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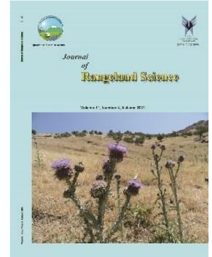

Research and Full Length Article:

Assessment of Forage Production and Its nutritional Values for Local Cattle Farming in Rangelands of Kupang Regency Indonesia

Edi Djoko Sulistijo [A]*, Ifar Subagyo [B], Siti Chuzaemi [B], Herni Sudarwati [B]
[A] Faculty of Animal Husbandry, Universitas Nusa Cendana, Indonesia * (Corresponding Author), Email: edisulistijo2@gmail.com
[B] Faculty of Animal Science, University of Brawijaya, Indonesia

Received on: 10/08/2020
Accepted on: 23/04/2021

Abstract. The rangeland potentials in Kupang regency, Indonesia, were evaluated by determining forages distribution, forages nutritional value, and growth performance of the cattle grazed or fed with forages grown in the area. Several rangelands namely Amarasi, Mamar Kering, and Selobua were evaluated for its forages' distribution from November to December 2015, while the reared cattle growth performance was observed for 12 months, starting from May 2016 to April 2017. A purposive sampling method was done to determine the forage distribution and a total of 22 cattle that fed in the areas were evaluated for its growth performances. The observed variables include forages distribution, nutritional value of the forages and cattle ration, feed intake (FI) and average daily gain (ADG) of the cattle. The forages distribution data were analyzed descriptively, while forages nutritional value and cattle growth were analyzed with nested ANOVA followed with LSD test to determine significant differences. The results showed that Mamar Kering had more plant species (77 species) compared to Amarasi (62 species) and Selobua (53 species) rangelands. The combination of Amarasi and Mamar Kering provides better forage availability (91.64%) compared to individual rangeland utilization (58.67 to 79.8%). The results also showed that different rangelands had a highly significant difference ($P<0.01$) on the neutral detergent fiber (NDF) of the forages, but no significant difference ($P>0.05$) difference was found for crude protein, feed intake and ADG of the cattle. Moreover, the highest ADG cattle were found for Amarasi and Mamar Kering which reached 0.30 kg/cattle/day. The research concludes that the combination of Amarasi and Mamar Kering rangelands provide higher forage availability and better cattle growth compared to individual or another rangelands combination, with adjustment of forages and cattle ratio should be done to achieve efficient cattle production.

Key words: Forage Production, Feed Quality, Cattle, Local Farmers

Introduction

Indonesia is an archipelagic country that covers a lot of potential rangeland areas for cattle farming, even though its efficiency is still poorly observed. Rangelands would provide a source of feed for the cattle, whether through grazing or cut and carry system. The forages distribution of the rangelands thus becomes the key factor for its utilization. Research has shown that more forage species and better forage quality in rangeland had a positive correlation to the grazed cattle productivity (Weller, 2010; Vertes *et al*., 2019). Ruminants require forages to fulfil their nutritional needs to support their growth through ruminal digestion (Galgal *et al*., 2000; Bencini *et al*., 2010; Weller, 2010). Forages are commonly given to the cattle through grazing and cut and carry system. In the cut and carry system, farmer's ability to access various forages in the rangeland would determine its farming efficiency. This feeding system is widely found in Zambia (Simbaya, 2002), Asian countries (Devendra *et al*., 2001; Harsh, 2006; Patil, 2006; Devendra, 2011), including Indonesia (Lisson *et al.*, 2010; Parikesit *et al*., 2005; Handayana *et al.*, 2014). An evaluation of forages distribution on rangeland is then become an approach to determine its potential as a source of forages for cattle farmers.

The forages distribution in rangeland could be changed over time as it is highly affected by the season and location. Research by Weller and Cooper (2001) showed the changes of forages distribution in the United Kingdom under different seasons. In Indonesia, the research is still limited in several provinces, such as East Java and Yogyakarta (Marjuki *et al*, 2000; Handayana, *et al*, 2014), while other rangelands, especially that are located on the rural area are yet to be evaluated. The evaluation is important, considering that aside from evaluates its availability; the understanding of forages distribution would also help farmers to determine the efficient feeding system. One of the examples could be seen in the research by Marjuki *et al*. (2000) and Lisson *et al.* (2010) in Indonesia which showed fluctuating cattle feeding management, both quantitatively and qualitatively, during the rainy and dry season, which then resulted in poor cattle farming performances.

