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Survey of Bali bull fattening practices in central Lombok, eastern Indonesia, based on feeding of *Sesbania grandiflora*

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Abstract. A longitudinal survey was conducted in 2013 to document the productivity of the *Sesbania grandiflora* feeding system for cattle fattening in central Lombok. Sesbania is integrated into the intensive rice-growing region by planting it along the rice bunds surrounding the rice fields. The hamlet of Nyerot in the subdistrict of Jonggat was chosen for the study as it had a long history of successful use of sesbania for fattening Bali bulls. Parameters measured included: area of rice paddy where sesbania could be planted; forage establishment, harvesting and feeding practices; cattle purchases and sales; and monthly liveweight gain. Farmers planted an average of 406 sesbania trees on bunds surrounding 0.6 ha of rice paddy. The median values for the main forages fed (dry matter offered) were harvested elephant grass (78% of diet), sesbania (12% of diet) and other feeds (mainly rice bran) (5% of diet). Sesbania was harvested by lopping the lower side branches of ~6 trees per bull per day and never completely defoliating single trees. The farmers fattened an average of 1.6 bulls at a time achieving a yearly mean liveweight gain of 0.41 kg/bull.day. New bulls were purchased with an average liveweight of 203 kg while the average sale weight was 260 kg. Purchase and sale prices were high at A$3.27 and A$3.29, respectively, while the average fattening period was 5 months. Bull liveweight gains were related to total amount of forage fed. No direct statistically significant link between liveweight gains and amount of sesbania fed was obtained due to the multiple factors that influenced forage and bull management. This survey has provided new insights into the practice of bull fattening in central Lombok. The survey has confirmed the high productivity of the feeding system and has highlighted the opportunity to scale out the use of system to other regions.

Additional keywords: Bali cattle, growth rate.

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Introduction

The Indonesian provinces of West Nusa Tenggara and East Nusa Tenggara have excellent potential for expansion of their smallholder beef enterprises. Provincial agencies promote cattle fattening as one of the most important ways to improve the incomes of the rural poor. Currently, their fattening systems are characterised by irregular and low turn-off of animals of poor carcass quality. This largely results from poor nutrition of cattle managed under traditional smallholder feeding systems which rely on communal grazing of overstocked and weedy native pastures.

Expanded feeding of forage tree legumes (FTL) offers the best opportunity for improving the nutrition of ruminants on poor quality diets, especially in the dry season. The value of FTL has been demonstrated repeatedly throughout the tropical world ranging from direct grazing in Australia (Shelton and Dalzell 2007) to cut-and-carry feeding of goats in Thailand (Phaikaew *et al*. 2012). In eastern Indonesia, there are two significant examples where farmers have been able to enhance the protein nutrition of ruminants by feeding leaf of FTL. These are sesbania (*Sesbania grandiflora*) in central Lombok and leucaena (*Leucaena leucocephala*) in West Sumbawa (Panjaitan *et al.* 2013). This paper examines the utilisation of sesbania.

Sesbania is indigenous to South-east Asia including Indonesia. It is a fast growing, multi-purpose tree legume used in the rice-growing region of central Lombok Island for the fattening of Bali cattle (*Bos javanicus*). It also provides pole timber, fuelwood, organic fertiliser and even human food in the form of flowers, young pods and young leaves. Farmers in Lombok have established a unique and highly productive integrated farming system by planting sesbania trees along the bunds of rice paddies without significantly compromising rice yield (Dahlanuddin *et al.* 2005). To our knowledge this system is not practised elsewhere in South-east Asia.

The purpose of this longitudinal study was to gain a detailed understanding of the unique sesbania feeding system used in Lombok. Quantitative data are needed to inform training programs and extension messages for farmers in other regions of Lombok, and more generally in Indonesia and South-east Asia. Given that cattle are commonly integrated with rice farming throughout South-east Asia, sesbania feeding has enormous relevance in the region. Our specific objective was to select a representative hamlet using sesbania for cattle fattening and then to characterise the system.

