Potential of wasted crops and its carrying capacity for improving Bali Cattle Productivity case study in Bali Province

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Abstract. The cattle business obstacle is limited availability of land due to competition from food crops. The farming system is integrated between food crop and livestock, one of the solutions to ensure the availability of feed. To analyze the potential development of Bali Cattle business in the province of Bali the calculation of the increasing capacity of ruminant livestock (KPPTR). This analysis requires data on harvested area and production of food crops such as sweet potatoes, cassava, mung beans, peanuts, soybeans, corn and paddy. The results of KPPTR-SL calculation, all the provinces in Bali have negative KPPTR values with the highest values found in Denpasar city, while the lowest values are found in Karangasem District. The food crop waste produced can be used as a source of forage for the high livestock population in Buleleng and Karangasem, but when viewed from the value of KPPTR-SL Karangasem and Buleleng regencies have overpopulated and low capacity for develop livestock. In terms of TDN and crude protein production from each food crop waste has not been sufficient to meet the nutritional needs of cattle in Buleleng and Karangasem districts. Karangasem and Buleleng as districts with the highest cattle population produce total digestible nutrient (TDN) based on crop waste is 38,633.08 DM/ton and 53,776.22 DM/ton. TDN production from food crop waste is still not sufficient to meet the needs of TDN for cattle weighing 250-350 kg. Karangasem district produces crude protein from agricultural waste of 3,103.37 tons/DM while the need for cattle assuming a weight of 250-350 kg 26.269,02 tons/year/populations. The same thing shown in Buleleng district that producing crude protein from agricultural waste of 3,226.75 tons/DM with needs that must be met for cattle weighing 250-350 kg is 28.718,61 – 33.697,11 tons/year/population. The combination of agricultural waste and legumes can be an effort to increase the crude protein content of feed, in addition to the add with concentrates with local feed ingredients can be use to increase the TDN content of feed.

1. Introduction

Increasing population growth has resulted in the conversion of agricultural land into increasingly high occupancy. On the other hand, an increase also occurs in public awareness of the important role of fulfilling animal protein. This has resulted in increased meat consumption, especially beef. The consumption of beef has increased but the level of consumption of beef in Indonesia is still relatively low. Based on data from

[1] the level of beef consumption in 2016 was only 0.417 kg / capita / year. High production cost make high price of beef however this lead low consumption .

Another problem with cattle business is the limited availability of land due to competition from food crops. The farming system is integrated between plants and livestock, one of the solutions to ensure the availability of feed. Utilization of agricultural waste as forage feed has been widely used in various regions.

Bali Province has been known as the development area of Bali Cattle as one of the indigenous cattle. The development of Bali cattle business in this province was constrained by the conversion of agricultural land [2]. The higher level of land use change results in decreasing land carrying capacity as a feed provider for Bali Cattle. The integration of Bali Cattle with agriculture is one of way to increase land use both for feed supply and agricultural cultivation. Farming integration of cattle with paddy is an efficient and effective farming to improve the income of farmers with ownership of narrow land in the countryside [3]. Food crop waste such as rice straw and corn is used as a source of fiber, while the waste of legumes, cassava leaves and sweet potatoes is used as a source of protein [4]. Five food crop commodities in the province of Bali, namely paddy, corn, peanuts, soybeans, sweet potatoes, cassava and mung beans [5]. The crop production of 2015 is presented in Table 1.

Table 1. The crop production of Bali Province in 2015

Regency/City	Crop production (Ton)						
	Sweet potatoes	Cassava	Mung beans	Peanut	Soybean	Corn	Paddy
Jembrana	0	452	42	127	2,397	510	65,295
Tabanan	129	757	0	22	679	5,035	194,134
Badung	8,238	6,009	0	610	1,509	149	105,951
Gianyar	746	3,816	51	229	988	727	192,518
Klungkung	1,522	5,989	35	734	1,242	5,378	38,070
Bangli	11,729	5,614	0	1,024	101	1,975	28,718
Karangasem	14,206	55,748	229	3,054	44	8,784	71,078
Buleleng	85	7,685	159	1,265	25	18,045	128,209
Denpasar	0	0	0	0	274	0	29,926
Bali Province	36,655	86,070	516	7,065	7,259	40,603	853,899

Source: [5]

In farm business the largest cost in production production process was feed cost whose source can be obtained from forage or food crop waste. This forage depends on the available land usually from platation and crops waste. Instead the function of agricultural land into settlements and the tourism industry causes pressure on the agricultural sector, one of which causes limited availability of land for forages. At present the number of Bali cattle population tends to decrease even though various efforts to increase the number of cattle populations have been carried out. Therefore, a clear picture of the current condition of the population and the ability to support the environment is needed to be able to increase the Bali cattle population. This study evaluates that cattle population and the strategies needed to achieve this. With this study expected it can help apropiate policies approach and technologies can be use in the future. .