Kupang regency is one of the rural provinces in Indonesia, which on average, had 4 months rainy season and 8 months dry season annually. Moreover, the regency also had varying soil characteristics, which depends on the ground level and social characteristics of how people are utilizing the soil. Research on the cattle farmer characteristics has shown that 14.2% of the farmers in Kupang regency were traditional farmers (Pelokilla *et al*., 2005), who highly depended on the forages in the rangeland. Furthermore, research by Sulistijo and Rosnah (2013) showed that cattle farmers in Kupang regency who mainly depend on the rangeland as a source of the forages reached 96.67% of total cattle farmers, with the most utilized rangelands were Amarasi, Mamar Kering and Selobua.

Even though all of the rangelands are located in the Kupang regency, each rangeland had distinctive characteristics between each other. Amarasi rangeland is mostly covered by *Leucaena leucocephala* plants and Mamar Kering is covered by different perennial plants with all of the plants in both rangelands are grown disorderly. In Selobua rangeland, the plants were grown in an intercropping pattern, consisted of *Leucaena leucocephala* and crops, mainly corn and cassava (Nulik *et al*., 2000; Roshetko and Mulawarman, 2002; Njurumana, 2008; Kapa, 2007; Jeus *et al*., 2012; Sulistijo and Rosnah, 2013). Furthermore, the utilization of Amarasi, Mamar Kering, and Selobua rangelands for forages supply by the local cattle farmers was also differ, with each rangeland was used as sole forage supplier, some local farmers combined forages from Amarasi and Mamar Kering rangelands as well.

The utilization of Amarasi, Mamar Kering, and Selobua rangelands in Kupang regency for the forages supplier has been practiced in a long time. However, the evaluation of the mentioned rangelands is yet to be done. In this research, the rangeland potentials of Amarasi, Mamar Kering, and Selobua in Kupang Regency, Indonesia, are evaluated by determining forages distribution, forages nutritional value, and growth performance of the cattle grazed or fed with forages grown in the area.

Materials and Methods

Study area

The evaluations were done for 12 months from May 2016 to April 2017 in Amarasi, Mamar Kering, and Selobua rangelands located in Kupang regency, Indonesia. The location was chosen under purposive sampling, considering that the rangelands are located in a rural part of the country and yet to be observed for its potential as the forage producers. The cattle growth performances were evaluated from 22 cattle reared by local farmers who fed their cattle in Amarasi, Mamar Kering, Selobua, and combination of Mamar Kering and Selobua rangelands through cut and carry system. Forages from each rangeland were also collected to be analyzed for its feed quality.

Methods

The research was conducted in a direct observation to determine forages distribution and cattle growth performances. The measured cattle growth performance includes daily feed intake (FI) and average daily gain (ADG). The measured forages quality in this research includes dry matter (DM), crude protein (CP), and neutral detergent fiber (NDF) content which analyzed in the Laboratory of Animal Nutrition, Faculty of Animal Science, University of Brawijaya.

Data analysis

The forages distribution data were analyzed descriptively, while forage quality and cattle growth were analyzed with nested ANOVA, and followed by an LSD test to determine any significant differences. The nested subgroups and codes are as follow:

Rangelands:

J1 = Amarasi rangeland as the source of forages

J2 = Mamar Kering rangeland as the source of forages

J3 = Combination of Amarasi and Mamar Kering rangeland as the source of forages

J4 = Selobua rangeland as the source of forages

Seasons:

P1 = Early dry season

P2 = Late dry season

P3 = Rainy season

Results

Forages distribution

The direct field observation identified a total of 117 different plant species distributed across on Amarasi, Mamar Kering, and Selobua rangelands. Specifically, 62 different plants species were found on Amarasi rangeland, 77 different plant species found on Mamar Kering rangeland, and 53 different plant species were found on Selobua rangeland. The density of *Leucaena leucocephala* in Amarasi rangeland was found to be 1.02 plants/m^2, in Mamar Kering was 0.28 plants/m^2, and in Selobua was 0.6 plants/m^2. Moreover, due to research limitations in this study, the forages distribution observation was done based on several plant categories, which were perennial plants, food crops, and shrubs (shrub, weed and grass). The perennial plants were also divided into *Leucaena leucocephala*, utilized non-*Leucaena leucocephala* forages (UNLFs), and unutilized forages. All of the forages distribution was also divided based on its growth stages and measured for its relative density (RD) and relative frequency (RF) value as presented in Table 1.

