Research article

Reasons and Criteria for Selecting and Culling Dairy Cows in Small and Medium Farms in the Northeastern Region of Thailand

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Abstract

The objective of this study was to investigate the criteria for cow culling and the methods used for semen selection in small and medium dairy farms in Thailand. Dairy cows on small and medium farms are culled for many different reasons. Methods of selection and culling were examined using data collected from a questionnaire asking about the number of milking cows, farm experience in raising dairy cows, criteria used for culling cows, selection of new cows, replacement cattle, and semen for breeding. Ninety-one farms were randomly selected using a snowball technique from dairy cooperatives in Khon Kaen, Maha Sarakham, and Sakon Nakhon Provinces, Thailand, with data analyzed using ANOVA and Chi-square statistics. The results showed that most farmers did not cull cows due to low milk production or aging (71.43%, 72.53%) and used 5 to >12 insemination events as a criterion for involuntary culling (50.55%). Chronic mastitis was the highest health reason for culling cows (52.10%). Farmers usually kept on-farm female calves as replacement cows (41.67%), chosen by considering their dams' milking ability. Most farmers (67.00%) let an artificial inseminator select suitable semen for their cows. When selecting pregnant heifers for replacement, the farmers considered body conformation, udder characteristics, and cow price. Farmers with small and medium farms conducted low levels of voluntary culling and paid less attention to the genetic information of the semen. In summary, this study explains various factors influencing the selection and culling of dairy cows. Challenges leading to cattle culling included mastitis and infertility. Educating farmers on hygiene, reproductive systems, and household accounting is imperative as it facilitates sustainable cattle rearing practices.

Keywords

chronic mastitis;
involuntary culling;
replacement cows;
rural dairy farms;
semen selection

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1. Introduction

Thailand is a tropical Asian country in the northern hemisphere. The Thai dairy industry has been developed for 70 years and is now supported by the Dairy Farming Promotion Organization of Thailand and the Department of Livestock Development (DLD). Upgrading zebu cows with Holstein semen is a traditional breeding practice. The farmers sell raw milk to dairy cooperatives or milk collection centers as their main source of income. In 2021, Thailand had around 812,000 lactating cows on 24,000 farms [1], with 61.10% raising 21-100 lactating cows, defined as medium farms; 36.30% raising 1-20 lactating cows, defined as small farms; and only 2.20% raising more than 100 lactating cows. Small and medium farms are the main milk production sources in Thailand, similar to other countries in Southeast Asia [2].

Good herd management practices are important for dairy farmers. The proportion of milking, dried, and replacement cows on the farm must be carefully managed to ensure a steady income. To maximize farm profit, low-producing, unprofitable milking cows should be culled and replaced by young cows with higher production. Culling is carried out for various reasons linked to both economic considerations and farm circumstances [3]. Voluntary culling is implemented for economic purposes, aiming to minimize costs by eliminating unproductive animals. Cows exhibiting low milk yields may lead farmers to opt for voluntary culling when the income from milk sales is inadequate to offset the expenses associated with feed for the cows [4]. Involuntary culling is conducted primarily for health reasons but is also considered for other reasons [5], such as cattle injury, chronic illnesses and reproductive problems. In developing countries, farmers frequently involuntary cull cattle, typically forced by prevalent health issues in cows such as chronic mastitis, infertility, or injury. However, there is no established criterion for determining the duration for which cattle are maintained in such conditions before they are removed from the herd. To optimize farm profits, involuntary culling should be minimized [6]. Importing replacement cows or selecting semen for breeding are also important factors for the optimal development of genetic competence and farm productivity [7]. Farmers can select the desired genetic traits from frozen semen, with cows normally inseminated by artificial inseminators.

Thailand has been developing dairy herds for a long time. Much work has been done on producing cows with high milking ability, excellent body conformation, and semen of high breeding value. However, breeding value selection has only been understood by a certain group of people. Dairy farmers in northeastern Thailand have not understood enough of the process. Moreover, very few studies have examined the reasons for culling and selection of cows and semen. Therefore, the aim of this study was to investigate the criteria for cow culling and the methods used for semen selection in small and medium dairy farms in Thailand. This research will provide a deeper understanding of the decision-making processes involved in cow culling and semen selection and will ultimately contribute to the improvement of dairy farming practices in Thailand.

