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Estimating Dairy Young Stock Rearing Cost of Different Management Systems in Keningau, Sabah, Malaysia

X.T. Ang, N. Mohd Nor, M.W.H. Hiew, U. Khairuddin[1], C.T. Tan[1], M.I. Shapiai[1], N.A.M. Suhaimi[2], P.A.K. Lee[3]

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ABSTRACT

Background: Rearing young stock is costly, yet study on the economics of dairy young stock rearing in Malaysia is scarce. This study aims to determine the cost of rearing dairy young stock in different management system at the largest milk producer area located in Keningau, Sabah, Malaysia.

Methods: A survey was conducted at 7 smallholders, 6 semi-commercial sand 1 commercial dairy farms between July and August 2019 to estimate costs of rearing young stock from birth until first calving age (FCA) with the average number of milking cows as 16±2.495, 40±3.256 and 1,303 heads, respectively and the average number of young stocks was 2±0.769, 14±4.578 and 2,221 heads, respectively. Only feed costs were estimated. Data were analysed using IBM SPSS software.

Result: The average cost of rearing was RM4, 052 (USD1,000)/heifer across three different management systems, which were RM3,478 (USD858)/heifer in small scale, RM4,380 (USD1,081)/heifer) in semi-commercial and RM4,300 (USD1,061)/heifer) in commercial farms.

Key words: Dairy, Management, Rearing cost, Tropical, Young stock.

INTRODUCTION

The state of Sabah contributed 22.7% (9.2 million litres) of the total milk production in Malaysia in 2018 (DVS, 2018). Furthermore, 7.9 million litres of fresh milk produced in Sabah were produced by two commercial farms located in Keningau district contributing 90.6% (7.2 million litres) of Sabah's milk production. High input and high feed cost are the common challenges facing the dairy industry in Malaysia (Akila and Senthilvel, 2012; Sim and Suntharalingam, 2015) other than the domination of smallholders with minimal inputs and low milk yield (Saadiah *et al*., 2019).

The rearing of young stock as replacement for culled dairy cows is vital to maintain optimal herd size (Boulton *et al*., 2017) but often neglected (Moran, 2012) because it does not generate income for the farmer in the first 24 months (Hawkins, 2019). The rearing of dairy young stock in tropics is also challenged by the high tropical conditions of temperature and humidity (Moran, 2012) causing problems such as heat stress (Hernández-Castellano *et al*., 2019) and disease (Boersema *et al*., 2010), which could lower the number of replacement stock available and increase rearing costs (Mohd Nor *et al.,* 2015).

Yet, the contributions of milk, herd size and number of smallholder dairy farms in Keningau have declined by 28% in 2018 as compared to 2017 (DVS and DFAS, unpublished data). There is insufficient research information on the feed management and cost of rearing dairy young stock in Malaysia (Devendra, 1984). It is needed to study the economics of the young stock enterprise in tropics to improve decision making in rearing management and lowering the rearing costs. The objective of this research is to estimate costs of rearing dairy young stock from birth to FCA under different Management Systems on Dairy Farms in Keningau, Sabah Malaysia.

MATERIALS AND METHODS

This study was conducted by the Faculty of Veterinary Medicine, UPM. At the beginning of the study, the list of dairy farms in Keningau district (5°20'00" N, 116°10'00" E) was obtained from the Department of Veterinary Services Sabah. Data on the total milk production and herd size per farm (2017-2019) were retrieved from the Dairy Farmers' Association (PPTS) and Dairy Industry Service Centre, Sabah (PPIT). Dairy farms categorized based on the number

Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia.
[1]Universiti Teknologi Malaysia, Jalan Semarak, 54100, Kuala Lumpur, Malaysia.
[2]Universiti Sultan Zainal Abidin, Kampus Besut, 22200, Besut, Terengganu, Malaysia.
[3]Department of Veterinary Services Sabah (DVS), Wisma Pertanian Sabah, 88999, Kota Kinabalu, Sabah, Malaysia.

Corresponding Author: N. Mohd Nor, Department of Veterinary Preclinical Sciences, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia.
Email: norhariani@upm.edu.my

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of milking cows (Sahu *et al*., 2012; Suntharalingam, 2019) which were small-scale (farm with 30 or fewer cows) (n=7), semi-commercial (farms with 31-49 cows) (n=6) and commercial (farms with more than 50 cows) (n=1) were visited between July and August 2019 (Fig 2) to complete a questionnaire and to obtain yearly records of birth dates, number of living and dead young stock at different age from the semi-commercial and commercial farms.

