Economic analysis of on-farm feeding strategies to increase post-weaning live weight gain of Bali calves[1]

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ABSTRACT: Feeding strategies to increase live weight gain of early weaned Bali calves were evaluated at the farm level at Central Sulawesi, East Java, East Nusa Tenggara and West Nusa Tenggara Provinces in Indonesia. The objective of this study was to identify opportunities for increased profit above feed costs on-farm through implementation of best-bet feeding strategies to increase live weight gain of early weaned Bali calves. A total of 53 feeding strategies were evaluated in 14 on-station experiments conducted at research stations within each of the four provinces. The best-bet feeding strategy at each site was then implemented, monitored and adapted on-farm in villages within each province for a period of 6 months. Parameters observed included growth rate of weaned calves along with input and output prices. The results indicated that the highest profit above feed cost was achieved through supplementation of commonly utilized low quality feeds with feeds high in crude protein, such as *Leucaena leucocephala* (East Java and East Nusa Tenggara), *Sesbania grandiflora* (West Nusa Tenggara) or copra meal mixed with rice bran (Central Sulawesi). The revenue over cost (R/C) varied between the sites, and ranged from 2.5 to 7.5, with profitability ranging from Rp. 1.1 to 2 million/head/6 months. The results indicate that there is considerable potential to change feeding management practices of weaned Bali calves, to increase live weight gain and farmers' income based on the availability of local feed resources. Tree legumes, such as *Leucaena leucocephala* and *Sesbania grandiflora*, have not been optimally utilized as a feed resource for Bali cattle in Indonesia but do provide the greatest potential to increase farm income, due to their availability and the live weight gain response. A low external input system is a crucial aspect for the profitable raising of Bali cattle by farmers in Indonesia.

Key words: profit, feeding strategies, post weaning, and Bali calves

INTRODUCTION

Bali cattle are the predominant cattle breed in Indonesia and have the potential to make a significant contribution to the development of the Indonesian beef cattle industry. The population of Bali cattle is approximately 4.2 million head, or about 33% of the total beef cattle population in Indonesia. Bali cattle are primarily kept by smallholder farmers (1.5 million households; Ditjen Peternakan, 2009) located in Bali, West Nusa Tenggara, East Nusa Tenggara, South Sulawesi, South Kalimantan, Lampung and South Sumatra (Ditjen Peternakan, 2010). Bali cattle systems may involve both cow-calf operations or fattening enterprises which turn animals of for slaughter. Bali cattle

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farming makes a significant contribution the household income of smallholder farmers, approximately 10-50% of household income in East Nusa Tenggara (Bamualim and Retnada, 2005), and consequently to the livelihoods of smallholder farmer households.

Bali cattle have characteristics which make them well suited to the smallholder farming systems of Indonesia. Bali cattle are well adapted to the tropics and perform well when feed quality declines, they are fertile, and have good carcass and meat quality. However, Bali cattle have constraints to the growth and size of animals, so that in some areas its condition has shown a decline in growth rate and mature size (Diwyanto and Priyanti, 2008). One reason for the lower growth rates is due to the shortage of available local feeds during the dry season, meaning that the genetic potential of Bali cattle cannot be fully achieved. A recent review of Bali cattle feeding and growth reported a large variation in growth rates across a range of experiments (Marsetyo, *et al*., 2006). However, these experiments rarely investigated the response of weaned Bali calves to various feeds. Panjaitan *et al*. (2008) has shown that there is a need to implement feeding strategies where early weaned calves are fed with high protein feeds at a rate of at least 10 g DM/kg live weight per day. This will increase calf growth rates and promote more efficient feed resource use that in turn will increase the population of the Bali cattle herd in Indonesia. However, the economic feasibility of the suggested feeding strategies has not been reported. The objective of this paper is to quantify the economic benefit of the best bet feeding strategy of the weaned Bali calves in response to the profit above feed cost. The results can be used in developing the profitable options for increasing post-weaning growth of Bali calves at the farmers' level.