2. Materials and Methods

This survey was conducted by three trained students, familiar with dairy production. Three provinces, Khon Kaen, Maha Sarakham, and Sakon Nakhon, were randomly selected from 20 provinces in Northeastern Thailand. Farms were randomly sampled using the snowball sampling technique until the required number of farms in each province was reached. All selected farms were members of a local dairy cooperative that was responsible for milk sales. Ninety-one dairy farm owners in upper Northeastern Thailand were interviewed, with data collected from Khon Kaen (31 out of 1,094 farms, representing 2.83%), Maha Sarakham (30 out of 238 farms, representing 12.60%), and Sakon Nakhon (30 out of 173 farms, representing 17.34%). According to Taro

Yamane's formula [8], the margin of error was 9.97%. A preliminary questionnaire was tested on smallholder dairy farmers and the question choices were modified accordingly. Some information, such as the age of the cows, was retrieved from farmer memory. The questionnaire comprised three parts: Part 1, general information; Part 2, reasons for cow culling and Part 3, reasons for cow and semen selection. In Part 1, general information included 1) dairy farming experience with options as i) less than 10 years, ii) 10 to 20 years, and iii) more than 20 years, 2) number of milking cows at that time, and 3) milk yield on last day. In Part 2, the reasons for culling were i) low milk (answered by checking the box and filling in the amount of milk produced by the cow to be culled or answered never been culled for this reason), ii) age of cow (answered by checking the box and filling in the age of cow to be culled, or answered never been culled for this reason), iii) number of services to conception (answered by checking the box and filling in the number of breeding failures of the cow to be culled, or answered never been culled for this reason), and iv) health problems (answered by checking the box for the diseases or symptoms of the cow that was to be culled). Reasons for culling were categorized as voluntary and involuntary. Voluntary culling depended on milk produced and age of cow, while involuntary culling considered the number of services to conception and health problems. In Part 3 (reasons for cow and semen selection), the questions comprised; i) the criteria used to select cows, ii) the criteria used to keep female calves, and iii) the criteria used to select semen. This study was ethically approved by Institutional Animal Care and Use Committee, Mahasarakham University (IACUC-MSU), Thailand with approval ID IACUC-MSU-25/2023.

Data were grouped by farm size according to the number of milking cows; farms with 1-20 cows were categorized as small farms, and farms with 21-100 cows were considered as medium farms [9]. Data were also grouped by the number of years of experience in dairy farming as less than 10 (<10Y), 10 to 20 years of experience (10-20Y), and more than 20 years (>20Y). Descriptive analyses were conducted on grouped data, including data counts, means, and standard deviations. Chi-square statistics were utilized to examine correlations between farm experience and culling considerations, aiming to assess the influence of farm experience on selection concepts. Milk yields were analyzed using the generalized linear model (GLM) procedure in the Statistical Analysis System [10], with least squares mean values of milk yield estimated for each province by farm size and farm experience as the independent variables. The validity of the questionnaire was assessed by an index of item-objective congruence (IOC) of 0.82 and Cronbach's alpha coefficient of 0.89 for culling and selection reasons.

3. Results and Discussion

Survey data were collected from 91 dairy farmers with 1,747 milking cows (average 19.20±1.31 milking cows per farm). The average milk yield was 12.27±2.64 kg/cow/day. Average milk production from the three provinces was not significantly different. Two farm sizes were defined: small (59 farms) and medium (32 farms). Experience in raising dairy cows was grouped as less than 10 years (35 farms), 10 to 20 years (28 farms), and more than 20 years (28 farms), as shown in Table 1.

3.1 Voluntary culling

Voluntary culling is a decision made by farm owners which directly impacts productivity. The findings indicated that a majority of farmers had culled cows, while a small proportion of farmers with less than 10 years of farming experience had not encountered issues necessitating culling. Regarding milk yield considerations, 71.43% of farmers did not factor in milk yield production

Table 1. Number of farms and milk yields in Khon Kaen, Maha Sarakham and Sakon Nakhon Provinces

	Number of Farms[1]				Milk Yield (kg/cow/day)			p-value
	KK	MS	SK	Total	KK	MS	SK	
Overall	31	30	30	91	11.98±2.21	12.39±2.17	12.45±3.49	ns
Farm size								
Small	16	20	23	59	12.44±2.43	12.77±2.36	11.92±3.49	ns
Medium	15	10	7	32	11.50±1.91	11.65±1.58	14.12±2.78	ns
Farm experience (year)[2]								
<10Y	11	14	10	35	11.99±2.22	12.66±2.67	12.78±4.29	ns
10-20Y	10	8	10	28	11.63±2.27	11.95±1.44	12.58±3.58	ns
>20Y	10	8	10	28	12.32±2.32	12.37±1.95	11.95±2.49	ns

[1] KK=Khon Kaen, MS= Maha Sarakham, SK= Sakon Nakhon Province
[2] Farm experience: <10Y=less than 10 years, 10-20Y=10 to 20 years, >20Y= more than 20 years
ns=not significantly different (p>0.05)

(milk yield per day) when culling, while 28.57% culled cows when milk supply fell below a specified limit. More than half of the farmers considered milk yield as a reason to cull cows if the yield dropped to less than 4 kg/day, which accounted for 16.48% of all farms (Table 2). In contrast, on large farms in the United States, cows are culled if they produce only 7.3 kg of milk per day, with this decision influenced by milk price, feed costs, and the value of culled cows [3]. Additionally, farmers considered milk yield in relation to conception; cows failing to conceive and producing minimal milk were removed from the herd, whereas cows yielding high milk quantities but failing to conceive were retained.

