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The influence of calf rearing methods and milking methods on performance traits of crossbred dairy cattle in Thailand

2. Reproductive performance and cow body weight

Abstract

Forty Thai x Holstein-Friesian (HF) crossbred dairy cows (75 % and 87.5 % HF upgrade level) with calves were used in experiments to investigate restricted suckling (RS) versus bucket rearing (BR) and hand versus machine milking in Thailand.

Calves were kept indoors and remained with their dams during the first 4 days and were then allocated to the RS or BS treatment. Milking was done twice daily and RS-calves were allowed to suckle for 15 minutes after milking. All experimental animals were fed according to requirements with concentrate supplements, minerals and water ad lib.

This paper reports effects on reproductive performance and weight of cows.

Calving to first oestrus interval in cows with RS and BR calves were 72.2 ± 2.5 and 54.7 ± 2.5 ($p < 0.001$), respectively, and days open 114.2 ± 6.68 and 86.5 ± 6.7 ($p < 0.01$).

Milking method (hand or machine) had no effect on days to first oestrus and days open. Primiparous cows had a longer calving to first oestrus interval than multiparous cows ($p < 0.001$) (72.3 ± 2.8 vs 54.5 ± 2.3) and a longer days open period ($p < 0.01$) (114.4 ± 7.4 vs 86.2 ± 6.1).

Body weight change of cows during the first 2 months of lactation was not affected by any treatment or systematic factor tested.

Key Words: dairy cattle, restricted suckling, milking method, reproductive performance, Thailand

Zusammenfassung

Titel der Arbeit: **Leistungseigenschaften bei Kreuzungs-Milchkühen in Thailand. 2. Mitt.: Fruchtbarkeitsleistung und Körpergewicht der Kühe**

40 Thai x Holstein-Friesen (HF) Kreuzungskühe (75 % und 87,5 % HF-Anteil) mit Kälbern aus der Anpaarung mit reinen Holstein-Friesen und 75 % Holstein-Friesen Bullen wurden in einem Experiment auf den Einfluss von Kälberaufzuchtverfahren (partielles Säugen, Eimeraufzucht) sowie einem Hand- und Maschinenmelkverfahren unterzogen.

Die Kälber verblieben in den ersten 4 Tagen nach der Geburt bei den Kühen und wurden danach den Kälberaufzucht-Behandlungen zugeordnet. Das Melken fand 2 x täglich statt und die Kälber der partiellen Säugegruppe wurden nach dem Melken 15 Minuten zum Säugen angehalten. Alle Versuchstiere wurden gemäß ihrer Bedarfsnormen gefüttert.

Die Rastzeit und die Serviceperiode der Kühe mit partiellem Säugen, respektive ohne Säugen der Kälber, war 72,2 ± 2,5 und 54,7 ± 2,5 ($p<0,001$), und 114,2 ± 6,68 und 86,5 ± 6,7 ($p<0,01$).

Die Melkmethode (Hand oder Maschine) zeigte keinen Effekt auf die Rastzeit und die Serviceperiode. Erstlaktierende Kühe hatten eine längere Rastzeit ($p<0,001$) (72,3 ± 2,8 bzw. 54,5 ± 2,3) und eine längere Serviceperiode ($p<0,01$) (114,4 ± 7,4 bzw. 86,2 ± 6,1) als Kühe in späteren Laktationen.

In den ersten 2 Monaten der Laktation verloren die Kühe 4 – 5 % ihres Körpergewichtes. Es war kein Einfluss der Behandlungen festzustellen.

Schlüsselwörter: Milchkühe, Thailand, Melkmethode, Reproduktionsleistungen, partielles Säugen

Introduction

Small holder dairy production is increasing in importance in Thailand and adequate methods for milking and calf rearing are required to secure the sustainable use of crossbred dairy cows. This paper reports results of an experiment comparing the effect of hand or machine milking and restricted suckling or bucket rearing of calves on reproduction and cow body weight of crossbred dairy cows.

Materials and methods

The experiment was conducted from February 1997 to October 1998 at the experimental station of the Ubon Ratchathani University, Thailand. 40 Holstein-Friesian crossbred cows of 75 % and 87.7 % HF blood with 16 in the first and 24 in later lactations were arranged into a 2x2 factorial experiment. Calf rearing management included bucket rearing of calves (BR), and restricted suckling (RS) for 15 minutes post milking until 84th day postpartum.

A detailed description of experimental procedures is provided in BOONBRAHM et al., 2004.