Table 1. Forages distribution of Amarasi, Mamar Kering, and Selobua rangelands based on the relative density (RD) and relative frequency (RF)

Life Stages	No	Forages	Amarasi		Mamar Kering		Selobua	
			RD (%)	RF (%)	RD (%)	RF (%)	RD (%)	RF (%)
Mature	1	Perennial plants	100.00	100.00	100.00	100.00	100.00	100.00
		a. *Leucaena leucocephala*	10.34	6.67	0.00	0.00	9.09	10.53
		b. UNLFs*	39.66	42.22	22.64	38.57	50.00	47.37
		c. Unutilized forages	50.00	51.11	77.36	61.43	40.91	42.10
	2	Food crops	0.00	0.00	0.00	0.00	0.00	0.00
	3	Shrubs (shrub, weed and grass)	0.00	0.00	0.00	0.00	0.00	0.00
Pole	1	Perennial plants	100.00	100.00	100.00	100.00	100.00	100.00
		a. *Leucaena leucocephala*	85.48	61.04	13.37	9.21	81.48	66.67
		b. UNLFs	5.39	14.29	33.13	39.47	11.11	20.00
		c. Unutilized forages	9.13	24.67	53.50	51.32	7.41	13.33
	2	Food crops	0.00	0.00	0.00	0.00	0.00	0.00
	3	Shrubs (shrub, weed and grass)	0.00	0.00	0.00	0.00	0.00	0.00
Sappling	1	Perennial plants	98.59	92.22	98.31	97.69	88.71	75.41
		a. *Leucaena leucocephala*	87.21	38.92	48.73	21.76	75.71	29.51
		b. UNLFs	6.27	25.75	14.83	25.00	6.21	19.67
		c. Unutilized forages	5.11	27.55	34.75	50.93	6.78	26.23
	2	Food crops	0.27	1.80	0.00	0.00	1.41	1.64
		a. Utilized as cattle feed	0.27	1.80	0.00	0.00	1.41	1.64
		b. Not utilized as cattle feed	0.00	0.00	0.00	0.00	0.00	0.00
	3	Shrubs (shrub, weed and grass)	1.14	5.99	1.69	2.31	9.88	22.95
		a. Utilized as cattle feed	0.11	1.20	0.14	0.46	1.41	1.64
		b. Not utilized as cattle feed	1.03	4.79	1.55	1.85	8.47	21.31
Seedlings	1	Perennial plants	37.86	41.98	37.58	51.50	18.97	20.91
		a. *Leucaena leucocephala*	26.27	16.31	16.69	12.05	17.74	13.64
		b. UNLFs	2.99	7.49	4.93	10.68	0.06	0.91
		c. Unutilized forages	8.60	18.18	15.96	28.77	1.17	6.36
	2	Food crops	4.99	8.82	0.70	1.37	0.83	4.55
		a. Utilized as cattle feed	4.99	8.82	0.70	1.37	0.83	4.55
		b. Not utilized as cattle feed	0.00	0.00	0.00	0.00	0.00	0.00
	3	Shrubs (shrub, weed and grass)	57.14	49.10	61.72	47.13	80.20	74.54
		a. Utilized as cattle feed	40.42	28.07	29.74	21.10	49.33	36.36
		b. Not utilized as cattle feed	16.72	21.12	31.98	26.03	30.87	38.18