In this study, 72.53% of farmers did not factor in age when culling cows, while 27.47% cited age as a reason for culling; specifically, 18.68% culled cows at 10 years old and 8.79% culled cows over 10 years old (Table 2). Some farmers retained cows on the farm as long as they maintained satisfactory milk production levels. In countries with well-established dairy farming industries, the average lifespan of cows on farms ranges from 2.4 to 4 years [11-13]. Cows typically reach peak productivity during their 3rd to 4th lactation and exhibit declining milk production as they age, though dairy cows can remain productive up to 9 years of age. The Chi-square test results indicated a significant association between cow culling based on age and health issues with both farming experience and farm size ($p<0.05$). Therefore, more experienced farmers tended to cull a greater proportion of cows due to age and health problems. However, culling because of the number of services and low milk yield was not contingent upon farming experience ($p>0.05$). Hence, varying levels of farm experience did not yield differing proportions of cows culled due to reproductive failure and low milk production (Table 3).

3.2 Involuntary culling

Involuntary culling was performed in response to various factors including disease, injury, infertility, or mortality. The majority of farmers (50.55%) contemplated culling cows based on the number of services to conception with the highest frequency observed at 12 times (14.29%), followed by 5 times (12.09%). Farmers that hopped for their cows to conceive during subsequent services refrained from culling to avoid forfeiting potential earnings from milk production.

Table 2. Voluntary culling criteria for dairy cows in upper Northeastern Thailand by farm size and farm experience

Voluntary Culling Criteria	Farm Size			Farm Experience (year)[1]			Total
	Medium	Small	Total	<10Y	10-20Y	>20Y	(%)
Low milk yield (kg/cow/day)							
<4 kg	7	8	15	7	3	5	15 (16.48)
4-8 kg	4	7	11	3	4	4	11 (12.09)
Total considered	11	15	26	10	7	9	26 (28.57)
Total not considered	21	44	65	25	21	19	65 (71.43)
Total	32	59	91	35	28	28	91 (100)
Age of cow (year)							
10 years	8	9	17	2	6	9	17 (18.68)
11-15 years	6	2	8	1	4	3	8 (8.79)
Total considered	14	11	25	3	10	12	25 (27.47)
Total not considered	18	48	66	32	18	16	66 (72.53)
Total	32	59	91	35	28	28	91 (100)

[1]Farm experience: <10Y=less than 10 years, 10-20Y=10 to 20 years, >20Y= more than 20 years

Table 3. Relationship between farm experience, farm size and culling decision criteria

	Number of Service Times		Low Milk		Age of Cow		Health Problems	
	Cons	Not Cons	Cons	Not Cons	Cons	Not Cons	Cons	Not Cons
Farm experience								
<10Y	16	19	10	25	3	32	24	11
10-20Y	16	12	7	21	10	18	26	2
>20Y	14	14	9	19	12	16	26	2
Chi-square	0.818		0.353		10.556		9.223	
p-value	0.664		0.839		0.005		0.010	
Farm size								
Small	28	3	15	44	11	48	63	14
Medium	18	14	44	21	14	18	56	1
Chi-square	0.642		0.815		6.563		8.891	
p-value	0.423		0.367		0.010		0.003	

Note: Cons =consider culling criteria. Not cons = do not consider culling criteria. Farm experience: <10Y=less than 10 years, 10-20Y=10 to 20 years, >20Y= more than 20 years

Involuntary culling signifies issues related to farm management and animal welfare [14], which are distinct from milk production concerns [15]. In this study, small-scale farmers solely culled cows when they ceased to be productive or failed to conceive, resulting in the retention of cows within the herd for longer periods of time. Smith *et al*. [16] observed that the number of artificial insemination services performed until culling was higher on small farms compared to larger farms. Given the limited heritability of reproductive traits [17-20], environmental factors

predominate over genetic factors for these traits [21]. Therefore, farmers are advised to prioritize environmental factors, such as nutrition, reproductive management, and insemination practices to enhance animal fertility [22].