Questionnaire

The questionnaire on rearing costs (Malay language) has 6 open-ended, 10 closed-ended and 1 semi-open questions organised into two sections; A: Background of the farm and B: Feed costs and available upon request to the corresponding author.

Data collection, editing and analysis

Equation (1) was used to calculate the cost for each type of feed at different rearing period: i) birth to weaning age (*i.e.* raw milk and CMR); ii) weaning to conception age (*i.e.* concentrate) and iii) conception to first calving (*i.e*. concentrate) in each farm.

$$\Sigma Cost\ of\ rearing = [(Price_{1,2,3..n} \times Amt_{1,2,3..n}) \times Freq) \times (Period_i)]... \quad (1)$$

Where;

$Price_{1,2,3..n}$= Market price per kg or litre of feed (Different feed type 1,2,3..n) (RM).

$Amt_{1,2,3..n}$ = Amount given for feed type *1,2,3..n* (kg or litre).

Freq= Number of feeding frequency per day (times).

$Period_i$= Number of days during rearing period *i.*

Prices for feed used included unpasteurised whole milk (RM2.90/litre), CMR (RM336/25kg), dairy cattle pellet (RM81.20/50kg), total mixed ration (TMR) (RM46.50/50kg) and palm kernel cake (RM33/50kg). Only feed costs were considered in our study (USD1=MYR 4.05 currency convert 12 December 2020) as it represents the largest rearing costs (Mohd Nor *et al*., 2015).

We calculated the annual mortality of dairy young stock by using Equation (2), assuming death of calves in semi-commercial farm occurred in the first year of life.

$$(\Sigma\ dead_n / \Sigma\ born_n) \times 100\% \quad (2)$$

Where;

$\Sigma\ dead_n$= Total number of dead young stock in year n.

$\Sigma\ born_n$= Total number of young stocks born in year n.

Data was collected and edited using Microsoft Excel version 2019 (Microsoft Corp. Redmond, WA, USA) and analysed descriptively using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA).

RESULTS AND DISCUSSION

Farm background

All of the surveyed farms in this study used milking machine for collecting milk from dairy cows. Only the commercial farm has milk processing plant; the other farms sold their milk to Dairy Industry Service Centre, Sabah (PPIT). From 2017 to 2019, milk production decreased by 18% in smallholder farms but increased by 42% in the commercial farms and showed fluctuating trends in the semi-commercial farm (Table 1). The decreased milk production observed in smallholder dairy farms coincided with decreasing herd sizes during the period. However, the semi-commercial farms showed a higher milk production despite decreasing herd sizes. This phenomenon represents a trend towards specialisation and greater scale in commercial farming (ERSUS, 2006).

The cost for rearing a dairy replacement heifer

Our study showed that the average cost of rearing was RM3,478 (USD858)/heifer on the smallholder dairy farms, lower than costs of rearing at the semi-commercial dairy farms RM4,380 (USD1,081/heifer) and the commercial dairy farms RM4,300 (USD1,061/ heifer) (Fig 1). The average cost of rearing was lower than previous studies in The Netherlands (Mohd Nor *et al*., 2015), United States (Heinrichs *et al*., 2013) and United Kingdom (Hawkins, 2019) (Table 3) however the comparison is difficult due to different currency and management. Small holder farms in our study did not keep proper records on feeding, therefore costs after breeding to FCA could not be estimated in agreement with a previous study (Lokhande *et al*., 2012). However, the FCA in smallholder farms were on average higher than previous findings by (Moran and Brouwer, 2013) in tropical countries (30-36 months) could increase herd level costs (Mohd Nor *et al*., 2015). The FCA of the commercial farm falls within the recommended range for farms in tropical countries that uses Holstein crossbreeds (Konkruea *et al*., 2017) and could be due to proper breeding (Eastham *et al*., 2018), nutrition (Konkruea *et al*., 2017) and farm management (Moran, 2012).