MATERIALS AND METHODS

A total of 53 feeding strategies were evaluated in 14 on-station experiments conducted at Central Sulawesi (Tadulako University), East Java (Beef Cattle Research Institute), West Nusa Tenggara (Mataram University) and East Nusa Tenggara (BPTP Kupang). Each experiment measured feed intake, digestibility and live weight gain of weaned Bali calves. A best bet feeding strategy at each station was introduced and then implemented, monitored and adapted in villages in each province for a period of 6 months. Based on the results of the on-station studies conducted at each station and the availability and price of feedstuffs for farmers, the best bet feeding strategy to enhance the growth of the weaned Bali calves was *Leucaena leucocephala* supplementation, *Sesbania grandiflora* supplementation, *Leucaena leucocephala* and forage legume supplementation, and a mixture of rice bran and copra meal, in East Java, West Nusa Tenggara, East Nusa Tenggara and Central Sulawesi, respectively (Quigley *et al*., 2004).

The experiments were conducted at geographically diverse regions across eastern Indonesia. This allowed feeding strategies to be developed within the context of different environmental conditions, different cattle management systems and different feed resources. At each site at least 20 Bali calves were introduced to the best bet feeding strategy. This strategy included weaning the calf at 6 months of age, feeding the calf the best bet feeding strategy and monitoring calf live weight each month over a 6-month period. This means that weaned calves were fed feeding strategies from 6 to 12 months of age, with the amount of supplementation offered adjusted at each monthly weighing according to the live weight of the calf. The live weight gain response of calves to the introduced feeding strategies was compared to the live weight gain of calves of a similar age managed under the prevailing feeding system either from the same, or a nearby, village. The parameters measured included live weight (which was used to determine average daily gain over the six-month period), feed intake as fed, input costs and the output price of the cattle.

Several approaches are available to quantify the economic benefits of any new animal technology. In this case, the technology was the robust feeding strategies developed to increase growth rates of the anticipated increased number of early-weaned Bali calves across eastern Indonesia. A partial budget analysis is one of its approaches that is simple to use and provides information about changes in costs and benefits caused by the implementation of the feeding strategies (Amir and Knipscheer, 1989). It is a method of balancing and examining the total gains (benefits) and losses (costs) that can be affected by the response in growth rate over a certain period of time. The major production costs were feed-

related. The feeding strategies were economically evaluated based on their profits, defined as returns from a unit of production minus its production costs.

Live weight gain is usually highly correlated with feed efficiency for growing animals. Based on the live weight gain, the profit above feed cost can be estimated as follows (Weller, 1994):

$$I = \Delta Q * P_Q - k * P_k$$

Where,

I = profit above feed cost (Rp/period)
ΔQ = live weight gain of the weaned calf (kg/d)
k = total amount of feed (kg/d)
P_k = price of feed cost (Rp/d)
P_Q = price of cattle (Rp/kg live weight)

The production cost is related to the feed cost which is the cost for the given feeding strategies, estimated using the current market price for each component. The labor cost to manage and to feed the animals were not taken into account as this was considered as an opportunity cost. The live weight gain multiplied by the rearing period and the cattle market price generate the revenue and yield its profit above feed cost for each feeding strategy.

Farmers were invited to visit the initial on-station experiments and field days were held at each of the village sites. Farmers were surveyed at on-station visits and at the commencement and conclusion of the village study period to ascertain their perceptions to the feeding strategies implemented in their villages.

RESULTS AND DISCUSSION

Best bet feeding strategies from the on-station studies and early weaning were implemented, monitored and adapted at each site and compared with calves managed under the prevailing conditions, which served as a control. The control feeding practice typically consisted of native grass and crop residues in East Java, native grass and gliricidia in West Nusa Tenggara, native grass and local legumes in East Nusa Tenggara, while that in Central Sulawesi was free grazing native grass on roadsides or in areas surrounding crops and plantation. The results indicated that supplementation of leucaena, sesbania, rice bran mixed with copra meal, leucaena and forage legume were the best bet feeding strategies, for sites in East Java, West Nusa Tenggara, Central Sulawesi and East Nusa Tenggara, respectively.

Economic analysis was undertaken in terms of profit above feed cost, which was estimated from the response in live weight gain over the study period. The results demonstrated that strategic supplementation of the weaned Bali calves significantly increased average daily gain, except in Oebola village in East Nusa Tenggara (Table 1). The lack of a response in Oebola was attributed to the high quality feeds that were offered to cattle under the existing cattle management systems (Quigley *et al*., 2004). Leucaena and local legumes comprise a large component of the diet in Oebola sites, which is essentially the same as the leucaena and forage legume treatments implemented.