Observations for oestrus signs (i.e. courting behaviour, standing heat and vaginal mucous discharge) were done three times daily starting 40 post partum. The cows in oestrus were recorded and inseminated within 10 hours after heat detection.

Rectal palpation was carried out twice weekly from day 45 post-insemination onwards to confirmed pregnancy at week 14 post-breeding. Cows were re-examined at 4 and 6 months of pregnancy.

Body weight and body condition scores of cows were taken once per month at the same time of the day. The "Rudd Weight Data Collecta" electronic scale calibrated to read in increments of 0.5 kg was used for weighing, and the body condition scores were taken according to an adapted version of HEINRICHS and ISHLER (1995) and WICKES (1983).

Data analysis:

The SAS procedure for General Linear Models (GLM) of the Statistical Analysis Systems Release 6.12 (SAS, 1998) was used for the analysis of variance applying the following linear model for the traits: services per conception, days open until conception, cow body weight, body condition score (BCS).

$$Y_{ijkl} = \mu + C_i + M_j + P_k + G_l + E_{ijkl}$$

Where

Y_{ijkl} = dependent variable
μ = mean
C = effect of calf rearing method$_i$
M = effect of milking method$_j$
P = parity number$_k$
G = HF inheritance$_l$
E = residual error

Results

Reproductive performance

Results of the analysis of variance for the main effects of milking method, calf rearing system, parity number of the cow and HF gene proportion on reproductive performances of the cows are presented in Table 1. The model explains between 6 and 60 % of the variation in reproductive performance traits. The highest CVs were observed for services per conception and days open until conception (36.81 and 30.48 % respectively).

Table 1
Least squares means of average reproductive parameters of the cows (LSQ-Mittel der Reproduktionsparameter der Kühe)

Main effects	n	Calving to first oestrus interval (day)	Service per conception (time)	Days open until conception (day)
Milking method		ns	ns	ns
Hand	20	64.48±2.53	2.27±0.19	101.77±6.68
Machine	20	62.38±2.54	2.24±0.19	98.89±6.70
Calf rearing		***	ns	**
Bucket rearing	20	54.68±2.54	2.19±0.19	86.49±6.70
Restricted suckling	20	72.18±2.53	2.32±0.19	114.17±6.68
Parity number		***	ns	**
Primiparous	16	72.31±2.80	2.38±0.20	114.44±7.39
Multiparous	24	54.54±2.29	2.14±0.17	86.22±6.05
HF gene proportion		ns	ns	*
75.0%	21	60.39±2.49	2.13±0.18	90.66±6.56
87.5%	19	66.47±2.59	2.38±0.19	110.00±6.84
n		40	40	40
R^2		0.60	0.06	0.40
CV (%)		18.24	36.81	30.48
Mean ± sem		63.43±1.81	2.25±0.13	100.33±4.78

HF = Holstein Friesian
ns = non significant, * = p<0.05, ** = p<0.01 and *** = p<0.001

Calving to first oestrus interval

The overall mean for calving to first oestrus interval was 63.4 days. Highly significant (p<0.001) effects were caused by calf rearing management and parity number, but not by milking method and the HF gene proportion.
Cows of the restricted suckling group showed their first oestrus postpartum on average 18 days later than those not suckled.
Cows in their first lactation had an 18 days longer calving to first oestrus interval than multiparous cows.

Number of services per conception

The overall mean number of services per conception was 2.25±0.13 (Table 1). There was no significant effect of any treatment or systematic factor on the number of AI services required per conception, although a trend to a higher number of services per conception was noticeable in hand-milked cows, in cows under restricted suckling management, in primiparous cows, and in cows with higher HF gene proportion.

Days open until conception and calving interval

The overall mean of days open until conception and of calving interval were 100.33 ± 4.78 and 380.03 ± 4.78 days, respectively (Table 1). The analysis of variance indicated a significant influence of the calf rearing method ($p<0.01$), parity number ($p<0.01$), and HF gene proportion ($p<0.05$) on days open until conception and on the calving interval of the cows.

The milking method had no significant effect on days open until conception. However, on average, hand-milked cows had a 3 days longer interval for both reproductive traits than their machine-milked herdmates.

Restricted suckling did delay conception significantly ($p<0.01$) by 27.7 days, and primiparous cows needed 28.2 more days than multiparous cows until conception.

Increased upgrading with Holstein-Friesian significantly ($p<0.05$) affected days open until conception causing 87.5 % HF cows on average to conceive 19.3 days later than 75 % HF cows.