This study revealed the period from birth to weaning as the most expensive rearing period among different management systems (Table 3) in agreement with a previous study (Hawkins *et al*., 2019). Calves in all farms (n=14) were fed an average 5.2±2.42 litres of cow's milk or calf milk replacer (CMR) twice daily which is higher than the recommended range (4-5L) (Moran, 2012). From previous studies, calves fed whole milk from birth at a rate of 10% of live weight along with concentrate had a higher weaning weight and better post weaning growth rate (Bhatti *et al*., 2012; Santos and Bittar, 2015), nevertheless calves fed with CMR can grow equally well (Moran, 2012). Most of the smallholder and semi-commercial farms (n=8) fed 4 litres/ calf/day raw milk. In contrast, the commercial farm fed 5 litres/calf/day of CMR (Table 3) which could be due to desire for producing high production cows (Erickson and Kalscheur, 2020) consequently lead to a heavier bodyweight of the calves (Silper *et al*., 2014) and higher feed costs (Uys *et al*., 2011) in commercial farms. Out of 14 surveyed farms, 12 (86%) farms fed unpasteurised whole milk to their pre-wean calves and bought dairy cattle pellet to feed older young stock (Fig 3). While 2 (14%) farms (semi commercial and commercial) fed CMR and own customised TMR to optimize

Table 1: Farm descriptors for smallholder, semi-commercial and commercial dairy farms according to management system, milk production, herd size and land size.

Farm variables	Type of dairy farms		
	Smallholder (n=7) mean ± SE	Semi-commercial (n=6) mean ± SE	Commercial (n=1) mean
Type of system	Semi-intensive	Intensive	Intensive
Definition	combination of limited grazing and stall feeding (Bandara *et al.*, 2011)	animal are housed in a free-stall system (Passetti *et al.*, 2016)	
Milk production (liters)			
2017	39,117.97±5,903	93,541±22,900.16	2,950,584
2018	33,007.33±7,164	85,307±20,116.72	3,682,346
2019	32,249.71±7,805	92,729±23,345.99	4,236,237
Herd size (number of milking cows)			
2017	21±1.724	43±4.072	1,697
2018	21±3.415	57±6.770	1,230
2019	16±2.495	40±3.256	1,303
Land size (acres)	10.86±3.98	21.33±11.50	277

Table 2: The demographic of respondent with farms grouped into smallholder, semi-commercial and commercial dairy farms based on number of milking cows available on the farms.

Demographic information	Types of farms		
	Smallholder (n=7)	Semi-commercial (n=6)	Commercial (n=1)
Gender			
Male	5 (71)	6 (100)	1 (100)[1]
Female	2 (29)	0 (0)	0 (0)
Age (months)			
21-30	0 (0)	2 (33)	1 (100)[1]
31-40	3 (43)	1 (17)	0 (0)
41-50	2 (29)	1 (17)	0 (0)
51-60	2 (29)	2 (33)	0 (0)
Race			
Malay	2 (29)	0 (0)	0 (0)
Chinese	4 (57)	3 (50)	0 (0)
Indian	0 (0)	0 (0)	1 (100)[1]
Others	1 (14)	3 (50)	0 (0)
Level of education			
Secondary	6 (86)	4 (67)	0 (0)
Tertiary	1 (14)	2 (33)	1 (100)[1]
Period of experience in dairy farming (years)			
Less than 10	3 (43)	4 (67)	1 (100)[1]
Between 11 and 20	4 (57)	0 (0)	0 (0)
More than 20	0 (0)	2 (33)	0 (0)
Experience in purchasing replacement heifer			
Yes	4 (57)	2 (33)	1 (100)[1]
No	3 (43)	4 (67)	0 (0)
Intention to increase herd size			
Yes	7 (100)	4 (67)	1 (100)[1]
No	0 (0)	2 (33)	0 (0)

[1]Survey was conducted to manager of the dairy farm, while survey at other farms were conducted with the owner.

Fig 1: Young stock rearing in dairy farm in Malaysia; A: Small-scale farm, B: Semi commercial farm, C: Commercial farm. Dairy farmers in Malaysia kept the pre-weaning calf in individual pens with different feeding management practices. Majority of farmers fed whole milk and minority fed calf milk replacer.

Fig 2: Different management systems in dairy farm in Malaysia; A: Small-scale farm, B: Semi commercial farm, C: Commercial farm. Small-scale farm is with 30 or fewer cows, semi-commercial are farms with 31-49 cows and commercial farms are with more than 50 milking cows.

