

Utilization of *Leucaena leucocephala* in Traditional Fattening Program of Bali Cattle in Amaras

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ABSTRACT

This field study was aimed to evaluate the availability and the utility of forage on Bali cattle in Amaras system in dry land area such as Kupang. Amaras system is a fattening production system (*paronisasi*), which traditionally utilizes *Leucaena leucocephala* forage in dry season of Amaras region. This field study was conducted during the period of July to December 2013 in Oesena and Merbaun Villages. The method used in this research was field survey. This type of survey was used to identify the forage availability and utility for Bali cattle; including determining the level of feed intake, measuring carrying capacity of both observe villages, and recording body weight of cattle. Cluster random sampling was applied in this study to determine sample used in the research, those were two villages with different altitudes, namely Oesena Village and Merbaun Village. Data were analyzed descriptively to describe the related existing conditions in the field. T-test was conducted to determine leucaena consumption and Bali cattle body weight in both villages. The results showed that during observation period, availability of leucaena forage for cattle was low based on dry matter intake 3.60 and 3.58 kg/head/day, which led to low consumption of cattle. Nevertheless, the use of leucaena in this system increased average body weight gain of Bali cattle up to 0.77 kg/day, due to high crude protein consumption. The conclusion of this study was the availability of leucaena as Bali cattle feed did not meet the cattle needs, but the use of leucaena increased the average of Bali cattle body weight gain.

Key words: amaras system, Bali cattle, Leucaena leucocephala, paronisasi

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi ketersediaan dan penggunaan hijauan pakan sapi Bali pada sistem Amaras di lahan kering. Sistem amaras adalah sebuah sistem penggemukan (*paronisasi*) ternak sapi Bali yang khas berbasis pakan hijauan lamtoro (*Leucaena leucocephala*) pada musim kemarau di wilayah Amaras. Penelitian ini dilaksanakan pada bulan Juli sampai dengan Desember 2013 di Desa Oesena dan Desa Merbaun Kabupaten Kupang Propinsi Nusa Tenggara Timur. Metode yang digunakan adalah survei lapang untuk mengidentifikasi hijauan pakan ternak yang terdapat di kandang, mengukur tingkat konsumsi pakan ternak, besarnya kapasitas tampung pada kedua desa dan pertambahan bobot badan ternak sapi Bali. Pengambilan sampel dilakukan menggunakan cluster random sampling. Dua desa dengan ketinggian berbeda dipilih, yaitu Desa Oesena dan Desa Merbaun. Data dianalisis secara deskriptif untuk menggambarkan kondisi di lapangan. Uji t dilakukan untuk mengetahui nilai bobot badan konsumsi lamtoro pada kedua desa. Hasil penelitian menunjukkan bahwa nilai konsumsi lamtoro, yaitu 3.60 dan 3.58 kg/ekor/hari serta kapasitas tampung di dua desa yang rendah, namun pertambahan bobot badan sapi Bali meningkat hingga 0.77 kg/ekor hari yang disebabkan oleh tingginya konsumsi protein kasar. Kesimpulan dari penelitian ini adalah ketersediaan lamtoro sebagai pakan sapi Bali belum memenuhi kebutuhan ternak, namun penggunaannya meningkatkan bobot badan sapi Bali.

Kata kunci: Leucaena leucocephala, paronisasi, sistem amaras, sapi bali

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INTRODUCTION

The forage portion in ruminant ration reaches approximately 3% of the body weight. Nutritionally leucaena, is source of fiber, mineral and protein, which traditionally fulfill animal requirements for growth. The difficulties in providing sustainable amount of forage often occur in Kupang due to long dry season. It causes low productivity of ruminants.

Amarasi region is located in Kupang Regency in East Nusa Tenggara province and consists of four sub districts namely Amarasi, West Amarasi, East Amarasi, and South Amarasi. The climates in these areas are influenced by the monsoon winds from Australia. Monthly rainfall ranges between 4 mm (in October) to 316 mm (in February) with humidity ranging from 64% to 84% (BPS, 2013). In Amarasi, farmers applied a traditional fattening system called "paronisasi" by using only leucaena as one of the most important forage on dry season.

Leucaena is daily feed on dry season in this system by cut and curry method. Farmers grow leucaena in their garden and harvest the forage regularly. This system was initially applied in 1930 under the rule of the Dutch government in Baun Village of Amarasi region (Metzner, 1981) which then being reinforced by the local customs authorities in 1932. Regulations made by the local authority (king) have significantly supported this system to a success story compared to breeder-farmers in other regions of the province.