* UNLFs= utilized non-*Leucaena leucocephala* forages

Forages composition as cattle feed by local farmers

Among 117 plants species distributed on all rangelands, with several species are presented in Table 1, only 14 forages species were utilized by local cattle farmers to be used as cattle feed (Table 2). Forages that were used as cattle feed include *Leucaena leucocephala*, *Sesbania sesban*, *Acacia leucophloea*, Shrubs, weed, and grass (*Sorghum timorensis and Pennisetum macrostachyum), Ceiba pentandra*, *Melochia umbellata*, *Ficus sp.*, *Timonius timun*, *Trigonella foenum-graecum*, *Musa paradisiaca* (stem part), *Arachis hypogea* (in hay form), *Zea mays* (leaves and stem part), and *Manihot esculenta* (leaves and stem part). The forages species in the cattle feed by local farmers under different rangelands and seasons are presented in Table 2. It can be seen from Table 2 that *Leucaena leucocephala* had higher compositions (up to 98%) compared to other forages on all rangelands and seasons in this research, aside on Selobua during rainy season. The condition was due to the dominant growth of the species which originally grown on the area, while on Selobua, *Pennisetum* species was grown by local people during rainy season to provide alternative forages for cattle feed.

Table 2. Forages composition of cattle feed by local farmers on different rangelands in seasons as early dry season (EDS), late dry season (LDS) and rainy season (RS).

Forages Species	Amarasi			Mamar Kering			Amarasi-Mamar Kering			Selobua		
	EDS	LDS	RS	EDS	LDS	RS	EDS	LDS	RS	EDS	LDS	RS
Leucaena leucocephala	91.11	96.23	97.34	78.70	90.41	78.63	90.03	93.56	98.94	81.29	62.57	8.60
Sesbania sesban	1.78	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	8.75	3.60	0.00
Acacia leucophloea	0.00	2.71	0.00	0.00	1.25	0.00	0.00	4.49	0.00	0.00	0.00	0.00
Grass (*Sorghum timorensis* and *Pennisetum macrostachyum*)	0.00	0.26	2.66	3.83	1.78	3.29	0.05	0.00	0.22	1.55	30.83	84.20
Ceiba pentandra	2.18	0.00	0.00	6.74	4.18	11.62	7.82	1.81	0.84	3.09	0.00	2.93
Melochia umbellata	1.91	0.00	0.00	1.57	0.00	0.00	0.82	0.00	0.00	5.32	0.73	0.00
Ficus sp.	1.92	0.00	0.00	2.77	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Timonius timun	0.00	0.00	0.00	1.35	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00
Trigonella foenum-graecum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.27	0.00
Musa paradisiaca (stem)	1.11	0.80	0.00	1.81	1.17	0.87	1.27	0.13	0.00	0.00	0.00	0.72
Arachis hypogea (hay)	0.00	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
Zea mays (leaves and stem)	0.00	0.00	0.00	0.00	0.00	4.98	0.00	0.00	0.00	0.00	0.00	3.21
Manihot esculenta (leaves and stem)	0.00	0.00	0.00	1.82	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description: Based on the dry matter content.

Nutrient composition of forages and cattle feed

The forages diversities and distribution of rangeland would be affected by seasons, which will then affect its nutritional value as well. In this research, the nutritional value of the cattle feed from each rangeland under different seasons was determined by measuring the dry matter (DM), crude protein (CP), and neutral detergent fiber (NDF) content. The CP and NDF content of each forages used for cattle feed in this study is presented in Table 3. The observed forages of this study showed various different family, which include Leguminosae (*Leucaena leucocephala*, *Sesbania sesban*, *Acacia leucophloea*, *Trigonella foenum-graecum*, and *Arachis hypogea*), Gramineae (*Sorghum timorensis*, *Pennisetum macrostachyum*, and *Zea mays*), Malvaceae (*Ceiba pentandra* and *Melochia umbellate*), Moraceae (*Ficus sp.*), Rubiaceae (*Timonius timun*), Musaceae (*Musa paradisiaca*), and Euphorbiaceae (*Manihot esculenta*). Each of the forages were measured for its nutrient composition to understand its potential and contribution for cattle feed. The nutrient composition measurement (Table 3) showed that *Leucaena leucocephala* and *Sesbania sesban* had higher dry matter (DM), crude protein (CP), and non-digestible fiber (NDF) composition compared to other observed forages, thus had high potential to be used as feed source for local cattle farming. The results are in accordance to previous research which explained that *Leucaena leucocephala* contain high nutrients, including protein and mineral (Sethi and Kulkarni, 1995), while research by Oosting *et al*. (2011) showed that *Sesbania sesban* had high feeding value and showed positive correlation to the sheep production performances. On contrary, other forages such as *Zea mays* (Santos-Donado *et al.*, 2021) and *Manihot esculenta* (Santos *et al*., 2020) had relatively low protein content even though high on carbohydrate, and the nutrient value of other forages in this research were rarely measured and utilized.