Economic analysis showed that the profit above feed cost of farmers that implemented the best bet feeding strategy in villages was higher compared to the control farmers, except in Oebola village in East Nusa Tenggara. The highest profit was achieved by implementation of the feeding strategies in Central Sulawesi, followed by East Java (Table 2). This yielded higher revenue over feed cost (R/C) in Central Sulawesi and East Java of 7.5 and 5.9, respectively. In Central Sulawesi, the R/C of the introduced feeding strategy was lower than that of the existing conditions, due to a smaller change in revenue relative to total feed cost. The profit above feed cost of farmers in West Nusa Tenggara and Usapinonot village in East Nusa Tenggara were Rp 7,405.00,/hd/d and Rp 5,730.00/hd/d (Treatment 1) and Rp 4,445.00/hd/d (Treatment 2), respectively, with R/C of 2.5, 4.5 and 4.9, respectively (Table 3).

Table 1. Average daily live weight gain of Bali calves with strategic supplementation[1]

Site	Average live weight gain (kg/d)			SEM[2]
	Control	Treatment 1	Treatment 2	
East Java[3]	0.179[a]	0.418[b]	N/A[2]	0.03
West Nusa Tenggara[4]	0.216[a]	0.353[b]	N/A	0.02
East Nusa Tenggara – Oebola[5,6]	0.359[b]	0.288[ab]	0.266[a]	0.05
East Nusa Tenggara – Usapinonot[5,6,7]	0.115[a]	0.308[c]	0.233[b]	0.04
Central Sulawesi[8]	0.289[a]	0.428[b]	N/A	0.02

[1] Quigley *et al*. (2009).
[2] Values are treatment means; SEM is standard error of differences of the means; N/A not applicable as only one treatment was implemented in the site.
[3] Treatment 1 was leucaena fed at approximately 10 g DM/kg W.d.
[4] Treatment 1 was sesbania fed at approximately 10 g DM/kg W.d.
[5] Treatment 1 was leucaena fed at approximately 15 g DM/kg W.d.
[6] Treatment 2 was forage legumes (*Clitoria ternatea*, *Centrosema pascuorum*, *Stylosanthes hamata* and *Lab lab purpureus*) fed at approximately 15 g DM/kg W.d.
[7] Study was conducted from 6 to 15 months of age.
[8] Treatment 1 was rice bran and copra meal mixed in equal proportions as fed and fed at approximately 10 g DM/kg W.d.

Table 2. Profit above feed cost of weaned Bali calves fed different diets under village conditions

Parameter	Feeding management system	
I. East Java	Control	Control + leucaena
Feed intake, kg/hd/d, as fed	10.29	(6.76 + 5.6)
Feed price, Rp/kg, as fed	150	(150 + 200)
Experimental period, d	184	184
ADG, kg/d	0.179	0.418
One year cattle price, Rp/kg W	30 000	30 000
Total feed cost, Rp/hd/period	284 004	393 024
Total revenue, Rp/hd/period	988 080	2 307 360
Profit, Rp/hd/period	704 076	1 914 336
R/C	3.48	5.87
II. West Nusa Tenggara	Control	Control + sesbania
Feed intake, kg/hd/d, as fed	15	(10 + 7)
Feed price, Rp/kg, as fed	250	(300 + 350)
Experimental period, d	180	180
ADG, kg/d	0.216	0.353
One year cattle price, Rp/kg W	35 000	35 000
Total feed cost, Rp/hd/period	675 000	981 000
Total revenue, Rp/hd/period	1 360 800	2 223 900
Profit, Rp/hd/period	685 800	1 242 900
R/C	2.02	2.27
III. Central Sulawesi	Control	Control + rice bran + copra meal
Feed intake, kg/hd/d, as fed	7.58	(6.43 + 1.15)
Feed price, Rp/kg, as fed	150	(150 + 650)
Experimental period, d	181	181
ADG, kg/d	0.289	0.428
One year cattle price, Rp/kg W	30 000	30 000
Total feed cost, Rp/hd/period	205 797	309 872
Total revenue, Rp/hd/period	1 569 270	2 324 040
Profit, Rp/hd/period	1 363 473	2 014 168
R/C	7.63	7.50

