in Madura island that consists of 18 sub-districts where the Madura cattle fattening operation is almost evenly distributed in all districts with total cattle population in 2021 is 276.476 heads and growth of cattle population over the last four years was lower (1.2%) compared to regional population growth (2.1%). Madura cattle are mostly owned by poor farmers and traditionally raised with minimum attention to nutritional needs and nutritional status, hence risking to low livestock production, There is ample evidence to show that average daily gain (ADG) achievement of Madura cattle ranges from 0.2–0.5 kg/d under farmers' feeding management [2, 3] where natural grasses or rice straw being dominant types of feed given all over the year with a very minimum input of concentrate. However, their growth rates can be increased up to 0,74 kg/d under confined fattening management [4] where 30:70% (forage: concentrate) diet was given and this suggests that there is a great potential growth of Madura cattle when the feeds are provided in appropriate amount throghout the year. Madura bulls consumed up to 2.5% of body weight (BW) achieved ADG of 600 g/d [5, 6]. Feeding Madura cows with concentrate that contained 16% CP as much as 2–2.5% of BW resulted in ADG of 500 g/d [7]. This paper will discuss various dimensions of beef cattle feeding systems in Bangkalan regency using efficiency gains, balancing of animal rations and sustainable sourcing of feeds, energy-efficient technologies and renewable energy sources and animal production.

2 Materials and Methods

Within the suite of current project aiming to study cattle production in Bangkalan regency, several activities have been done such as monitoring range of current feeding systems, feed availability, land-use and access to local feed resources. Eighty small beef cattle farmers in Bangkalan regency were purposively sampled to obtain informations related to their activities in raising beef cattle included number of beef cattle kept, types and amount of feed offered and the whole-yearly feeding systems applied. Data on production

of agricultural commodities officially published by The Indonesian Central Bureau of Statistics has been used to provide information on types and number of some agricultural waste or by-products that can be considered as potential local feed resources for beef cattle in Bangkalan regency (Table 2). Samples of feeds were taken for proximate analysis following the procedure of AOAC [8] and in vitro assessment for digestibility was done according to the method of Tilley [9].

3 Results and Discussion

3.1 Beef Cattle Population in Bangkalan Regency

Beef cattle has been the major ruminant animals kept by the farmers in Bangkalan regency (approximately 49%) followed by goats (37%), sheep (13%), and negligible number of dairy cattle (1%). Figure 1 presents data on the Madura cattle population in each sub-district, Bangkalan Regency [1]. There seems to be an indication that areas adjacent to the central city of Bangkalan have a lower beef cattle population compared to areas away from the central city of Bangkalan. Extensive conversion of agricultural lands into new settlements and offices has led to a significant reduction in the area used for crop production as well as the farmers' interest in keeping beef cattle. In the past, cattle has been used for ploughing the lands but with the advance mechanization, their roles have been switched over to tractor ploughing as maintenance of cattle became an increasingly costly and also cater to the growing demands of the farmers for ploughing at faster pace. However, in some areas, the use of cattle for ploughing the land is still used in farming communities as it is much cheaper and environmentally safer. Farmers are using draft animals can carry out all farming activities as effectively as with a tractor. It may take longer, but the farmers still do all the activities on time, taking full advantage of the window of opportunity for planting at a cost that matches their pocket. This illustration helps to explain the evidence showing lower number of beef cattle kept by farmers living closer to the central city of Bangkalan.

The data presented in Table 1 shows a trend of beef cattle population in Bangkalan regency. The average population growth of beef cattle from year 2020 to 2021 was 6.36% where male cattle was higher than female cattle population. Since productive female cattle have a very important role in increasing the population, the slower increased in their population needs to be handled seriously, especially the efforts related to the feeding management and evaluation of reproductive successes and failures, as they determine growth rate of beef cattle population. Proper farming systems that include selection process of young calves, feeding and reproductive management, fattening method applied are key factors that influence productivity. The smallholder farmers usually buy cheaper calves from local market and raise the calves up to 4 years old conventionally by feeding low quality feeds *i.e.* natural grasses, rice straw or maize stover, but feeding supplements for their cattle are scarce and this, of course, has led to low ADG achieved.