2. Material and methods

This research was conducted in the scope of Bali Province during the period of January-May 2019. The data collected was secondary data obtained from the Central Bureau of Statistics of Bali Province and several results of literature studies relating to the nutrient content of feed ingredients in agricultural waste. In this

study, total digestible nutrient and crude protein requirement of Bali Cattle used standard nutrient requirement of ruminant in developing countries [6].

To analyse the potential development of Bali Cattle business in the province of Bali, the calculation of the increasing capacity of ruminant livestock (KPPTR) according to [7] method is calculated with the following steps:

Maximum Potential Based on Natural Resources / PMSL (Regional Carrying Capacity) is formulated:

PMSL = carrying capacity of agricultural land + carrying capacity of food crops

Description :

1. Carrying capacity of agricultural land = contribution of agricultural land x 3.75 carrying capacity of agricultural land obtained from contributions to grasses and non-grasslands (rice fields, plantations, forests, fields)
2. Contribution of agricultural land = land area x coefficient of land contribution
3. 3.75 is the coefficient
4. Carrying capacity of food crops = agricultural waste production / 2.3 carrying capacity of food crops is obtained from the contribution of production of food crops agricultural waste (rice, corn, peanuts, cassava, sweet potatoes, soybeans)
5. Production of agricultural waste = harvest area x coefficient of harvest area contribution
6. 2,3 are coefficients calculated as dry weight requirements (tons / year) for one livestock unit
7. The provisions of carrying capacity of land in producing grass are presented in Table 1 and the contribution of agricultural waste based on harvest area in the supply of forage is presented in Table 2.

Table 2. The ability of the land to produce grass

No	Land Type	Land contribution
1	Pasture	100% from land area
2	Rice field	2% from land area
3	Rice field line	2,5% from land area
4	Plantation	5% from land area
5	Homogen forest	5% from land area
6	Secondary forest	3% from land area
7	Road side area	0.5% from land area
8	Dry land	1% from land area

Source: [7]

Table 3. Convertion rate availability of straw for animal feed

No	Real land area	Land area availability
1	Paddi straw	2.5 x harvest area (Ha) x 0.70 ton DM year^{-1}
2	maize straw	6.0 x harvest area (Ha)x 0.75 ton DM year^{-1}
3	Cassva waste	1.0 x harvest area(Ha) x 0.30 ton DM year^{-1}
4	Sweet pottato waste	1.5 x harvest area (Ha) x 0.80 ton DM year^{-1}
5	Pea straw	2.5 x harvest area (Ha) x 0.60 ton BK year^{-1}
6	Groundnut straw	2.5 x harvest area (Ha) x 0.60 ton BK year^{-1}
7	Leguminous	2.5 x harvest area (Ha) x 0.60 ton BK year^{-1}

Source: [8]

Data in the form of food crop harvest area in Bali province (Table 4) and straw food content of various food crops (Table 5) were then processed and analysed descriptively.

Table 4. Harvest area of Food Crops in the Province of Bali in 2017

District	Harvest area (Ha)					
	Maize	Groundnut	Pea	Sweet potato	Cassava	Rice
Jembrana	284.7	72	1474.8	0	36	10614.3
Tabanan	1242.7	19	836.4	11	56	36809.8
Badung	37.9	465	639	462	254	18673
Klungkung	2259.7	1220	631	76	751	5075.7
Bangli	627.5	826	29.8	1113	307	5053.9
Karangasem	4627.2	3241	9.7	1344	5605	10846
Buleleng	6032.1	1083	3.9	9	763	21468.9
Denpasar	13.5	0	191.6	0	0	4374.6
Gianyar	502.2	142	262.6	126	247	28574.7

Source: [9]

Table 5. Nutrition content of Crops straw

Kind of Straw	Nutrients content (%DM)					
	Ash	Crude Protein	Crude fat	Crude fiber	NFE	TDN
JJ	8.42	4.77	1.06	30.53	55.82	85.94
JKT	18.69	11.06	1.80	29.92	38.21	80.41
JK	7.56	10.56	2.82	36.28	42.80	88.99
JUJ	16.10	19.20	2.60	16.20	45.90	60.00
DUK	12.10	24.10	4.70	22.10	37.00	72.30
JP	19.97	4.51	1.51	28.79	45.21	77.09

JJ: corn straw, JKT: peanut straw, JK: soy bean straw, JUJ: sweet potato straw, JUK: cassava straw, JP: rice straw. Source: [10]

3. Result and discussion

3.1. The increased capacity of livestock based on natural resources (KPPTR-SL)

The results of KPPTR calculations based on land resources based on the [7] methods are presented in Table 6. The capacity for increasing the population of ruminants shows the capacity of land or natural resources in providing forage as the main feed source for ruminants. Based on the results of the KPPTR-SL calculation, all the provinces in Bali have negative KPPTR values with the highest values found in Denpasar City, while the lowest values are found in Karangasem District. The negative KPPTR-SL value indicates that land resources in the region can no longer support the development of ruminant livestock populations.