The results show that farmers in East Java, West Nusa Tenggara and Usapinonot village in East Nusa Tenggara, yield a higher profit from implementing the best-bet feeding strategies compared to farmers that maintained the existing management practices. In East Java, the inclusion of leucaena in the diet resulted in a R/C of 5.87 compared to that of 3.48 for the control. In West Nusa Tenggara, the inclusion of sesbania in the diet resulted in a R/C of 2.27 compared to that of 2.02 for the control. In Usapinonot village, East Nusa Tenggara, the inclusion of forage legumes or leucaena in the diet resulted in a R/C of 4.87 and 4.45, respectively, compared to that of 1.66 for the control. This difference in R/C between introduced and control strategies at Usapinonot was the greatest across all villages and feeding strategies implemented due to the response in live weight gain attained with minimal feed costs associated with the additional inputs.

The use of rice bran and copra meal as a supplement to the basal diet of the weaned Bali calves in Central Sulawesi resulted in a small decrease in the profits of farmers. This was due to the large cost of the rice bran and copra meal inputs relative to the modest increases in live weight gain and, hence, revenue.

In Oebola village in East Nusa Tenggara, the inclusion of forage legumes in the diet resulted in a greater profit above feed cost (4.3) compared with the control (4.0). However, supplementation with leucaena resulted in a profit above feed cost which was lower (3.2) than that of the control. These results indicate that the existing feeding management in the village is more proftibale to farmers than the introduced feeding strategies and farmers should continue with their prevailing feeding management in Oebola.

Table 3. Profit above feed cost of weaned Bali calves fed different diets in the villages in East Nusa Tenggara

Parameter	Feeding management system		
I. Oebola	Control	Control + leucaena	Control + forage legumes
Feed intake, kg/hd/d, as fed	8.58	(3.8 + 4.78)	(3.8 + 2.12)
Feed price, Rp/kg, as fed	250	(250 + 250)	(250 + 250)
Experimental period, d	182	182	182
ADG, kg/d	0.359	0.288	0.266
One year cattle price, Rp/kg W	24 000	24 000	24 000
Total feed cost, Rp/hd/period	390 390	390 390	269 360
Total revenue, Rp/hd/period	1 568 112	1 257 984	1 161 888
Profit, Rp/hd/period	1 177 722	867 594	892 528
R/C	4.02	3.22	4.31
II. Usapinonot	Control	Control + leucaena	Control + forage legumes
Feed intake, kg/hd/d, as fed	6.65	(2.95 + 3.7)	(2.95 + 1.64)
Feed price, Rp/kg, as fed	250	(250 + 250)	(250 + 250)
Experimental period, d	196	216	216
ADG, kg/d	0.115	0.308	0.233
One year cattle price, Rp/kg W	24 000	24 000	24 000
Total feed cost, Rp/hd/period	325 850	359 100	247 860
Total revenue, Rp/hd/period	540 960	1 596 672	1 207 872
Profit, Rp/hd/period	215 110	1 237 572	960 012
R/C	1.66	4.45	4.87

Farmers' perceptions of the implemented feeding strategies to enhance live weight gain of weaned Bali calves were also surveyed using a structural questionnaire. The majority of farmers who attended the on-station demonstrations conducted at the end of each experiment indicated that the visit had changed farmers' perception on weaning and feeding calf management and were likely to implement change in their own management system. Pamungkas *et al*. (2008) had reported that a large number of farmers (84%) practiced weaning in the average of 5.7 months of age as a management strategy, while the remainder did not practice weaning and allowed the cows to wean the calves naturally. Even though farmers initially expressed concerns about feeding leucaena to calves due to low palatability, upon completion of the 6 month study period around 82% of the farmers were willing to adopt the

leucaena supplementation strategy in an attempt to increase live weight gain of the weaned Bali calves.

The average number of Bali cattle owned by smallholder farmers in Indonesia is approximately 2 cows per household. By enhancing the productivity of Bali cattle through feeding and management systems (early weaning and preferential feeding) to achieve one calf per cow per year, each household will potentially have two calves for sale per year. The profit per household of raising two weaned Bali calves from 6 to 12 months of age under the recommended feeding strategies will be Rp. 4 028 336, Rp. 3 828 672, Rp.2 485 800 and Rp.2 475 144 in Central Sulawesi, East Java, West Nusa Tenggara and Usapinonot village in East Nusa Tenggara, respectively. This figure is the equivalent of 15-25% of the minimum regional wages paid by the Government of Indonesia, excluding tax. To further add value to Bali cattle farming at the household level, an increase in the number of cows owned by each household, from 2 cows to 4 cows, would be required. This will also empower farmers as small producers in agribusiness and facilitate better access to production factors and economic returns.