Farmers with fewer than 10 years of experience exhibited a higher rate of cow culling due to health issues compared to their more experienced peers (Table 4). The predominant reason for culling cows stemmed from incurable diseases, with chronic mastitis representing the most prevalent cause (52.10%), followed by lameness issues (13.45%). Aiumlamai [23] identified chronic mastitis as a major health concern for small and medium-sized dairy farms in Thailand, and it was attributed to inadequate sanitation practices. Similarly, in Jordan, approximately 22% of dairy cows, predominantly Holstein Friesians, were culled due to mastitis [13], a proportion similar to that observed in Holstein herds in Egypt (24.2%) [24]. Beaudeau *et al*. [25] reported that mastitis and retained placenta were more common causes of culling than failure to conceive. Conversely, in Iran, culling due to failure of conception stood at 23.6%, surpassing that of mastitis at 6.3% [6]. In tropical regions, dairy cows face heightened susceptibility to mastitis. Krachangwong *et al*. [26] reported a mastitis prevalence of 77.52% in Prachuap Khiri Khan Province, Southern Thailand, while the prevalence of subclinical mastitis among dairy cows in Khon Kaen Province, upper Northeastern Thailand, was 36.14% [27]. It is imperative for farmers to prioritize milking hygiene and management practices to mitigate mastitis occurrences [28].

Table 4. Involuntary culling decision criteria of dairy cows in upper Northeastern of Thailand by farm size and farm experience

Involuntary Culling Decision Criteria	Farm Size			Farm Experience[1]			Total (%)
	Medium	Small	Total	<10Y	10-20Y	>20Y	
Number of services to conception							
5 times	4	7	11	4	4	3	11 (12.09)
6 times	2	0	2	0	0	2	2 (2.20)
8 times	5	1	6	1	3	2	6 (6.59)
10 times	3	3	6	2	4	0	6 (6.59)
11 times	1	0	1	1	0	0	1 (1.10)
12 times	1	12	13	5	2	6	13 (14.29)
> 12 times	2	5	7	3	3	1	7 (7.69)
Total considered	18	28	46	16	16	14	46 (50.55)
Total not considered	14	31	45	19	12	14	45 (49.45)
Total	32	59	91	35	28	28	91(100)
Culling by health problems							
Chronic mastitis	26	36	62	18	23	21	62 (52.10)
Lameness problems	5	11	16	8	5	3	16 (13.45)
Chronic illness	6	7	13	5	4	4	13 (10.92)
Foot and mouth disease	8	3	11	4	5	2	11 (9.23)
Injury	1	2	3	1	2	0	3 (2.52)
Others	10	4	14	3	3	8	14 (11.76)
Total	56	63	119	50	44	40	119 (100)

[1]Farm experience: <10Y=less than 10 years, 10-20Y=10 to 20 years, >20Y= more than 20 years

Other significant issues are leg and hoof injuries or lameness problems, together ranking as the second highest cause of involuntary culling (13.45%). When a dairy cow suffers from lameness, it can substantially impact both its health and milk production [29]. Lame cows may encounter difficulty in accessing food and water, resulting in reduced feed intake, potential weight loss, and an increased risk of culling [30]. Lameness in dairy cattle also contributes to economic losses and animal welfare concerns [31]. Rilanto *et al*. [32] observed that the primary reasons for culling dairy cows in Estonia were feet/claw disorders, followed by udder disorders, metabolic and digestive disorders, and fertility issues. A high prevalence of reproductive issues was observed on farms where lameness was prevalent in Thailand. Ratanapob *et al*. [33] suggested that the incidence of non-pregnant and lame cows can be reduced through proactive lameness prevention measures. Lameness problems are frequently attributed to hard and slippery stall floors [34, 35]. Through observations conducted in this study, it was noted that milking pen floors often made of hard and slippery concrete, which increased the likelihood of cattle slipping and sustaining injuries. Hence, farmers should consider enhancing milking pen floors through resurfacing [36] or employing rubber as a flooring material [37] to alleviate the occurrence of leg and hoof injuries. Additionally, utilizing claw blocks, as suggested by Arunvipas *et al*. [38], can expedite the healing process after hoof trimming.

3.3 Semen selection

Dairy farmers procure genetic material for breeding purposes through two main channels: female cows and sire semen. Farmers allocated particular attention to body conformation (29.50%), followed by udder structure (18.71%), dairy cow price (10.79%), and milk yield (7.19%) (Table 5). These traits were positively correlated with milk production [39]. In selecting female calves born on the farm as replacement dairy cows, the majority of farmers (41.67%) opted to retain all female calves, while 33.33% based their decision on the milk yield history of the calves' dams, and 17.59% chose not to retain any calves as replacements.