Since this system was introduced, great numbers of farmers are interested in implementing this system and are entirely relying on *L. leucocephala* as the main feed source. Forage *L. leucocephala* can be used as a protein, minerals, and vitamin sources (Haque *et al.*, 2008; Kang *et al.*, 2012). Dahlanuddin *et al.* (2013) reported that Bali cattle fed leucaena increase average daily gain by 0.47 kg/head/d. Furthermore, addition of *S. cerevisiae* and *L. leucocephala* on low-quality feed improved nutrient digestibility and cattle performance (Herawaty *et al.*, 2013). In previous studies, supplementation of *L. leucocephala* increased total dry matter intake and crude protein digestibility in goats (Aregheore & Parera, 2004; Kanani *et al.*, 2005; Abdulrazak *et al.*, 2006; Yousuf *et al.*, 2007; Fasae *et al.*, 2011), as feed additive for growing lambs and cow's milk production (Salem *et al.*, 2011; Salem *et al.*, 2014).

Nevertheless, the flea's attack in the early 1986 had tremendously destroyed leucaena stands and directly influenced the declining of livestock productivity in Amarasi. *Leucaena* shortage in beef cattle affected the fattening program period is longer and the number of cattle are fattened be less. In such condition, the Amarasi system became better and are flea's tolerant leucaena being re-cultivated. Based on the above information this study was undertaken to evaluate the availability and the use of leucaena (*L. leucocephala*) on Amarasi system in Kupang.

MATERIALS AND METHODS

Leucaena Intake Measurement

Edible part of leucaena intake was recorded by weighing the forage before feeding and the residue of leucaena on the next day. Forage intake was observed for seven consecutive days. The number of respondents were 15 farmers for each villages and coded as F1, F2, until F15 to collect primary data including leucaena consumption, chest circumference to estimate body weight, and nutrient quality of leucaena. These farmers were part of total respondent (75) that were interviewed.

Research Accomplishment

The survey was conducted to investigate information regarding cattle condition by farmers, field, and farmer's profiles. Along with this, questionnaires were used to obtain information on general condition of production system and feed resources in farm level. Data used in the study were primary and secondary data. Primary data were obtained from the results of leucaena intake, chemical composition of forage and cattle body weight. Secondary data contained climatic data, village resources agriculture.

Cluster random sampling was applied in this study to determine sample used in the research, those were two villages with different altitudes, namely Oesena Village located in the hills at 500 m above sea surface in Amarasi sub district and Merbaun Village which located near the shore areas at 30 m above sea surface in West Amarasi sub district (BPS, 2013).

The number of samples was calculated using the following formula (Som, 1996):

$$n = N / (1 + Ne^2)$$

Notes:

N : total farmers

e : error (10%)

n : total sample

The number of respondents was 75 farmer families from both villages. The information regarding farmer, number of cattle, and forage supply patterns were obtained by using questionnaires. T-test was used to determine Bali cattle body weight and leucaena consumption value in both villages.

Carrying Capacity Measurement

Carrying capacity is a number of cattle that can graze on a pasture without destroying the land, crops, and livestock. The carrying capacity was calculated based on the space of plant with assuming the population of leucaena was 2500 trees/ha and plant spacing was 2 x 2 m and cutting frequency was 3 times in dry season (8 months). Carrying capacity was calculated using a modified method of Halls *et al.* (1964).

Body Weight Gain Estimation

Body weight gains were estimated from chest circumference using the pattern Zurahmah (2011).

$$BW = 2.62 CC - 192$$

Notes:

BW = body weight (kg)

CC = chest circumference (cm)

Bali cattle body weight daily gain was calculated using the following formula:

$$ADG = [\text{body weight week } n - \text{body weight } n(n-1)] / 7$$

Data Analysis

The data were analyzed descriptively to describe the general state of the research sites. Those were temperatures, humidity, rainfall and livestock rearing systems and patterns of green fodder supply that can support the efforts of ruminant livestock in East Nusa Tenggara.

Analysis of Chemical Composition of Leucaena

The chemical composition of leucaena forage was analyzed using proximate analysis method (AOAC, 2005) and Van soest (Tillman, 1998). Forage feed samples were taken from the both Oesena and Merbaun vilages.