Materials and methods

The first requirement was to locate a representative site for the study. The hamlet of Nyerot (8°40′S, 116°13′E) in the subdistrict of Jonggat was chosen following a situation analysis commencing in May 2011. The survey was conducted from January to December 2013. Criteria used to select the village were: existing use of sesbania as cattle feed in a predominant cattle fattening enterprise; private land ownership; village location and accessibility; and group functionality. Visits were made to relevant subdistrict offices (local government, livestock department, extension centre); and discussions were held with village group officials, extension officers, and hamlet representatives using a matrix ranking exercise for hamlet selection. The situation analysis profiled the needs and opportunities for improving the cattle fattening system from the perspectives of the various stakeholder groups. Analysis and final selection was completed in November 2011. This process ensured that the hamlet of Nyerot was representative of best practice for fattening cattle using sesbania grown on the rice paddy bunds.

In the hamlet, 34 farmers were independently fattening one or two bulls each but operated as a group in a shared cattle barn (for security reasons). The land surrounding the hamlet was flat, and had irrigation available. Farmers practised double cropping with rice followed by a single crop of peanut or soybean in the dry season.

Parameters measured in the longitudinal survey were: climatic conditions; area of land for rice and length of rice bunds planted to sesbania; agronomy and management of sesbania trees; monthly bull liveweights following overnight fasting; purchase and sale weights from February to October 2013. Feed measurements were made on three consecutive days per month during February and March and 6 consecutive days per month from April to October. The fresh weight data were converted to dry weights using unpublished dry matter contents from similar feeds (Tanda Panjaitan, unpubl. data).

Results and discussion

Climate

Central Lombok has a tropical climate with an annual rainfall of 1500 mm, 85% of which falls in the wet season from October to April. The temperatures range from 24.0–33.1°C in December to 22.3–28.5°C in July. In 2013, 1517 mm of rain fell almost entirely from January to June and in December.

Sesbania plant management and growth

Observations and measurements indicated that an unnamed local variety of sesbania was normally transplanted in single rows along the bunds of rice paddies. Dry season seed-fall provided seedlings in the early wet season for transplanting in December when rice land was being prepared. The average spacing was 1.5 m (range 1–2 m) and the average number of trees planted in 2013 was 406 ± 55 per farmer (range 70–1000) (Table 1). In response to questions, farmers indicated that the sesbania trees had no discernable deleterious effect on rice yields.

The limited areas of rice land (average area 0.6 ± 0.1 ha, range 0.1–1.5 ha) constrained the length of bund available for planting sesbania trees. For instance, measurements in the Nyerot region indicated that the length of rice bund per ha of land varied from 250 to 1000 m/ha depending on the size of rice paddies, which was often determined by slope. Rice paddies were smaller on sloping land, resulting in increased length of bunds. These data suggest that tree plantings are limited to 167–667 trees/ha if plant spacing was ~1.5 m, which ultimately would restrict the maximum amount of sesbania available for feeding bulls.

The growth of sesbania was rapid. Seedlings (n = 265) transplanted on 6 December 2011 were monitored and reached a height of 498 ± 8 cm after 1 year (by 13 December 2012). Growth was initially slow following transplanting and slowed again in May and June coincident with rice harvest when pest and disease challenges (aphid, caterpillar, grasshopper, assassin bug, spider mite, fungus) temporarily transmigrated from rice plants to sesbania trees. Some farmers practised removal of apical tissue from young plants (<3 months) to encourage branching, while other farmers removed lower branches of young trees to encourage extra height and pole quality.

Observations indicated that first harvest of foliage occurred at first flowering when the trees were 6–9 months old and

Table 1. General data on areas of land, bull number and feeding management in Nyerot, central Lombok

Item	Mean	s.e.	Range
General			
Area of rice land (ha)	0.6	0.1	0.1–1.5
Number of bulls	1.6	0.2	1–5
Feeding data – grass and sesbania			
Distance walked to collect forage (m)	235	34	10–500
Type of grass harvested	Elephant grass	n.a.	n.a.
Frequency of feeding bulls (times per day)	2.5	0.1	2–3
No people involved in collection of forages	1.6	0.1	1–3
Number of sesbania trees	406	55	70–1000
Number of sesbania trees harvested per day	9.4	0.8	4–15
Interval between harvest of trees (days)	25.5	3.4	7–60
Interval between offering sesbania (days)	1.7	n.a.	1–3 days

2.5–3 m in height. Local practice harvesting technique was to cut 2–3 of the lowest, and therefore oldest, side branches from ~6 trees per bull.day (range 4–15 trees) depending on the amount needed (Table 1). Farmers reported that removal of younger branches and leaves or complete defoliation reduced the growth rate of sesbania trees. The average interval between harvest of sesbania trees was 25 ± 3.4 days (range 7–60 days) (Table 1). The average distance walked to harvest forage (all types) was 235 ± 34 m (range 10–500 m). The principal component of harvested forage was elephant grass (*Pennisetum purpureum*). The mean number of family members involved in collecting forage was 1.6 ± 0.1 people (range 1–3 people) (Table 1).