Beef cattle feed and feeding is the basic of livestock systems as it directly or indirectly affects the productivity, product quality, land use and land-use change. It is unlikely that the growth rates of beef cattle could be sustained in the future only by increasing costs of energy, grains and other inputs, but it rather depends on proper integrations of efficient use of local feed resources, protection of the environment, and socio-cultural benefits.

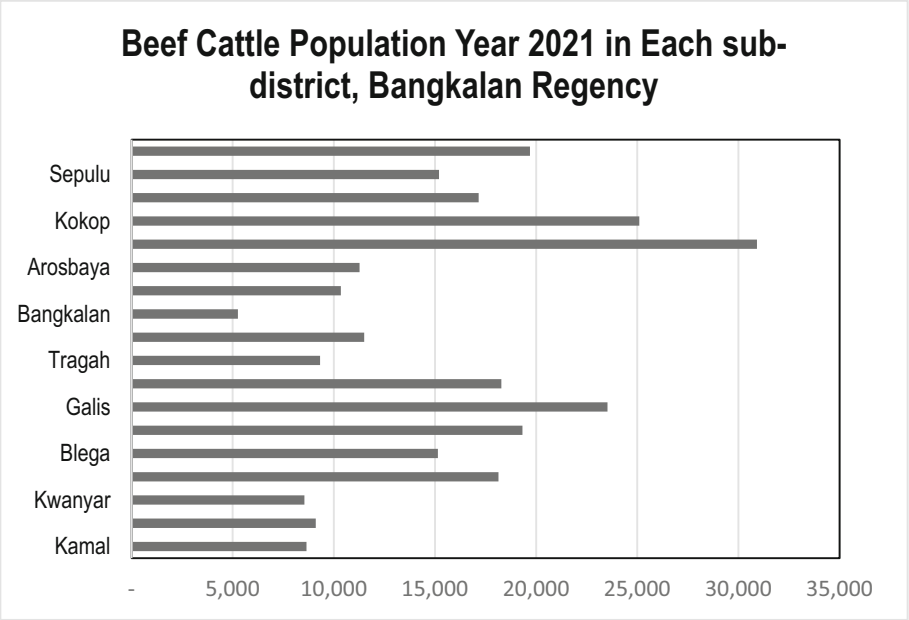

Fig. 1. Beef Cattle Population in each sub-district, Bangkalan Regency Year 2021

Under traditional feeding practices as seen in Bangkalan regency, the beef cattle farmers do not plan to produce feeds for maximum animal production and giving high economic benefits, and so, this current system of livestock production needs to improve the use of available local feed resources by introducing more efficient feed processes and feeding systems.

3.2 Production of Agricultural Commodities

Table 2 presents data on production of agricultural commodities that provides information on types and number of some agricultural waste or by-products that can be considered as potential local feed resources for beef cattle in Bangkalan Regency.

3.3 Local Feed Resources and Estimated Production

Table 3 presents data on the types of agricultural commodities whose byproducts can be used as feed for beef cattle in Bangkalan Regency. Based on this data, it can be explained that areas with high beef cattle populations such as in Geger, Kokop and Galis sub-districts are not always followed by the increase in area of agricultural lands, and vice versa, so that agricultural wastes or byproducts potential for beef cattle feed have not been utilized optimally yet because some farmers who plant crops do not raise beef cattle. Rice and maize are the main agricultural commodities planted by farmers in Bangkalan