Cow liveweight change

The average liveweight of cows at calving was 440.95 ± 53.63 kg ranging from 368.0 to 542.0 kg. Results of the analysis of variance for treatment and systematic effects (milking method, calf rearing method, parity number of the cows, HF gene proportion) are shown in Table 2. The model explains only 4-11 % of the variation in cow liveweight. After calving the body weight had a CV of 12.55 % only but drastically changed over lactation leading to a CV of up to 281 %. None of the treatments and systematic factors had a significant influence on cows liveweight at calving and on liveweight change during lactation (Fig.).

Table 2
Results of the analysis of variance (GLM) of cow liveweight change postpartum (Ergebnisse der Varianzanalyse der Gewichtsveränderungen der Kühe nach dem Abkalben)

Main effects	n	Weight at	Average weight change of cows/day (kg)		
		calving	0-12 weeks	0-24 weeks	0-36 weeks
Milking method		ns	ns	ns	ns
Hand	20	439.12±12.56	-0.24±0.03	-0.09±0.02	-0.02±0.01
Machine	20	442.98±12.59	-0.24±0.03	-0.09±0.02	-0.01±0.01
Calf rearing method		ns	ns	ns	ns
Bucket rearing	20	440.63±12.59	-0.21±0.03	-0.08±0.02	-0.02±0.01
Restricted suckling	20	441.47±12.56	-0.27±0.03	-0.10±0.02	-0.02±0.01
Parity number		ns	ns	ns	ns
First	16	431.16±13.90	-0.23±0.03	-0.09±0.02	-0.02±0.01
Second and third	24	450.94±11.37	-0.25±0.03	-0.09±0.02	-0.01±0.01
HF geneproportion		ns	ns	ns	ns
75.0 %	21	439.50±12.33	-0.21±0.03	-0.07±0.02	-0.01±0.01
87.5 %	19	442.60±12.85	-0.27±0.03	-0.11±0.02	-0.03±0.01
n		40	40	40	40
R^2		0.04	0.11	0.08	0.08
CV (%)		12.55	54.25	84.09	281.05
Mean±sem		440.95±53.63	-0.24±0.02	-0.09±0.01	-0.02±0.01

HF = Holstein Friesian
ns = non significant, ∗ = $p<0.05$, ** = $p<0.01$ and ∗∗∗ = $p<0.001$

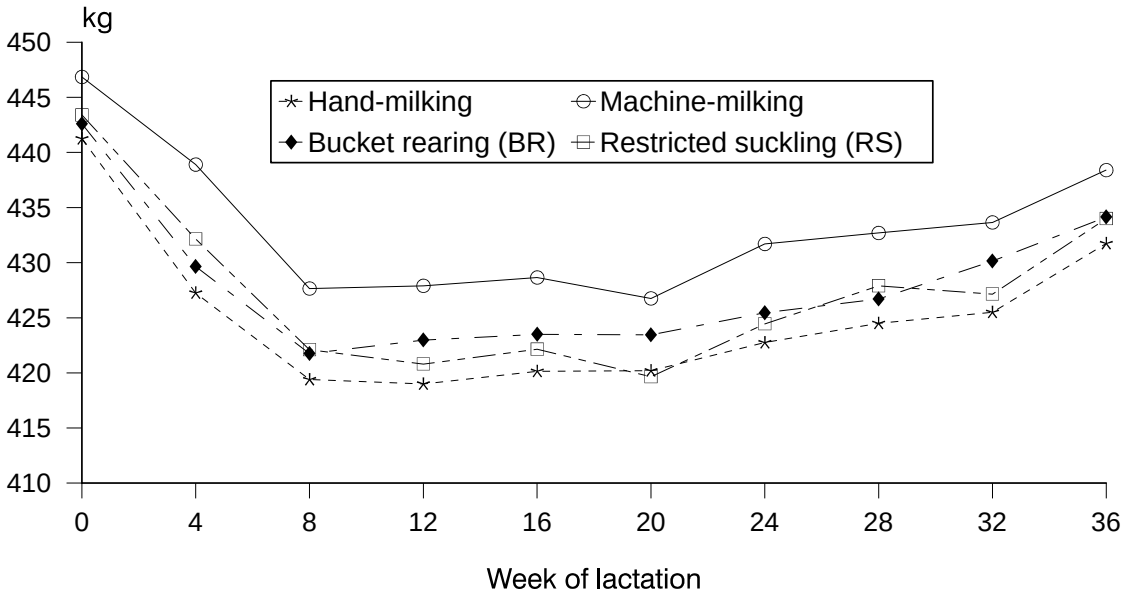

Figure: Cow body weight change during lactation (Gewichtsveränderungen der Kühe während der Laktation)

As illustrated in the Figure, cows' liveweight change from calving to day 252 postpartum had a similar pattern in all treatments. The cow liveweight declined during the first 8 weeks postpartum (between 4 and 5 %), remained relatively constant during week 8-12, and increased slightly during week 12-36 postpartum.