Total digestible nutrient (TDN) from leucaena forage was calculated using the following formula as described by Hartadi *et al.* (1980):

$$\begin{aligned} \text{TDN (\%)} = & - 54.572 + 6.769 (\text{CF}) - 51.083 (\text{EE}) + 1.851 \\ & (\text{NFE}) - 0.334(\text{CP}) - 0.049 (\text{CF})^2 + 3.384 (\text{EE})^2 \\ & - 0.086 (\text{CF}) (\text{NFE}) + 0.687 (\text{EE}) (\text{NFE}) + 0.942 \\ & (\text{EE}) (\text{CP}) - 0.112 (\text{EE})^2 (\text{CP}) \end{aligned}$$

Notes:

CF : crude fiber

EE : ether extract

NFE : nitrogen-free extract

CP : crude protein

RESULTS AND DISCUSSION

General Condition of the Research Area

Farmer in Oesena Village and the Merbaun Village spread evenly because of the existence land in the vilages. The lands were used not only for *L. leucocephala* but also to graze livestock traditionally in both extensive and semi-intensive system. In addition the cattle were kept in cage during the day and some of the Bali cattle kept freely around the house. *L. leucocephala* was planted as fence around the house in some farmers, but some other farmers planted leucaena as garden to fed Bali cattle.

The average of farmer ages in both vilages were 33-48 years old. Farming has become an integral part of the culture and is existed as a complementary income generator that is inherited from each generation. The farmers came from different formal education background such as elementary, junior high school, senior

high school and bachelor degree (S1), and also farmers who had not a formal education. The main occupations of the farmers in both vilages were varied, they were mostly working as a farmer, gardener, and motorcycle taxi drivers. Hence, it could be assumed the average income of farmers without fattening program in economic standard of farmers were low. As it was considered as another source of income, the farmers took care of their cattle once the main occupation had finished. The profit from derived fattening was budgeted for paying children school fee, marriage, and other traditional events. On average, each farmer in the two vilages had their own 2-6 cattle as the heritance from the parents as well as purchasing their own cattle.

Bali cattle production system used in the two vilages was semi-intensive, cattle are tied up and then being fed with leucaena twice a day in the morning and afternoon. This system is also called "paronisasi". Defoliation systems of leucaena forage conducted in the vilage is cut and carry. Residue of leucaena forage in the form of twigs and stems are collected by the farmers and are used as firewood and poles for construction. Another function of *L. leucocephala* was reforestation, poles for construction, firewood, shade in permanent plantations, traditional medicine (Nehdy *et al.*, 2014), pulp production (Lopez *et al.*, 2008), green manuring (Sharma & Behera, 2010), and in wood production (Prasad *et al.*, 2011). Forages given to cattle were collected from their own garden or around the yard. There is a law that is regulated by the government since ancient time that is when farmers stole forage from other breeders, they will have to pay approximately 1 million IDR. The law enforces the farmers to grow leucaena in their garden. In accordance to the results of our interview, each farmer in average possessed 2.5 ha of leucaena field in Oesena, while in Merbaun Village they had 6.25 ha.

Based on the field observation, Psyllid was found in some stands of leucaena in both vilages. Integrated pest management applied by the community and vilage government to eliminate the fleas was entirely successful. Since leucaena was still considered as a major feed in Amaras, new tolerant fleas varieties of *Lamtoro* cv. *Tarrambah*, was extensively cultivated in the area (Nulik *et al.*, 2013).

Leucaena has been chosen due to its ability to adapt to a longer dry season and palatable. Besides, support from the government to apply the forestation program,

Table 1. Chemical composition (%) of leucaena (dry matter basis)

Nutrients	Oesena vilage	Merbaun vilage
Crude protein	27.35	19.88
Crude fiber	18.26	14.88
Crude fat	3.21	5.61
Nitrogen-free extract	43.03	50.70
Neutral detergent fiber	71.19	70.55
Acid detergent fiber	44.99	64.83

Note: Analyzed by Feed Technology Laboratory, Faculty of Animal Science, Bogor Agricultural University

pave the way to make leucaena as the major feed crop in Amaras until now.

Nutrient Quality of Leucaena

The chemical compositions of leucaena forage in both study areas were not significantly different. Crude protein contain in leucaena forage grown in Oesena (mountainous) 27.35% was higher than Merbaun which was located nearby the beach 19.88% (Table 1).