Table 1. Trend of Beef Cattle Population from 2020–2021 in Bangkalan Regency

No	Sub-district	Population 2020		Total	Population 2021		Total
		Male	Female		Male	Female	
1	Kamal	2,473	5,256	7,729	3,859	4.786	8,645
2	Labang	2,604	5,535	8.139	4,138	4,964	9,102
3	Kwanyar	2,429	5,163	7,592	3,766	4,776	8,542
4	Modung	5,506	5,163	7.592	7,813	10,327	18,140
5	Blega	4.540	11,699	17.205	6,864	8277	15,141
6	Konang	5,884	9,647	16.387	8,194	11,131	19,325
7	Galis	7,228	12,503	22,587	9,537	13,987	23.524
8	Tnh. Merah	5,548	15,359	17,337	7,887	10,395	18,282
9	Tragah	2,671	5,676	8,347	4,304	5,018	9,322
10	Socah	3,433	7,294	10,727	5,582	5,922	11,504
11	Bangkalan	1,402	2,980	4,382	1,584	3,674	5,258
12	Burneh	3,004	6,383	9,387	4,986	5,360	10,346
13	Arosbaya	3,338	7,094	10,432	5,549	5,722	11,271
14	Geger	9,649	20,503	30,152	11,813	19,101	30,914
15	Kokop	7,721	16,406	24,127	9,932	15,170	25,102
16	T.Bumi	5,199	11,048	16,247	7,482	9,676	17,158
17	Sepulu	4,553	9,674	14,227	6,899	8,303	15,202
18	Klampis	5,994	12,738	18,732	8,332	11,366	19,698
	TOTAL	83,176	176,747	259,923	118,521	157,955	276,476

Source: BPS - Statistics of Bangkalan Regency[1]

regency and they have been extensively grown over the year, either in monoculture or mixed cropping, besides cassava, groundnut, mungbean, sweet potatoe and soybean. The straws, peels and by-products of those plants then become potential feed resources for beef cattle. In addition to rice and maize stover, another feed resources ranging from grasses, legumes, agricultural wastes/byproducts and industrial byproducts that can also be considered as important energy and protein sources for growing beef cattle (see Table 4).

3.4 Potential Production of Madura Cattle

Table 5 outlines how ADG of Madura cattle varies with type of feed offered and feeding systems on-farm/off-far, and on station from previous studies. It can be seen form Table 5 that Madura cattle can grow from 0.50 to 0.74 kg/d at higher quality rations (higher ME and CP contents) compared to growth rate achieved under small-scale farmers using natural grass, rice straw and rice bran. Priyanti et al. [12] reported that small scale (1–2

Table 2. Production of Agricultural commodities (t/yr)

No	Sub-district	Agricultural commodities						
		Rice	Cassava	Maize	Groundnutt	Mungbean	Sweet potatoe	Soybean
1	Kamal	9,038.5	747.4	3,662.4	553.1	-	-	-
2	Labang	4,509.5	647.9	3,185.3	1,201.2	20.5	116.7	-
3	Kwanyar	11,202.9	597.9	7,424.4	142.2	735.6	189.9	-
4	Modung	12,586.9	146.5	8,105.2	1,891.2	254.1	98.4	-
5	Blega	17,753.9	292.9	7,863.4	1,502.1	698.7	225.4	255.7
6	Konang	13.298.0	683.6	7,015.8	6,256.4	321.2	7,145.2	98.9
7	Galis	7,653.2	2,916.4	12,283.7	1,618.9	162.3	2,859.9	1.233.2
8	T.Merah	20,749.8	167.8	5,299.9	2,276.9	47.5	99.4	-
9	Tragah	15.929.5	263.6	3,615.9	942.2	23.9	-	-
10	Socah	14.428.1	675.4	5,706.8	929.8	-	-	-
11	Bangkalan	10,001.5	-	1,655.8	18.2	-	-	-
12	Burneh	36,730.4	71.8	1,982.7	122.2	46.6	385.7	-
13	Arosbaya	23.225.0	1,054.4	2,747.6	660.0	81.9	-	-
14	Geger	22,333.4	2,987.1	7,021.1	1,459.6	139.7	186.8	-
15	Kokop	10,447.6	173.3	6,161.5	221.3	3.3	412.8	-
16	Tnjg.Bumi	5,873.7	3,613.3	8,155.3	352.9	274.9	1,96.84	-
17	Sepulu	9,602.3	2,649.0	3897.8	124.4	103.7	-	-
18	Klampis	7,199.6	159.6	8,059.3	68.2	25.6	-	2.4
Total		252,664.2	17,309.8	103.843.8	20,340.9	2.939.5	11,917.0	1,590.2