In semen selection, 67.00% of farmers deferred to an artificial inseminator for choosing semen for mating, while 22.00% considered only the bull breed type, and 6.00% based their selection on the expected breeding value (EBV). The findings highlight a minimal emphasis on EBV's role in semen selection among farmers in the northeastern region of Thailand. Over the past 60 years, Thailand has developed dairy cow genetics to optimize semen quality in terms of body structure, milk content, composition, and heat tolerance [40-42]. However, the adoption of estimated breeding value (EBV) in semen selection remains notably low among farmers, particularly in small and medium-sized farms in the northeast region of Thailand. Instead, most farmers rely on the expertise of artificial inseminators for semen selection. Nevertheless, a study by Sarakul *et al*. [43] in the central region of Thailand demonstrated that when farmers do utilize EBV for semen selection, they can choose sires with superior genetic merit for desired traits, potentially leading to enhanced genetic progress and improved performance of their dairy herds.

4. Conclusions

The findings of this study show that the main factors leading to involuntary culling in small and medium dairy farms were chronic mastitis and breeding failure. Farmers lack specific criteria for culling, and the process involves the consideration of multiple factors simultaneously. Farmers do not pay adequate attention to sire semen selection; instead, they entrust artificial inseminators to choose sire semen for them.

Table 5. Voluntary culling decision criteria for dairy cows in upper Northeastern Thailand by farm size and farm experience

Female selection	Farm size			Farm experience (year)			Total (%)
	Medium	Small	Total	<10Y	10-20Y	>20Y	
Cow source							
Female calves born on farm	29	44	73	22	26	25	73 (57.30)
Pregnant heifers	17	35	52	25	17	10	52 (40.63)
Dairy cows	0	2	2	2	0	0	2 (1.56)
Female calf form	0	1	1	0	0	1	1 (0.78)
Total	46	82	128	49	42	36	128 (100)
Reasons and criteria to select cow							
Body conformation	15	26	41	22	13	6	41 (29.50)
Udder	10	16	26	16	5	5	26 (18.71)
Cow prize	8	7	15	8	6	1	15 (10.79)
Milk yield	2	8	10	3	4	3	10 (7.19)
Breed	0	2	2	1	1	0	2 (1.44)
Neighborhood	0	1	1	1	0	0	1 (0.72)
Others	1	4	5	1	2	2	5 (3.60)
Never select new cow	15	24	39	10	11	18	39 (28.06)
Total	51	88	139	62	42	35	139 (100)
Reasons and criteria to keep calves							
Keep all female calves	18	27	45	12	17	16	45 (41.67)
Dam milk records	16	20	36	11	12	13	36 (33.33)
Do not keep all calves	4	15	19	13	4	2	19 (17.59)
Body conformation	4	4	8	2	0	6	8 (7.41)
Total	42	66	108	38	33	37	108 (100)
Semen selection							
Sexing semen	0	1	1	1	0	0	1 (1.00)
Beef semen	1	0	1	0	1	0	1 (1.00)
Breed of high fat production	1	1	2	1	1	0	2 (2.00)
Source of semen	0	1	1	1	0	0	1 (1.00)
EBV value	4	2	6	2	0	4	6 (6.00)
Breed of sire	14	8	22	6	5	11	22 (22.00)
Selected by artificial inseminator	20	47	67	28	22	17	67 (67.00)
Total	40	60	100	39	29	32	100 (100)

The findings underscore the necessity of education and training for small and medium-sized dairy farmers, especially those managing fewer than 100 dairy cows. Tailored programs should focus on reproductive management strategies aimed at enhancing fertility in dairy herds. These programs should include estrus testing, artificial insemination techniques, and nutritional interventions to optimize reproductive performance. Moreover, maintaining a hygienic environment is crucial to mitigating the incidence of mastitis. Providing guidance on proper milking procedures, hygiene protocols, and routine udder health monitoring can substantially mitigate the risk of mastitis outbreaks. Additionally, by including farm accounting concepts into training curricula, farmers can gain knowledge about the financial management techniques and cost-benefit analyses that are relevant to their particular operations. To address the gaps identified in this study, better understanding of breeding objectives on small and medium dairy farms is crucial for addressing specific practices and challenges related to semen selection. Research can help in creating targeted strategies for optimizing genetic improvement and overall herd performance on small and medium dairy farms. Farmers with advanced knowledge and practical skills in reproductive management, hygiene protocols, farm accounting, and sire semen selection, can make well-informed decisions and thus bolster overall productivity, profitability, and sustainability of their dairy operations.

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