CONCLUSIONS

The implementation of the best-bet feeding strategies at each of the sites resulted in an increase in smallholder profits over the 6-month feeding period, compared with the prevailing practices (control) over the same period, with the exception of Oebola village in East Nusa Tenggara where there was no difference. The inclusion of tree legumes in the diet of weaned Bali calves will result in increased annual household cash flow compared with the existing feeding strategies.

In conclusion, there is considerable potential to improve the feeding management of weaned Bali calves and to increase farmers' income through the use of locally available feed resources. Tree legumes, such as leucaena and sesbania, have the greatest potential to increase profits from growing weaned Bali calves and at this stage have not been fully utilized as a feed source for Bali cattle in Indonesia. It is evident that a low cost external input system is crucial for the profitable raising of Bali cattle by smallholder farmers.

LITERATURE CITED

Amir, P. and H.C. Knipscheer. 1989. Conducting On-Farm Animal Research: Procedures and Economic Analysis. Winrock International Institute for Agricultural Development, USA and International Development Research Centre, Canada. Singapore.

Bamualim, A. and Retnada. 2005. Kearifan lokal pola penggembalaan ternak dalam system usahatani tanaman – ternak di Nusa Tenggara Timur. Makalah disampaikan dalam Seminar Sistem dan Kelembagaan Usahatani Tanaman – Ternak di Indonesia. Yogyakarta, 20-22 September 2005. Fakultas Peternakan Universitas Gadjah Mada, Yogyakarta.

Ditjen Peternakan. 2009. Statistik Peternakan. Direktorat Jenderal Peternakan. Departemen Pertanian, Jakarta.

Ditjen Peternakan. 2010. Blue Print Program Swasembada Daging Sapi 2014. Kementerian Pertanian. Direktorat Jenderal Peternakan, Jakarta.

Diwyanto, K and A. Priyanti. 2008. The use of Bali cattle on local feed resources for beef cows development in Indonesia. Indonesian Bulletin of Animal Science, Wartazoa, 18 (1). Pusat Penelitian dan Pengembangan Peternakan, Bogor. pp 34-45.

Marsetyo, D. Pamungkas and A. Priyanti. 2006. Growth performance of young Bali cattle under various feeding management. Proceedings of the 4th ISTAP Animal Production and Sustainable Agriculture in the Tropics. Yogyakarta, November 8-9, 2006. Faculty of Animal Science, Gadjah Mada University, Yogyakarta. pp. 637-642.

Pamungkas, D., S. Quigley, Y.N. Anggraeny, D. Poppi and A. Priyanti. 2008. The effect of the inclusion of *Leucaena leucocephala* leaves in the diet of weaned Bali calves of smallholder farmers in Pasuruan District, East Java. Prosiding Seminar Nasional Sapi Potong, Palu, 24 November 2008. Universitas Tadulako bekerjasama dengan Sub Dinas Peternakan, Dinas Pertanian, Perkebunan dan Peternakan Sulawesi Tengah, Palu.

Panjaitan, T., S.P. Quigley, Dahlanuddin, Marsetyo, D. Pamungkas, E. Budisantoso, A. Priyanti and D. Poppi. 2008. Management strategies to increase calf numbers of smallholder farmers in eastern Indonesia. Prosiding Seminar Nasional Sapi Potong, Palu, 24 November 2008. Universitas Tadulako bekerjasama dengan Sub Dinas Peternakan, Dinas Pertanian, Perkebunan dan Peternakan Sulawesi Tengah, Palu.

Quigley, S., D. Poppi, E. Budisantoso, Dahlanuddin, Marsetyo, S. McLennan, D. Pamungkas, T. Panjaitan and A. Priyanti. Strategies to increase growth of weaned Bali calves. ACIAR Final Report of Project: LPS/2004/023.

Weller, J.I. 1994. Evaluation of Genetic Differences from Profit Equations in: Economic Aspects of Animal Breeding. Chapman & Hall, London