cattle) systems have a higher income over feed cost (IOFC) because they expended less on external feed and used more home-grown feed which was not assigned a cost. If a cost is assigned to home grown feed, then there is little difference between the systems as ADG is similarly low and there is a large opportunity to increase ADG but at the right cost for a ration. Table 5 indicates that ADG observed in Bangkalan regency is low and can be predicted of having a low IOFC as well, and this relates to the use of low-cost ingredients, e.g. rice straw and other crop residues, natural grass, and cheap by-products when available, all of which are low in ME and CP content. However, the cost of some of these ingredients can vary markedly depending on the inclusion of labour or opportunity cost. Farmers do not generally put a value on their labour to gather grass or feed cattle but they are costs to the system.

Concept of sustainable beef cattle feeding system as mentioned earlier integrates the importance of efficient use of natural resources, protection of the environment, and socio-cultural benefits which requires active participation of policy makers, researchers, extension workers, industry and farmers. The concept places animal diets in a holistic sustainability context. The survey done in this on-going study shows a strong message

Table 3. Local Feed Resources and Estimated Production (t/yr)

No	Sub-district	Agricultural byproducts						
		Rice straw	Cassava leaf	Maize stover	Groundnut straw	Mungbean straw	Sweet potatoe leaf	Soybean straw
1	Kamal	6,583.5	31.0	7,659.0	142.5	0	0	0
2	Labang	4,196.5	26.0	5,683.5	305.9	7.83	7,2	0
3	Kwanyar	8,477.0	2.0	15.687.0	36.0	254.9	12.0	0
4	Modung	9,159.5	6.0	16,416.0	526.2	87.1	6.0	0
5	Blega	11,718.0	12.0	15,799.5	361.8	269.7	14.4	293.9
6	Konang	9,324.0	28.0	13,626.0	1,695.4	124.0	457.2	111.6
7	Galis	6,338.5	106.9	24,844.5	411.2	55.4	182.4	1,666.5
8	T.Merah	13,548.5	6.0	10,143.0	566.6	16.3	6.0	0
9	Tragah	11,350.5	11.0	6,763.5	239.9	8.1	0	0
10	Socah	9,831.5	24.0	12,132.0	239.3	0	0	0
11	Bangkalan	695.8	-	2,938.5	4.3	0	0	0
12	Burneh	23,051.0	3.0	3,456.0	31.6	15.9	24.0	0
13	Arosbaya	14.672.0	44.0	5,040.0	183.5	27.9	0	0
14	Geger	14.630.0	106.0	15,435.0	403.4	47.6	12.0	0
15	Kokop	7,469.0	7.0	11,929.5	60.1	1.3	26.4	0
16	Tnjg.Bumi	4,291.0	136.0	15,790.5	88.3	95.5	12.0	0
17	Sepulu	7,283.5	101.0	7,915.5	31.0	35.4	0	0
18	Klampis	5,729.5	6.0	16,344.0	17.2	9.7	0	3.03
Total		174,611.5	656.0	207,598.5	5,343.5	1,056.1	759.6	2,077.1

that could be derived that making profit is important and this drives the beef cattle production system, but making profit at the cost of the environment, socio-cultural benefits to people of raising beef cattle may not be appropriate. Currently the feeding systems are based on evaluation of feed ingredients and formation of beef cattle diets based on the nutrient composition and nutrient availability. However, to face new and emerging challenges that the beef cattle sector faces, it is important to integrate the dimensions of sustainable feeding systems into development of a global framework on beef cattle management practices. Better understanding of the processes involved in beef cattle nutrition could also contribute to improved management that operate at high levels of animal performance.