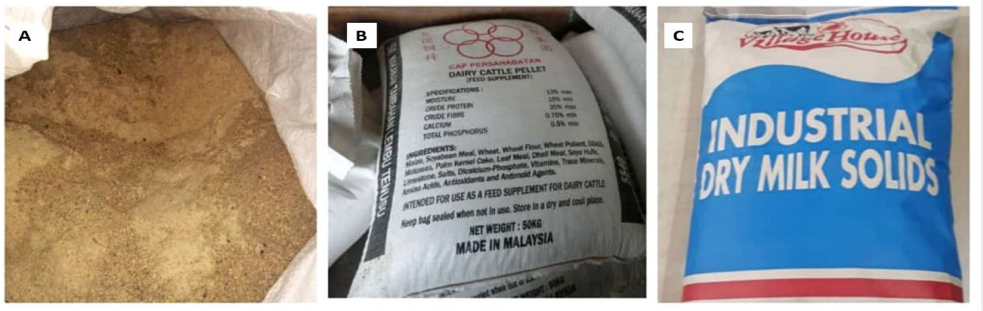

Fig 3: The types of feed provided to the dairy young stock, A: Total mix ration, B: Dairy cattle pellet, C: Calf milk replacer. Total mixed ration was the mixture of palm kernel cake, pollard, fish meal, salt, corn bran and rice bran. Instead of providing total mixed ration, there are farmers provided dairy cattle pellet. Calf milk replacer was provided by one of the semi-commercial farm and commercial farm for pre-weaning calf.

Table 3: The age and estimated feed cost for rearing dairy replacement heifer in Keningau, Sabah, Malaysia.

Period / farm types	Smallholder (n=7)	Semi-commercial (n=6)	Commercial (n=1)
		Age (months) (Average ± SE)	
Weaning	3±0.11	2.8±0.08	3
Start breeding	27±2.51	19.2±1.2	15
First calving	39±1.33	31±1.44	24
		Costs (RM) (Average±SE)[1]	
Birth to weaning	1,443±276.59	1,194±289.92	868.50
Weaning to breeding	1,372±44.11	1,685±356.70	1,771.20
Breeding to first calving[2]	-	1,600±282.15	1,660.50
Total	3,478.8±382.87	4,380±584.21	4,300.20

[1]The rearing costs only include feed cost (milk, CMR, own TMR, dairy cattle pellet and palm kernel cake).

[2]Smallholder dairy farmers are unable to provide the amount of feed given to young stock.

costs of rearing. Previous study revealed CMR was lower (50%) than the cost of unpasteurised raw milk (Moran, 2012), but further studies are required using the current price of CMR and different growth performance. Nevertheless, farmers who preferred raw milk believed high technical skill is needed in preparing CMR in order to avoid complications of diarrhoea and mortality. Insufficient technical skill on CMR and TMR among farmers in this study could hinder the productivity of smallholder dairy farms (Tawaf and Russanti, 2017).

To our knowledge, our study is the first to show average mortality rate in commercial dairy farm in Malaysia. Calf death in the semi-commercial farm was recorded without specifying the actual date but previous studies reported that calf mortality occurred mostly in the first year (Lora *et al*., 2014). The annual mortality rate of dairy young stock in the commercial farm from birth until FCA (2015-2019) was 9% (7%-10%) and the average mortality rate from birth to 12 months (2014-2018) in one of the semi-commercial farms was 21% (11%-32%) in agreement with a previous study conducted in tropics (Moran, 2012). As our result is higher than the mortality reported in UK (6%) (Lorenz *et al*., 2011) and Australia (3%) (McNeil, 2009), more emphasis must be placed on the proper calf management and recording of calf mortality data because most farms might underestimate the problem.

The difficulty in calculating feed cost is evident especially to smallholder farm, in our case, the small sampling size is justified (Table 2) due to the time inquiring the detailed feed management and costs of rearing young stock, in a comparable environmental conditions and represented 20% of all dairy farms and 90.6% of total milk production in state of Sabah. Previous similar studies showed the high cost of rearing young stock (Boulton *et al*., 2017) and consequently the additional calf mortality could influence sustainability of dairy farms (Kochewad *et al*., 2013) thus, government should support farmers to keep a proper record for instance by using computer vision to improve individual record keeping (Vate-U-Lan *et al*., 2017) but more research needs to be done on the cost-effectiveness and its applicability to smallholder dairy farms.

CONCLUSION

The average cost of rearing was RM4, 052 (USD1, 000)/ heifer across three different management systems, which were RM3,478 (USD858)/heifer in small scale, RM4,380 (USD1,081)/heifer) in semi-commercial and RM4,300 (USD1,061)/heifer) in commercial dairy farm.

Conflict of interest

The authors declare there is no conflict of interest.

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