Protein content in Oesena village was higher than Merbaun village, this could be due to the fertility of the soil and climate. Merbaun village is located near the beach so it has a higher salinity levels and lower rainfall than Oesena village which stated in the hills.

Leucaena Consumption

The average of dry matter intake of leucaena (DMIL) in Oesena was 3.60 ± 0.83 kg/head/d, while in Merbaun Village DMIL was average of 3.59 ± 0.72 kg/head/d (Table 2). The DM consumption on rates of leucaena in both village were still low about 1.59% of body life weight and 2.05% of body life weight or approximately 53% and 72% of total leucaena feed in Oesena and Merbaun, respectively. According to Kearn (1982), daily DMI for cattle as about 2.8% body weight. Based on the calculation of the consumption, the weight of the cattle in the two villages were livestock feed shortage. Kearn (1982) states that the average cow body weight between 150-200 kg with an increase in body weight 0.50 kg/head/d of dry matter intake 4.2 kg/h/day or 2.8%. The shortages occurred due to long period of drought that lead to the declining of feed availability. Prolonged drought and high temperatures resulted in lost of leucaena leaves. Then, the flea invasions also caused the two villages

to the lack of forage availability. Nevertheless cattle in these two villages were able to utilize nutrients leucaena well; this was followed by an increase in body weight of Bali cattle in wet season. DMIL in Merbaun is significantly higher $P < 0.05$ (T-test) than those in Oesena. This was perhaps due to greater area of leucaena possessed by farmers in Merbaun than in Oesena.

Crude Protein and TDN Consumptions

Consumption of crude protein in Oesena Village was higher 0.98 ± 0.21 kg/head/d than Merbaun Village 0.71 ± 0.08 kg/head/d (Table 2), it was because of the high crude protein content in leucaena forage from Oesena (27.35%). Crude protein consumption in the cattle was higher than crude protein of requirement 0.57-0.67 kg/d as recommended by Kearn (1982).

TDN consumption of two villages did not much different, and it fulfilled the TDN need in cattle. TDN consumption in Oesena and Merbaun village was 2.61 ± 0.33 kg/head/d and 3.87 ± 0.46 kg/head/d (Table 2). Based on the calculations of TDN requirement Kearn (1982) standard for 150-200 kg cattle body weight was 2.75-3.55 kg/d.

Bali Cattle Body Weight Gain

Average daily gain (ADG) of cattle in two villages were varied. It can be grouped into two ADG level ie: $ADG \leq 0.50$ kg/head/d as group A and $ADG \geq 0.50$ kg/head/d as group B. The lowest daily gain average of Bali cattle of group A in the Oesena was 0.17 kg/head/d and Merbaun Village was 0.32 kg/head/d (Table 3). Cattle in group A was growing cattle, so feed consumed was used for the growth of the animal itself. The highest ADG of Bali cattle of group B in the Oesena Village was

Table 2. Daily dry matter intake, crude protein, and total digestible nutrient of Bali Cattle consumed leucaena in Oesena and Merbaun Villages