Data depicted in Table 5 implies that many ingredients used in those previous studies were not found in Bangkalan regency (see Table 4) and so they have to be purchased from outside the region. Therefore, to achieve a higher growth rates of Madura cattle, there should be a higher external input of feedstuffs into the whole beef cattle feeding

Table 4. Estimated local feed resources and their nutrient contents

No	Feedstuffs	Estimated yield (t DM/yr)[1)]	Nutrient contents				
			DM (%)	CP (%)	Ca (%)	P (%)	TDN (%)
A. FORAGES							
1	Natural grasses	34,128.1	24,6	8.4	0.38	0.26	58.6
2	Elephant grass	1,277.6	22.6	9.5	0.45	0.32	58.6
3	Leucaena	59,876.4	24.8	24.3	1.69	0.22	87.9
4	Glyricidia	8,326.3	26,2	18.4	0.64	0.14	75.2
5	Sesbania	27,436.6	29.2	19.4	0.22	0.28	70.2
B. AGRICULTURAL WASTES AND BYPRODUCTS							
1	Rice straw	174,611.5	33.9	6.9	0.37	0.27	45.1
2	Maize stover	207,598.5	26.7	9.2	1.24	0.10	49.6
3	Groundnut straw	207,598.5	35.2	11.9	1.47	0.21	62.3
4	Mungbean straw	1,056.1	35/2	22.39	1.31	3.62	59.1
5	Soybean straw	2,077.1	34.6	11.7	1.24	0.22	47.8
6	Dried cassava flour	4,327.5	86.8	2.1	0.08	0.06	73.5
7	Cassava leaves	656.0	21.9	23.9	1.51	0.43	64.8
8	Rice bran	11,349.8	87.8	7.5	0.08	1.35	55.8
9	Maize bran	22.8	89.7	8.5	0.70	0.26	71.2
10	Groundnut peel	1,244.7	89.8	7.6	0.26	0.09	50.0
11	Sweet potato leaves	759.6	16.6	14,3	1.32	0.49	66.7
C. INDUSTRIAL WASTES							
1	Tofu wastes	37,500.0	75.2	23.7	0.65	0.27	75.7
2	Soybean hulls	359.0	87.4	14.3	0.22	0.49	58.7
Total		577,861.1					

[1)] Estimated yields were calculated using a method of Syamsu et al. [10] and Edi [11]

systems. Taking into account the economic conditions of the smallholder farmers, it is unlikely that the beef cattle farmers in Bangkalan regency will be able to spend money to buy feeds and they will use the available local feeds in their surrounding areas. Roles of policy makers, animal scientists and extension workers then become important in designing programs that integrate crop-livestock in a sustainable manner that are able to produce better animal production system, as well as improving economic benefits of small-scale beef cattle farmers.

Table 5. Effects of feeds and feeding system on growth of Madura Cattle

No	Ingredients	ADG	Location		References
1	Elephant grass, rice bran, dried cassava powder, wheat bran, soybean meal	0.71 kg/d	On-station	Bulls	[6]
2	Natural grasses, soybean peel, cassava waste, wheat pollard, tofu waste, molasses	0.72 kg/d	On-station	bulls	[2]
3	Natural grasses, rice straw, maize stover, rice bran, maize bran, fish meal and dried water spinach	0.50 kg/d	On-farm	bulls	[3]
4	Elephant grass, cassava bagasse, palm kernel cake, copra meal, mineral mix	0.74 kg/d	On-station	bulls	[4]
5	Corn hull, cassava waste, soybean peel, cassava peel, rice bran, palm kernel cake, maize cob, soybean meal, molasses, growth promotor	0.57 kg/d	On-farm	bulls	[5]
6	Rice straw, natural grasses, rice bran	0.30 kg/d	On-farm	bulls	[13]

4 Conclusions

Based on the result of current study, it can be concluded that small-scale beef cattle farmers in Bangkalan regency who have 1–3 heads will never change their traditional way of keeping their animals, unless new feed technologies introduced are compatible with the existing feed resources. Better farming systems of beef cattle can be introduced through more and intensive extension activities that teach the farmers on how proper feeding strategies using local feed resources may provide sustainable systems in all aspects (nutrition, reproduction and marketing).

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