Table 3. Dry matter (DM), crude protein (CP), and neutral detergent fiber composition (NDF) of the cattle feed on different seasons

Forage Species	Early Dry Season			Late Dry Season			Rainy Season		
	DM%	CP%	NDF%	DM%	CP%	NDF%	DM%	CP%	NDF%
Leucaena leucocephala	29.62	18.72	44.29	29.64	18.49	39.17	24.46	18.82	50.16
Sesbania sesban	22.39	24.21	33.85	26.60	19.25	30.83	-	-	-
Acacia leucophloea	-	-	-	35.19	14.07	48.43	-	-	-
Sorghum timorensis	18.64	6.66	78.89	15.85	9.27	66.35	16.45	6.91	70.23
Pennisetum macrostachyum	19.36	10.10	75.15	-	-	-	13.26	8.42	71.01
Ceiba pentandra	26.13	10.41	74.52	26.23	13.68	60.27	23.19	12.57	72.39
Melochia umbellata	28.90	11.34	43.66	-	-	-	-	-	-
Ficus sp.	30.40	12.40	56.48	30.71	13.00	49.36	-	-	-
Timonius timun	31.37	9.67	50.06	-	-	-	28.91	10.88	43.82
Trigonella foenum-graecum	-	-	-	34.51	8.55	27.68	-	-	-
Musa paradisiaca (stem)	5.00	6.72	64.39	4.47	7.65	59.52	4.35	7.44	64.20
Arachis hypogea (hay)	25.23	11.15	53.04	-	-	-	16.05	11.37	69.75
Zea mays (leaves and stem)	-	-	-	-	-	-	21.73	8.30	66.50
Manihot esculenta (stem and leaves)	24.93	10.03	63.30	27.49	11.45	61.61	-	-	-

In this research, it has been found that there were 4 feeding patterns by local farmers, who were obtained their cattle feed from Amarasi, Mamar Kering, and Selobua individually, as well as combined from Amarasi and Mamar Kering (Amarasi – Mamar Kering). The nutritional value of the cattle feed on each feeding pattern during the early dry season, late dry season, and the rainy season were also further observed by measuring the dry matter (DM), crude protein (CP), and neutral detergent fiber (NDF) as presented in Table 4. The statistical analysis showed that feeding patterns significantly affect ($P<0.01$) NDF content of the cattle feed, but had no significant effect on CP ($P>0.05$). On the other hand, different seasons showed a highly significant effect ($P<0.01$) on both CP and NDF of the cattle feed. This indicates that season plays a vital factor not only on forage distribution and availability, but also to the nutrient intake of the cattle as well.

Aside from Selobua during the rainy season, all feeding pattern was mostly composed of *Leucaena leucocephala*. In this research, we found that the cattle consumed additional edible parts of *Leucaena leucocephala* (branches and twigs) during the rainy season, which then explained higher NDF of cattle feed during rainy season compared to early and late dry seasons.

Table 4. Dry matter (DM), crude protein (CP), and neutral detergent fiber composition (NDF) of cattle feed on different rangelands and seasons

Rangelands	Season	DM (%)	CP (%)	NDF (%)
Amarasi	Early dry season	29.14	18.16±0.28[a]	45.22±1.01[b]
	Late dry season	29.55	18.26±0.16[a]	39.65±0.34[a]
	Rainy season	24.20	18.52±0.26[a]	50.70±0.47[c]
Mamar Kering	Early dry season	28.40	16.83±0.96[a]	48.92±1.13[b]
	Late dry season	29.02	17.87±0.36[a]	41.09±1.01[a]
	Rainy season	23.48	17.06±0.79[a]	54.31±2.67[c]
Amarasi-Mamar Kering	Early dry season	29.02	17.85±0.59[a]	46.95±1.81[b]
	Late dry season	29.79	18.19±0.31[a]	40.00±1.03[a]
	Rainy season	24.43	18.74±0.12[a]	50.39±0.41[c]
Selobua	Early dry season	28.68	18.42±1.23[c]	44.76±2.21[a]
	Late dry season	25.38	15.40±1.42[b]	47.01±3.58[a]
	Rainy season	15.98	8.84±1.95[a]	68.77±2.78[b]
Total average				
Amarasi		27.63	18.31±0.26[a]	45.19±4.82[a]
Mamar Kering		26.97	17.25±0.80[a]	48.11±5.96[b]
Amarasi-Mamar Kering		27.75	18.26±0.52[a]	45.78±4.62[a]
Selobua		23.35	14.22±4.45[a]	53.52±11.76[c]