No	Body Weight (kg)		DM Intake (kg/head/d)		DM Intake (% BW)		CP Consumption (kg/head/d)		TDN Consumption (kg/head/d)	
	Oesena Village	Merbaun Village	Oesena Village	Merbaun Village	Oesena Village	Merbaun Village	Oesena Village	Merbaun Village	Oesena Village	Merbaun Village
F1	208.89	207.50	4.07±0.41	3.75±0.29	1.95±0.19	1.81±0.14	1.12±0.11	0.75±0.05	2.95±0.29	4.04±0.31
F2	203.62	202.32	4.82±1.16	3.53±0.15	2.37±0.57	1.75±0.08	1.32±0.32	0.70±0.03	3.49±0.84	3.80±0.16
F3	220.00	224.41	4.67±0.84	3.58±0.30	2.12±0.38	1.59±0.14	1.28±0.23	0.71±0.06	3.38±0.61	3.85±0.33
F4	268.73	140.41	4.50±0.40	3.73±1.37	1.67±0.15	2.66±0.97	1.23±0.11	0.74±0.25	3.26±0.29	4.02±1.47
F5	211.15	141.72	2.84±0.37	2.73±0.76	1.34±0.18	1.93±0.53	0.78±0.10	0.54±0.14	2.06±0.27	2.94±0.82
F6	214.10	145.33	4.68±1.71	4.89±1.02	2.18±0.80	3.36±0.70	1.28±0.47	0.97±0.19	3.39±1.24	5.26±1.10
F7	237.52	192.98	3.12±0.99	3.61±0.14	1.32±0.42	1.87±0.08	0.85±0.27	0.72±0.03	2.27±0.72	3.88±0.16
F8	260.72	153.51	3.59±0.59	3.90±1.19	1.38±0.23	2.54±0.77	0.98±0.16	0.77±0.22	2.61±0.43	4.20±1.28
F9	234.08	163.01	3.76±1.67	3.81±0.41	1.61±0.71	2.34±0.25	1.03±0.46	0.76±0.08	2.73±1.21	4.10±0.45
F10	201.00	172.18	2.68±0.40	4.42±1.10	1.34±0.20	2.57±0.63	0.73±0.11	0.88±0.20	1.95±0.29	4.76±1.17
F11	183.97	98.17	3.58±0.66	4.09±1.22	1.95±0.36	4.16±1.23	0.98±0.18	0.81±0.22	2.60±0.48	4.40±1.30
F12	213.51	230.80	2.48±0.60	1.77±0.59	1.16±0.28	0.77±0.26	0.68±0.16	0.35±0.11	1.80±0.43	1.91±0.64
F13	288.44	216.07	3.91±0.61	3.83±0.21	1.36±0.21	1.77±0.10	1.07±0.17	0.76±0.04	2.84±0.44	4.12±0.23
F14	222.68	206.24	2.49±0.33	3.12±0.58	1.12±0.15	1.51±0.28	0.68±0.09	0.62±0.11	1.80±0.24	3.36±0.63
F15	236.34	182.33	2.78±0.46	3.13±0.44	1.18±0.20	1.72±0.24	0.76±0.13	0.62±0.08	2.02±0.34	3.37±0.47
Average	226.99±28.00 ^a	178.46±37.72 ^b	3.60±0.45	3.58±0.43	1.60±0.21 ^b	2.10±0.53 ^a	0.98±0.21	0.71±0.08	2.61±0.33	3.87±0.46

Note: Means in the same row with different superscripts differ significantly ($P < 0.05$). F= Farmers, BW= Body Weight, DM= Dry Matter, CP= Crude Protein, TDN= Total Digestible Nutrient.

Table 3. The average daily gain (ADG) of Bali cattle observed in Oesena and Merbaun Village

Group A (ADG ≤ 0.50 kg/head/d)				Group B (ADG ≥ 0.50 kg/head/d)			
Oesena Village		Merbaun Village		Oesena Village		Merbaun Village	
Farmers	ADG	Farmers	ADG	Farmers	ADG	Farmers	ADG
F1	0.32	F1	0.32	F8	0.64	F6	1.12
F2	0.27	F2	0.39	F9	0.80	F7	0.64
F3	0.21	F3	0.05	F10	0.80	F8	0.86
F4	0.27	F4	0.37	F11	0.81	F9	0.80
F5	0.00	F5	0.48	F12	0.75	F10	0.67
F6	0.11			F13	0.70	F11	0.70
F7	0.00			F14	0.86	F12	1.07
				F15	0.75	F13	0.56
						F14	0.52
						F15	0.72
Average	0.17		0.32		0.76		0.77

0.76 kg/head/d and Merbaun Village was 0.77 kg/head/d (Table 3). The increased of Bali cattle ADG was caused by high protein consumption which was 0.98 kg/head/d in the Oesena Village and 0.71 kg/head/d in the Merbaun Village (Table 3). Kearl (1982) stated that the standard of protein consumption for cattle with ADG 0.50 kg/head/d was 0.60-0.70 kg/head/d. The excess of the protein was converted into energy.

Carrying Capacity

The average of leucaena leaf dry matter production in both villages Oesena and Merbaun were 3.2 ton/ha and 2.4 ton/ha, respectively (Table 4). Leucaena production and carrying capacity were calculated based on population leucaena per hectares with a spacing 2 x 2 m. Therefore, in one hectare of leucaena farm were 2500 trees by three times cutting during the dry season.

Season has an important role on the productivity of the leucaena farm, so that the rest leucaena period used was 70 days. In the dry season, the result of carrying ca-

capacity at Oesena and Merbaun village was 1.94 AU and 1.43 AU, respectively (Table 4).