The highest KPPTR-SL value is found in Denpasar City due to the low Bali Cattle population. The population of cows in the city of Denpasar in 2017 is 6,340 [1]. High land competition between the agriculture-livestock sector and population occupancy results in low carrying capacity of land in Denpasar for agriculture and livestock. The lowest KPPTR-SL value is found in Karangasem District with a cattle population of 117,126 cattle [1]. Karangasem is included in the centre of Cattle development in Bali Province after Buleleng District but this is not supported by the carrying capacity of land resources in the provision of forage. The carrying capacity of land for the provision of forage is low due to the absence of grasslands. Plantation land plays an important role in the supply of forage in Karangasem District with a land area of 30,650 Ha.

Table 6. Data on Increasing capacity analysis results per district in Bali Province

Parameter	District								
	Jembrana	Tabanan	Badung	Gianyar	Klungkung	Bangli	Karangasem	Buleleng	Denpasar
Carrying capacity of Agriculture land	4332.038	8759.906	3907.425	3049.8	3631.294	5559.413	8463.638	17777.72	441.7688
Carrying Capacity of Crops	9646.598	31009.74	15276.04	23086.01	9627.88	6251.946	20857.93	28950.03	3479.413
PMSL	13978.64	39769.65	19183.47	26135.81	13259.17	11811.36	29321.57	46727.75	3921.182
Cattle population	29759	45268	28511	45516	45472	64754	117126	128048	6340
KPPTR (SL)	-15780.4	-5498.35	-9327.53	-19380.2	-32212.8	-52942.6	-87804.4	-81320.2	-2418.82

PMSL = Maximum pottency based on Natural resources
KPPTR (SL) = Increasing capacity of Cattle population

3.2. Potency of agricultural waste

Agricultural waste plays an important role in the cattle business sector as a provider of forage. The agricultural waste as feed can reduce production costs and overcome competition between agricultural sector for food stuff and animal husbandry. Agricultural waste data used in this study were rice straw waste, corn straw, cassava straw, sweet potato straw, soybean straw, peanut straw and legumes [8]. Data calculation of crop straw production based on harvested area per district in Bali Province in 2017 was showed on Table 7.

Table 7. Production of Crops waste and sraw in Bali Province (ton/ha)

District	Crops Waste Production (BK/ton)*					
	JJ	JKT	JK	JUJ	JUK	JP
Jembrana	1281.15	108	2212.2	0	10.8	18575.03
Tabanan	5592.15	28.5	1254.6	13.2	16.8	64417.15
Badung	170.55	697.5	958.5	554.4	76.2	32677.75
Klungkung	10168.65	1830	946.5	91.2	225.3	8882.47
Bangli	2823.75	1239	44.7	1335.6	92.1	8844.33
Karangasem	20822.4	4861.5	14.55	1612.8	1681.5	18980.5
Buleleng	27144.45	1624.5	5.85	10.8	228.9	37570.58
Denpasar	60.75	0	287.4	0	0	7655.55
Gianyar	2259.9	213	393.9	151.2	74.1	50005.73

Agricultural waste in the form of corn straw and rice straw plays a major role in the supply of forage in Karangasem and Buleleng Regencies. The production of corn straw in Karangasem Regency is 20,822.4 tons BK while for rice straw production it is 37,570.58 tons BK. The production of corn straw for Buleleng Regency is 27,144, 45 tons BK and rice straw production is 37,570.58 tons BK. Karangasem and Buleleng Regencies have the most livestock populations in Bali Province which are 117,126 heads and 128,048 heads. Based on this, the agricultural waste produced can be used as a source of forage for the high livestock population in the district, but when viewed from the value of KPPTR-SL (Table 6) Karangasem and Buleleng regencies have overpopulated and low capacity for develop livestock. The available land for the supply of forage is still not sufficient for the quantity of forage needs for the development of livestock.