There was no local information concerning availability of different sesbania varieties, and no source of regular seed supply. Technical information on sesbania agronomy was also lacking. For instance, there was no agreed standard spacing or harvest methodology that maximised biomass production. Gathering this information should be an objective of future work.

Bull number and liveweight gains

The average number of bulls monitored was 24.2 bulls, owned by up to 20 farmers in any given month (Table 2). Housing and hygiene provided in the cattle barn were adequate. All bulls were drenched with an anthelmintic (albendazole) on arrival. Other work has demonstrated that this confers control of nematode but not trematode infections (Astiti *et al*. 2013). Average monthly liveweight gain (LWG) for the year was 0.40 ± 0.04 kg/bull.day. This varied over time from 0.59 ± 0.04 kg/bull.day in January, early in the wet season, to 0.24 ± 0.05 kg/bull.day in August when less grass was available. However, mean village liveweight gain was lowest in December (0.22 ± 0.05 kg/bull.day) when there was less labour available for harvesting grass as villagers prepared their land for the first wet season rice planting.

The weight gain of the best performing bull/s (often different bull/s each month), however, averaged above 0.82 ± 0.05 kg/bull.day over the 12 months of measurement. The first month's LWG of each bull was excluded due to the effect of compensatory LWG when bulls in poor condition were first introduced to the FTL feeding system. These data indicated that several farmers had sufficient forage resources and knowledge of feeding and nutrition to achieve close to the potential liveweight gain for Bali bulls (0.85 kg/bull.day) reported by I. M. Mastika (2003).

Average growth rates, and certainly the best growth rates, were higher than previously recorded data: namely 0.38 kg/bull.day for bull calves of similar age fed 30% sesbania (Dahlanuddin *et al.* 2013*a*) and 0.26–0.34 kg/bull.day for fattening systems generally in West Nusa Tenggara (Deblitz and Kristedi 2011). Our data are much higher than that achieved in traditional grazing systems (0.20 kg/bull.day) comprising diets of predominantly local grass species (Dahlanuddin *et al.* 2013*b*).

Feeding strategy

Fresh weights of the various feed components were converted into dry forage using the dry matter (DM) proportions: grass – 20%, sesbania – 25%, rice bran – 85%, peanut/soybean residue – 40%

Table 2. Village bull fattening, liveweight gain and purchase/sale data for the hamlet of Nyerot, central Lombok in 2013

Parameter	Mean for year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. of farmers	17.2 ± 0.5	15	15	17	19	15	16	17	17	19	19	20	17
No. of bulls weighed	24.2 ± 1.0	21	21	25	28	22	23	24	26	27	27	24	22
Avg. weight gain (kg/bull.day)	0.40	0.59	0.56	0.37	0.35	0.38	0.35	0.29	0.24	0.52	0.42	0.54	0.22
(s.e.)	0.04	0.04	0.04	0.05	0.05	0.03	0.04	0.03	0.05	0.04	0.03	0.04	0.05
Best weight gain (kg/bull.day)	0.82 ± 0.05	0.88	0.86	0.78	0.79	0.68	0.79	0.58	0.73	0.79	0.74	0.79	0.61
Lowest weight gain (kg/bull.day)	0.02 ± 0.06	0.34	0.24	–0.15	–0.26	0.13	–0.03	0.06	–0.37	0.14	0.09	0.15	–0.13
No. animals purchased/month	5.5 ± 1.1	138	3	0	4	7	10	4	2	6	2	5	10
No. animals sold/month	4.6 ± 0.6	5	1	6	4	7	2	8	4	4	3	7	4
Purchase weight (kg)	203 ± 7	191	226	n.a.	184	189	187	202	230	201	225	236	157
Sale weight (kg)	260 ± 11	290	201	263	219	299	287	227	249	319	224	285	261
Purchase price (A$/kg)	3.27 ± 0.07	3.22	3.31	n.a.	3.21	3.24	3.08	2.91	3.35	3.16	3.18	3.45	3.81
Sale price (A$/kg)	3.29 ± 0.07	3.55	3.17	3.08	3.09	3.19	3.19	2.99	3.1	3.6	3.28	3.52	3.72

(Tanda Panjaitan, unpubl. data). Feeding strategies from February to October 2013 are represented by a box plot analysis (Fig. 1).