Description: Different superscripts in the same column in each area indicate a highly significant difference (P<0.01)

Feed intake and average daily gain of the cattle

The growth performances of cattle fed in the Amarasi, Mamar Kering, Selobua, and Amarasi – Mamar Kering rangelands were observed by determining feed intake, nutrient intake (DM and CP), and average daily gain (ADG) of the cattle (Table 5). The finding showed that DM and CP intake of all feeding patterns in this research is still in accordance to the standard intake by Gadberry (2018), who determined standard daily DM intake at 2.3 % cattle weight and daily CP intake at 0.19 % cattle weight. In Table 5, it can be seen that higher DM and CP intake was found on Amarasi-Mamar Kering rangeland. The higher DM and CP intake in Amarasi-Mamar Kering rangeland showed that *Leucaena leucocephala*, the forage species which was found higher in Amarasi-Mamar Kering provide better nutritional value for cattle feed, which can be seen on the higher cattle ADG as well.

Table 5. Feed offered, nutrient intake, and average daily gain of local cattle fed with forages from different rangelands and seasons

Rangelands	Season	Feed offered		Nutrient intake		ADG
		Non-edible part* (kg)	Edible part** (kg)	DM (% BW***)	CP (% BW)	(kg/day)
Amarasi	Early dry season	12.8±0.29	3.04±0.21	2.62±0.14ᵃ	0.48±0.03ᵃ	0.23±0.03ᵃ
	Late dry season	12.35±2.71	3.07±0.57	2.71±0.39ᵃ	0.50±0.08ᵃ	0.25±0.10ᵃ
	Rainy season	13.23±1.10	2.82±0.12	2.58±0.04ᵃ	0.48±0.01ᵃ	0.25±0.07ᵃ
Mamar Kering	Early dry season	9.42±1.90	2.40±0.35	2.27±0.31ᵃ	0.38±0.03ᵃ	0.14±0.15ᵃ
	Late dry season	8.42±0.96	2.23±0.14	2.15±0.12ᵃ	0.38±0.03ᵃ	0.15±0.01ᵃ
	Rainy season	10.81±0.77	2.29±0.19	2.19±0.18ᵃ	0.38±0.05ᵃ	0.14±0.03ᵃ
Amarasi-Mamar Kering	Early dry season	16.18±3.60	3.50±0.52	2.81±0.29ᵃ	0.50±0.06ᵃ	0.31±0.09ᵃ
	Late dry season	11.57±1.06	3.06±0.37	2.76±0.25ᵃ	0.50±0.05ᵃ	0.27±0.11ᵃ
	Rainy season	13.03±1.67	2.81±0.39	2.73±0.28ᵃ	0.51±0.05ᵃ	0.33±0.09ᵃ
Selobua	Early dry season	12.16±0.71	3.04±0.31	2.51±0.20ᵃ	0.46±0.04ᵇ	0.25±0.10ᵃ
	Late dry season	10.96±0.78	2.72±0.53	2.27±0.16ᵃ	0.35±0.05ᵇ	0.22±0.08ᵃ
	Rainy season	15.71±1.40	2.35±0.14	2.20±0.11ᵃ	0.20±0.04ᵃ	0.17±0.02ᵃ
Total average						
Amarasi		12.79±1.52	2.98±0.33	2.64±0.22ᵃ	0.48±0.04ᵃ	0.25±0.06ᵃ
Mamar Kering		9.55±1.54	2.31±0.22	2.20±0.19ᵃ	0.38±0.03ᵃ	0.14±0.08ᵃ
Amarasi-Mamar Kering		13.59±2.96	3.12±0.50	2.77±0.26ᵃ	0.50±0.05ᵃ	0.30±0.09ᵃ
Selobua		12.94±2.31	2.70±0.44	2.33±0.20ᵃ	0.34±0.12ᵃ	0.21±0.07ᵃ