Rainfall is a major factor that affecting the growth of the plant. The low and spread of intensity of rainfall can bring a difficulties for farmers to get the forage for cattle, particularly during the dry season. In addition, topography also influences the availability of forage. The land slope is relating to land management and erosion. The land elevation is relating to temperature and solar radiation.

CONCLUSION

The availability of leucaena as a fodder for Bali cattle in two villages did not meet the cattle need as seen from the dry matter intake and low carrying capacity. Nevertheless the use of leucaena as Bali cattle feed was able to meet the nutrient requirement of crude protein, thereby increasing daily body weight gain of Bali cattle.

REFERENCES

- Abdulrazak, S. A., R. K. Kahindi, & R. W. Muinga.** 2006. Effects of Madras thorn, Leucaena and Gliricidia supplementation on feed intake, digestibility and growth of goats fed Panicum hay. *Livest Res Rural Dev.* 18 (9).
- AOAC.** 2005. Official Methods of Analysis. Assoc. Off. Ana. Chem, Washington DC (US).
- Aregheore, E. M. & D. Parera.** 2004. Effects of *Erythrina variegata*, *Gliricidia sepium* and *Leucaena leucocephala* on dry matter intake and nutrient digestibility of maize stover, before and after spraying with molasses. *Anim. Feed Sci. Technol.* 111: 191-201. <http://dx.doi.org/10.1016/j.anifeedsci.2003.06.001>
- BPS.** 2013. Kupang dalam Angka. Badan Pusat Statistik Kabupaten Kupang.
- Dahlanuddin, O. Yanuarianto, D. P. Poppi, S. R. McLennan, & S. P. Quigley.** 2013. Liveweight gain and feed intake of weaned Bali cattle fed grass and tree legumes in West Nusa Tenggara, Indonesia. *Anim. Prod. Sci.* 54: 915-921.
- Fasae, O. A., A. L. Adesope, & V. O. A. Ojo.** 2011. The effect of leucaena leaf supplementation to maize residues on village goat performance. *J. Anim. Plant Sci.* 10: 1276-1282.
- Halls, L. K., R. H. Hughes, R. L. Rummel, & B. L. Southwel.** 1964. Forage and Cattle Management in Longleaf-slash

Table 4. Forage production and carrying capacity in Oesena and Merbaun Village

Component	Oesena village	Merbaun village
Leucaena production (kg dry matter/plant)	0.49	0.36
Leucaena production in dry season (ton/ha)	3.20	2.40
Leucaena intake (%)	53.00	72.00
Bali cattle body weight average (kg)	226.99±28.00	178.46±37.72
Leucaena consumption (kg/head/d)	3.88	3.85
Carrying capacity in dry season (AU/ha)	1.94	1.43

Note: AU= Animal unit.