Table 8. Production of TDN dan Crude Protein from agricultural waste per District in Bali Province

District	Nutrient					
	Ash	Crude Protein	Crude Fat	Crude Fibre	Beta-N	TDN
Jembrana	4,006.04	1,147.00	358.90	6,576.17	10,104.99	17,484.64
Tabanan	13,439.30	3,314.18	1,069.00	20,722.53	32,804.67	55,627.26
Badung	6,841.41	1,785.07	552.82	10,123.08	15,828.23	27,140.76
Klungkung	3,085.56	1,259.80	314.50	6,617.25	10,921.47	18,118.25
Bangli	2,465.10	953.96	226.10	4,032.02	6,714.41	11,149.17
Karangasem	6,916.49	3,103.37	716.20	13,914.29	23,430.38	38,633.08
Buleleng	10,121.90	3,226.75	895.49	19,644.28	32,850.56	53,776.22
Denpasar	1,555.66	378.51	124.35	2,326.85	3,617.99	6,209.95
Gianyar	10,279.32	2,475.10	801.40	15,334.10	24,215.86	41,159.75

The nutritional quality aspects of forage provided are important factors to support the growth of ruminants. According to [4], livestock consuming forage is to get sufficient energy for living and production processes. These energy needs are obtained from fiber and protein sources. Agricultural crop wastes have a disadvantage when used as a single feed, which is high crude fiber content and low crude protein so need to combined with other feeds source. Crop wastes have many limitations as feedstuffs-they have low contents of metabolizable energy (< 7 MJ/kg DM) and crude protein (<50 g/kg DM), and their intake by ruminants is limited (often less than 15 g DM per kg live weight daily) [11]. Total digestible nutrients requirement for cattle with weight ranging from 250-350 kg and daily weight gain is 0.5 kg is 3,2-4,1 kg/head/day [6]. In Table 8 presents data on agricultural waste production from aspects of nutrient content. Karangasem and Buleleng as districts with the highest cattle population produce total digestible nutrient (TDN) of 38,633.08 DM / ton and 53,776.22 DM / ton. The production of TDN from agricultural waste is still insufficient for the needs of Bali cattle when compared with the needs of beef cattle based on body weight assuming the body weight of Bali Cattle 250-350 kg requires the needs of TDN 134,929.15-172,877 tons/year/population. This also applies to Buleleng District which produces TDN from agricultural waste amounting to 53,776.22 DM / ton, not sufficient for cattle needs assuming a weight of 250-350 kg, which is equal to 147,511.30-188,998.85 tons / year / population (Table 9).

Table 9. The requirement of TDN and CP for cattle with a weight of 250-350 kg

District	Weight	TDN (ton/year/population)	Crude protein (ton/year/population)
Karangasem	250	134929.15	26269.02
	300	156011.83	28630.28
	350	172877.98	30822.88
Buleleng	250	147511.30	28718.61
	300	170559.94	31300.05
	350	88998.85	33697.11

The need for crude protein has also not been fulfilled by the utilization of agricultural waste as the main source of forage for cattle. Crude protein requirement of cattle with weight ranging from 250-350 and daily weight gain is 623-731 gram/head/day [6]. Karangasem District produces crude protein from agricultural waste of 3,103.37 tons / DM while the need for cattle assuming a weight of 250-350 kg 26,269.02 tons / year / population. The use of agricultural waste has also not been able to meet the needs of the crude protein that livestock need to grow. The same thing show in Buleleng District that producing crude protein from

agricultural waste of 3,226.75 tons / DM with needs that must be met for cattle weighing 250-350 kg is 28,718.61-33,697.11 tons / year / population. Crude protein deficiency was caused by agricultural waste components having a low crude protein content so these can not be used as a single feed for cattle with a growth phase. Karangasem and Buleleng District require additional feed to meet the needs of TDN and CP. The combination of agricultural waste and legumes can be an effort to increase the crude protein content of feed, in addition to the add with concentrates with local feed ingredients can be use to increase the TDN content of feed.

Bali cattle business needs further solution to develop new forage source problem. Forage sources depend on the area of land available and also the quality of feed source. This forces the maintenance of agricultural land, forest land and marginal land. Including find new kind of forage with good quaity nutrient. According to previous research [2] showed that the analysis results of the modeling of forage supply showed the need for animal feed would increase 91.4% for the total cattle population. Changes in land use cause the carrying capacity of cultivated land to produce forage feed has the potential to decrease from 64.5% of the total feed to 48.5% in 2034. Optimizing moor margins for feed sources such as optimizing corn and rice production with technology and building a feed shed [2].

4. Conclusion

1. The capacity of existing natural resources in Bali province has passed the threshold of its ability to increasing the livestock populations.
2. There is a need for solutions and effort to increase the carrying capacity of Bali cattle population for sustainability of this livestock in the future including land area availability and new forage resources.

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