Bulls were fed on average 2.5 ± 0.1 times daily with total forage offered of 4.8 ± 0.1 kg DM/bull.day (range 1.3–11.3 kg DM/bull.day). The majority and most consistent component of bull diets was cut elephant grass collected from around the rice fields (Fig. 1). The annual median value was 78% of diet, with monthly median values ranging from 57% to 90% of diet. Farmers fed sesbania to their bulls less consistently once every 1.7 days (range 1–3 days). The median yearly proportion was 12% but monthly medians varied from a high of 22% in February to none in May and September as availability of sesbania and/or labour was reduced. The overall median proportion of other feeds (mainly rice bran) was 5% and varied monthly from 0% to 11% among months. Peanut and soybean resides were offered only in October (while many farmers did not have access, other farmers fed up to 56%). Banana stem was a minor component of bull diets in all months (data not shown).

A comprehensive analysis was performed on the feeding data to examine factors related to bull performance including total forage offered, amount of sesbania in diet, number of sesbania trees planted, and area of rice paddy. These analyses were completed using yearly average data, mean values for individual farmers, and for individual bulls. While there was a positive linear correlation between monthly liveweight gains and amount of feed offered ($P = 0.02$), it was not possible in this study to establish a statistically significant link between animal performance and other factors including level of sesbania feeding. We suggest several possible reasons for this lack of association, namely: (1) The high level of elephant grass in diet which was of variable quality; (2) variability in the feed offered data (collected on only 3–6 days per month); (3) variability in genetic growth potential of the bulls; (4) variability in weaning and early feeding management before entering the stalled feeding system; and (5) general management, especially gastro-intestinal parasite control, of stalled bulls which varied with individual farmers.

Thus while a statistical link between increased sesbania feeding and increased LWG could not be confirmed, this was nevertheless an important result as it demonstrated that improving liveweight gains in village environments is not just a matter of increasing sesbania feeding but requires attention to all aspects of bull management. Nevertheless, other work has clearly demonstrated the value of incorporation of sesbania in diets of Bali bulls (Dahlanuddin *et al.* 2012, 2013*a*); thus the nutritional value of dietary sesbania cannot be discounted by the lack of statistical association.

Observations of the practices of the farmers with the highest weight gains supported this conclusion. The best farmers: (1) had good skills in selecting feeder stock for fattening (frame, age