- Pine Forest. Farmer's Bulletin Vol. 2119. US Department of Agriculture, Washington.
- Haque, N., T. Saroj, M. L. Saraswat, & M. Y. Khan.** 2008. Effect of feeding *Leucaena leucocephala* leaves and twigs on energy utilization by goats. *Anim. Feed Sci. Technol.* 142: 330-338. <http://dx.doi.org/10.1016/j.anifeedsci.2007.09.027>
- Hartadi, H., S. Reksohadiprojo, S. Lebdoekojo, A. D. Tillman, L. C. Kearl, & L. E. Harris.** 1980. Tabel-tabel dari Komposisi Bahan Makanan Ternak untuk Indonesia. Published by the International Feedstuffs Institute. Utah Agricultural Experiment Station, Utah State University Logan, Utah.
- Herawaty, R., N. Jamarun, M. Zain, Arnim & R. W. S. Ningrat.** 2013. Effect of supplementation *Sacharomyces cerevisiae* and *Leucaena leucocephala* on low quality roughage feed in beef cattle diet. *Pakistan J. Nutr.* 12: 182-184. <http://dx.doi.org/10.3923/pjn.2013.182.184>
- Kanani, J., S. D. Lukefahr, & R. L. Stanko.** 2005. Evaluation of tropical forage legumes (*Medicago sativa*, *Dolichos lablab*, *Leucaena leucocephala* and *Desmanthus bicornutus*) for growing goats. *Small Rum. Res.* 65: 1-7. <http://dx.doi.org/10.1016/j.smallrumres.2005.04.028>
- Kang, S., M. Wanapat, P. Pakdee, & A. Cherdthong.** 2012. Effects of energy level and *Leucaena leucocephala* leaf meal as a protein source on rumen fermentation efficiency and digestibility in swamp buffalo. *Anim. Feed Sci. Technol.* 174: 131-139. <http://dx.doi.org/10.1016/j.anifeedsci.2012.03.007>
- Kearl, L. C.** 1982. Nutrient requirements of ruminants in developing countries. International Feedstuffs Institute. Utah Agricultural Experiment Station. Utah State University, Logan Utah.
- Lopez, F., M. M. Garcia, R. Yanez, R. Tapiaz, M. Fernandez, & M. J. Diaz.** 2008. *Leucaena* species valoration for biomass and paper production in 1 and 2 year harvest. *Bioresource. Technol.* 99: 4846-4853. <http://dx.doi.org/10.1016/j.biortech.2007.09.048>
- Metzner, J. K.** 1981. Old in the New: Autochthonous Approach toward stabilizing an agroecosystem: The case from Amaras (Timor). *App. Geogr. Dev.* 17: 1-17.
- Nehdy, I. A., S. Hassen, Chin Ping Tan, & S. I. Al-Resayes.** 2014. *Leucaena leucocephala* (Lam.) de wit seed oil: Characterization and uses. *Ind. Crops. Prod.* 52: 582-587. <http://dx.doi.org/10.1016/j.indcrop.2013.11.021>
- Nulik, J., Dahlanuddin, D. Kana Hau, C. Pakereng, R. G. Edison, D. Liubana, S. P. Ara, & H. E. Giles.** 2013. Esthablissement of *Leucaena leucocephala* cv. *Tarramba* in Eastern Indonesia. *Trop. Grasslands – Forages Tropicales.* 1: 111-113.
- Prasad, J. V. N. S., G. R. Korwar, K. V. Rao, U. K. Mandal, G. R. Rao, I. Srinivas, B. Venkateswarlu, S. N. Rao, & H. D. Kulkarni.** 2011. Optimum stand density of *Leucaena leucocephala* for wood production in Andhra Pradesh, Southern India. *Biomass Bioenergy.* 35: 227-235. <http://dx.doi.org/10.1016/j.biombioe.2010.08.012>
- Salem, A. Z. M., M. Olivares, S. Lopez, M. Gonzalez-Ronquillo, R. Rojo, L. M. Camacho, S. M. A. Cerrillo, & H. P. Meija.** 2011. Effect of natural extracts of *Salix babylonica* and *Leucaena leucocephala* on nutrient digestibility and growth performance of lambs. *Anim. Feed Sci. Technol.* 170: 27-34. <http://dx.doi.org/10.1016/j.anifeedsci.2011.08.002>
- Salem, A. Z. M., A. E. Kholif, M. M. Y. Elghandour, G. Buendia, M. D. Mariezcurrena, S. R. Hernandez, & L. M. Camacho.** 2014. Influence of oral administration of *Salix babylonica* and *Leucaena leucocephala* extract on milk production and composition in dairy cows. *Ital. J. Anim. Sci.* 13:10-14. <http://dx.doi.org/10.4081/ijas.2014.2978>
- Sharma, A. R. & U. K. Bahera.** 2010. Green leaf manuring with prunings of *Leucaena leucocephala* for nitrogen economy and improved productivity of maize (*Zea mays*)-wheat (*Triticum aestivum*) cropping system. *Nutr. Cycl. Agroecosyst.* 86:39-52. <http://dx.doi.org/10.1007/s10705-009-9272-9>
- Som, K. R.** 1996. *Practical Sampling Techniques.* 2th ed. Revised and Expanded. Marcel Dekker, Inc. New York.
- Tillman, A. D., H. Hartadi, S. Reksohadiprojo, S. Prawirokusomo, & S. Lebdoekojo.** 1983. Ilmu Makanan Ternak Dasar. Gadjah Mada University, Yogyakarta.
- Yousuf, M. B., M. A. Belewu, J. O. Daramola, & N. I. Ogundun.** 2007. Protein supplementary values of cassava-, leucaena- and gliricidia-leaf meals in goats fed low quality *Panicum maximum* hay. *Livest. Res. Rural Dev.* 19(2).
- Zurahmah, N.** 2011. Pendugaan bobot badan calon pejantan sapi bali menggunakan dimensi ukuran tubuh. *Bul Petern.* 35: 160-164.