Description: Different superscripts in the same column within each rangeland, indicate a highly significant difference (P<0.01). *fresh weight; **dry weight; *** body weight

Discussion

The research found that among 117 different plant species distributed across Amarasi, mamar Kering, and Selobua rangelands, only 14 forages were used as cattle feed by local farmers. Moreover, among obvious forages distribution in Amarasi, Mamar Kering, and Selobua rangelands, a notable similarity is that *Leucaena leucocephala* is the most grown forages in all observed rangelands. In Table 1, it can be seen that all of the observed rangelands were rich of forages that showed the potential to be used as cattle feed. Moreover, the research also found that *Leucaena leucocephala* was the major forage grown in the rangelands, especially on the poles and sapling stage. The forages distribution in this research is presented as relative density and forages frequency, with special observation was done on *Leucaena leucocephala*. Aside from the condition that *Leucaena leucocephala* was the major forage grown on the rangeland, the more specific observation on the forage compared to other forages in this research was due to the utilization of *Leucaena leucocephala* as main source of cattle feed by local cattle farmers. Other perennial plants, food crops, as well as grass were also observed as the plants were used as substitute and/or added with *Leucaena leucocephala* as cattle feed.

The forages used as cattle feed by local farmers in this research were relatively similar to the finding by Nulik *et al*. (2000), Pelokilla *et al*. (2005), Sulistijo and Rosnah (2006; 2014) and Kapa (2007). In Table 2, it can be seen that *Leucaena leucocephala* made up most of the cattle feed with a varying ratio under different seasons. The highest ratio of *Leucaena leucocephala* on cattle feed was found on farmers who obtain the forage from Amarasi rangeland, which was 91.11% during the early dry season (EDS), 96.23% during the late dry season (LDS), and reached 97.34% during the rainy season (RS). Moreover, a notable difference was found on farmers who obtained their forage from Selobua rangeland during rainy seasons, with their cattle feed was mostly consisted of *Sorghum timorensis* and *Pennisetum macrostachyum* (84.20%). This finding showed that season also played a major part in determining cattle feed of local cattle farmers in Kupang regency, thus will also affect their cattle performances and overall farming practice. It can also be seen in Table 2 that food crops by-products, namely stem part of *Musa paradisiaca*, hay of *Arachis hypogea*, leaves and stem part of *Zea mays*, as well as leaves and stem part of *Manihot esculenta* were used, especially by farmers who obtained their cattle feed in Mamar Kering and Selobua rangelands. The finding indicates that cattle farmers in Mamar Kering and Selobua rangelands have applied an integrated farming system that combined food crops for human consumption and utilized its by-products for cattle feed. Such effort can be seen from the availability of *Manihot esculenta* during the dry season and *Arachis hypogaea* as well as *Zea mays* during rainy seasons, which each respective season is suitable for growing the crops.

Moreover, this research it was found that local cattle farmers were divided into four different feeding patterns, which were farmers who obtained the cattle feed from Amarasi, Mamar Kering, and Selobua rangelands individually as well a combination of Amarasi and Mamar Kering. The combination of Amarasi and Mamar Kering was due to the condition that Mamar Kering rangeland was poor of *Leucaena leucocephala* plants, while farmers who prefer a higher ratio of *Leucaena leucocephala* in their cattle feed would obtain the forage from Amarasi rangeland. The different feeding patterns were then used to evaluate the rangeland's potential by measuring its forages composition, nutrient value, and cattle growth performances as discussed in the respective sections. In Table 3, it can be seen that only *Leucaena leucocephala* and *Sesbania sesban* fulfilled the minimum CP requirement for ruminants, which at least 12% of dry matter (Smith, 2002). Research has shown that the critical CP intake for ruminants is at 6 to 8% and the value would only enough to maintain its body metabolism, thus not effective to support the growth performance (Subagiyo, 2012), thus improving protein intake in cattle managed on tropical pastures has been a major concern for animal nutritionists (Detmann *et al*., 2010). Aside from CP, one of the critical factors in determining forage quality for cattle feed is its digestibility. In this research, the digestibility of the forage is evaluated by measuring NDF of the forages, and from 14 observed forages, *Sesbania sesban* has shown the lowest NDF (33.85% during early dry season EDS and 30.83% during late dry season LDS), which indicates the best digestibility compared to other observed forages. It can be seen that the NDF of cattle feed on Selobua rangeland was significantly higher ($P<0.01$) compared to the other three feeding patterns, even though the CP was lower compared to other treatments ($P>0.05$). The result was due to the condition that in both Amarasi and Mamar Kering feeding pattern, the cattle feed mostly consisted of *Leucaena leucocephala* (Table 2), thus the CP of the cattle feed would be higher compared to other feeding patterns (Table 4). On the other hand, in Selobua feeding, the addition of *Sorghum timorensis* and *Pennisetum macrostachyum* on the cattle feed results on lower CP, noting that both plants had lower CP compared to *Leucaena leucocephala*.