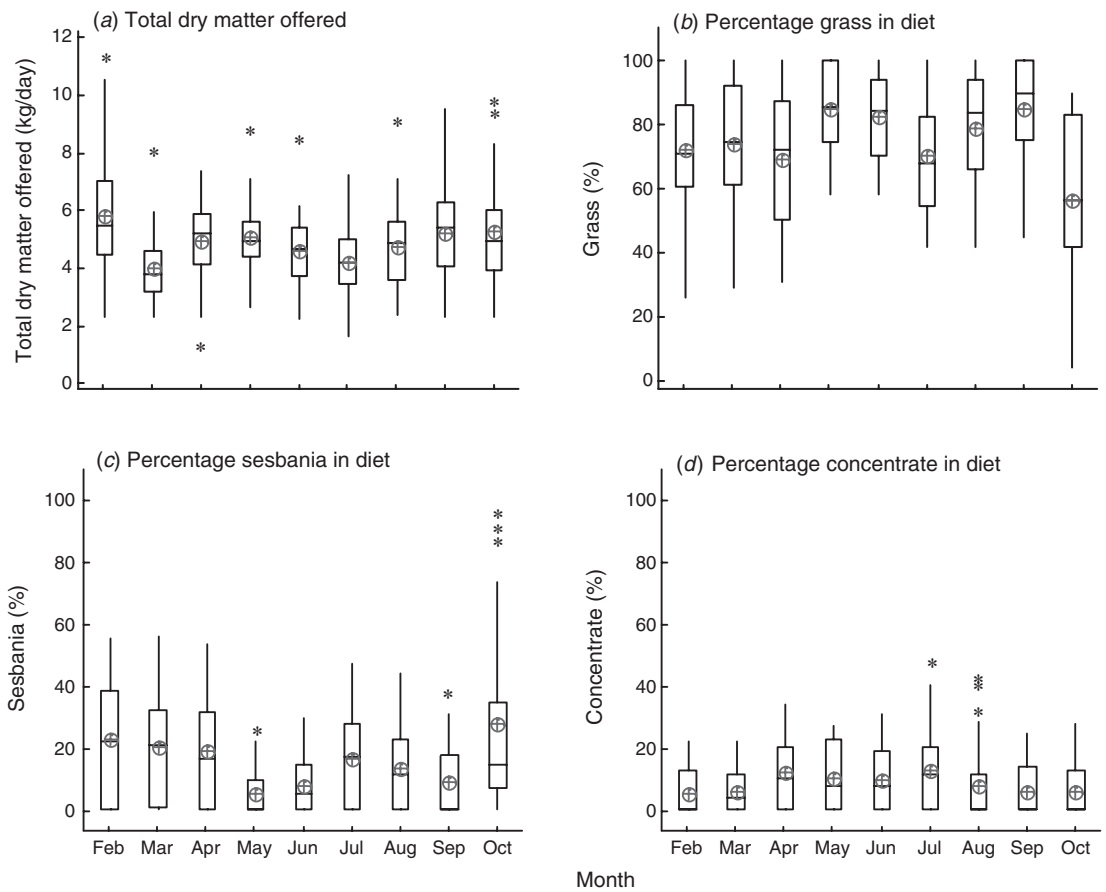

Fig. 1. Box plot analysis of monthly feeding strategies by farmers in Nyerot from April to October 2013.

and health); (2) fed good quality green forage and fed sesbania daily; (3) frequently offered low cost feed supplements such as tofu waste and rice bran; (4) owned more land with more sesbania trees and were able to feed greater amounts of sesbania; and (5) employed better cattle hygiene and pen sanitation.

Purchase and selling practices

The average purchase weight was 203 ± 7 kg with the highest purchase weight of 236 kg in November and the lowest of 157 kg in December (Table 2). The average sale weight was 260 ± 11 kg with the highest of 319 kg in September and the lowest of 201 kg in February. The average difference between purchase and sale was 56 kg (range –16 to 165 kg) with an average fattening period of 5 months (range 1–12 months).

Most bulls were sold before they reached the recommended sale weight of 300 kg although 33% of bulls sold reached this target sale weight. This meant that dressing % of these lighter bulls would be less than 50%, indicative of inefficient fattening practice (Deblitz and Kristedi 2011). These latter researchers also reported purchase weight ranges of 70–220 kg and sale weight ranges of 180–275 kg. The target weight could be achieved by increasing daily weight gains and by extending the period of fattening e.g. a fattening period of 200 days with an average LWG of >0.5 kg/bull.day. This will require an increase in amount and consistency of feeding of sesbania; and an improvement in the current knowledge and skill of farmers in the nutrition and feeding of bulls.

Both purchase and sale weights were determined by economic circumstances and market demand. Purchase weight was influenced by the amount of loan funds received from the bank (younger and smaller bulls were cheaper), and since most farmers did not have other sources of immediate cash they were often unable to keep their bulls longer than 4 months, selling when funds were needed.

The average purchase and sale prices of A$3.27/kg and A$3.29/kg, respectively, were higher than Australian prices. Gross profit margin was driven by length of fattening period, month of sale and price per kg. Sale of bulls in December (A$3.72/kg) (end-of-year celebrations), and September (A$3.60/kg) (Ramadan) made greatest profit margins. Use of scales provided greater certainty to farmers when negotiating sale price with traders.

Conclusions

This survey has provided new insights into the practices and productivity of sesbania feeding systems in central Lombok. While a specific association between liveweight gain and sesbania was not obtained, the survey has confirmed the high productivity of the system, especially compared with traditional systems, and highlighted the opportunity to increase the productivity of bull fattening enterprises in rice-growing areas where sesbania can be integrated and bull management is skillful.

Sesbania plantings currently cover ~25% of the island's rice field bunds (Dahlanuddin *et al*. 2005). Since there are over 50 000 ha of rice paddy in central Lombok (~12 500–50 000 km rice field bunds), increased plantings of sesbania into new and existing areas, and adoption of best practices as outlined in this study, would significantly increase the number and productivity of ruminant livestock on the island. The system is also highly relevant elsewhere in South-east Asia where cattle are integrated with rice paddy production.

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