Moreover, the higher NDF in Selobua cattle feed resulted in lower feed digestibility compared to Amarasi, Mamar Kering, and Amarasi–Mamar Kering. According to Campbell *et al.* (2003), the nutrient composition is highly determined by its feed digestibility, considering that it would affect its total consumption. Swanepoel *et al*. (2010) added that among all of the nutrient composition, crude protein plays an important role in microbial rumen growth and rumen activity, with higher crude protein would provide better growth performance (Subagiyo, 2012). In Table 4, it can be seen that the NDF of cattle feed in all feeding patterns were significantly higher (P<0.01) during the rainy season, while the significant difference on CP under different season was only found on Selobua, with the highest value was found during the early dry season (EDS). In all feeding patterns, the major forage that compiles cattle feed was *Leucaena leucocephala*, except for Selobua during rainy seasons, which mostly consisted of *Sorghum timorensis* and *Pennisetum macrostachyum*. This results in the poor nutritional value of the feed as both *Sorghum timorensis* and *Pennisetum macrostachyum* had lower CP and higher NDF compared to *Leucaena leucocephala* (Table 2).

The ADG in this research (Table 5) was lower compared to other findings in local cattle growth performances in Indonesia reared in a traditional farming practice, which was at 0.12 to 0.48 kg/day (Nulik *et al*., 2000; Manggol *et al*., 2007; Pelokilla *et al*., 2005; Mulik and Jelantik, 2010; Qomariah and Bahar, 2010; Ratnawaty and Pohan, 2010; Rosnah and Yunus, 2017). The statistical analysis showed that both feeding patterns and different seasons did not show a significant effect (P>0.05) to the nutrient intake and ADG of the cattle (Table 5). It has been known that feed quality and quantity, determine the growth performance of the cattle. The similar nutrient intake and ADG in this study showed that even though forages distribution was varied among all rangelands during different seasons, its overall feed qualities were similar. The CP and NDF content in cattle feed would determine the feed quality, as CP was required for microbial rumen activity and NDF affects forage digestibility (McDonald, *et al*., 2010). On Mamar Kering, even though the cattle feed quality was better compared to other rangelands, the feed intake was lower, thus inhibit the cattle growth performance had similar results to other feeding patterns. A similar finding by Suwignyo *et al* (2016) also showed that feed intake determines the growth performance of the cattle, while feed efficiency could differ, cattle feed in ad libitum had better growth performance compared to cattle that had limited feed intake.

Conclusion

The research found that the most grown forages on Amarasi, Mamar Kering, and Selobua were *Leucaena leucocephala*, while 14 forage species were utilized as cattle feed by local farmers. The highest *Leucaena leucocephala* density and frequency were found on Amarasi rangeland, while the highest forages availability and cattle growth performances were found in the combined forages from Amarasi and Mamar Kering rangelands.

Acknowledgment

Authors would like to thank Faculty of Animal Husbandry, Universitas Nusa Cendana, local authorities and farmers in Amarasi, Mamar Kering and Selobua rangelands for their support in this research, Laboratory of Animal Nutrition, Faculty of Animal Science, University of Brawijaya for facilitating the forages analysis, and Aldyon Restu Azkarahman for his input in the manuscript improvement.

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