Table 3
Results of the analysis of variance (GLM) of body condition score (BCS) of the cows (Ergebnisse der Varianzanalyse der Körperkonditionsbewertung)

Main effects	n	At calving[1/]	Week postpartum		
			12nd	24th	36th
Milking method		ns	ns	ns	ns
Hand	20	3.30±0.13	1.97±0.17	2.67±0.19	3.19±0.17
Machine	20	3.20±0.14	2.18±0.17	2.83±0.19	3.34±0.17
Calf rearing method		ns	ns	ns	ns
Bucket rearing	20	3.40±0.14	2.03±0.17	2.73±0.19	3.39±0.17
Restricted suckling	20	3.10±0.13	2.12±0.17	2.77±0.19	3.14±0.17
Parity number		ns	ns	ns	ns
First	16	3.25±0.15	2.19±0.19	2.88±0.21	3.44±0.19
Second and third	24	3.25±0.12	1.96±0.16	2.63±0.17	3.09±0.16
HF gene proportion		ns	ns	ns	ns
75.0 %	21	3.28±0.13	2.02±0.17	2.74±0.19	3.22±0.17
87.5 %	19	3.22±0.14	2.13±0.18	2.76±0.20	3.30±0.18
n		40	40	40	40
R^2		0.08	0.05	0.03	0.09
CV (%)		18.36	37.60	31.09	23.94
Mean±sem		3.25±0.10	2.05±0.12	2.73±0.14	3.23±0.12

[1/] = BCS at calving evaluated within 12 hours after calving
HF = Holstein Friesian
ns = non significant, ∗ = p<0.05, ** = p<0.01 and ∗∗∗ = p<0.001

Body condition score (BCS) of the cow

The analysis of variance of the influence of treatments (i.e. milking method, calf rearing method), and systematic factors (parity number, HF gene proportion) on body

condition score (BCS) is shown in Table 3. None of the main effects included in the model had a significant influence on BCS of the cow during the study period.
As illustrated in the Figure, the BCS declined during the first two months postpartum and reached the lowest average score of 1.81 at week 8 of lactation. The BCS seemed to be constant during weeks 8-20, and to slightly increase thereafter from week 20 until the end of the study period. Cows on the different treatments had similar body weight changes over the whole lactation period.

Discussion

Reproductive performance

The overall mean of days open until conception in this study was 100.3 days, shorter than the 167-174 days open reported by CHANTRAPRATEEP et al. (1990) and POLPAK (1994) under small farm condition in Thailand. The better reproductive performances of crossbred HF cows in this study may be related to the feeding regime implementation at the Exp. Station, intensive oestrus observation and the optimum timing of artificial insemination.
The milking method had no effect on the reproductive performance. Cows in both milking groups exhibited a similar calving to oestrus interval, days open until conception, and number of service per conception, though GOREWIT et al. (1992) suggested a higher level of reproductive hormones (oxytocin and prolactin) and stress-hormone (cortisol) released in hand-milked cows than in cows milked by machine. Two possible reasons may explain this result. The first, the milkers are well trained and experienced in milking techniques either hand or machine. The milkers usually finished milking each cow within 3-6 min and 5-8 min after udder stimulation for machine and hand-milking, respectively. The second reason is related to oxytocin release during milking, which was within the normal surge of oxytocin.
Significant differences of reproductive parameters were found among the two calf rearing methods. Cows under the restricted suckling system had a significantly longer period between calving and first oestrus and days open than cows not suckled (AR).
Suckling has been identified as one of the critical components affecting the duration of postpartum anoestrus (WILLIAMS, 1990; MEJIA et al., 1998) and long calving intervals (UGARTE, 1991) in cattle. Regulation of suckling is a viable management option to decrease postpartum intervals to first ovulation. The results in the present study agreed with SHORT et al. (1972), SMITH et al. (1981) and MEJIA et al. (1998). Among suckled cows, reproductive performance is poorer in cows subjected to more intense suckling (EDMUND, 1977). Suckling twice daily as opposed to unrestricted suckling has a lower effect on reproductive performance (EDMUND, 1977).
The possible cause of poor reproductive performance among RS cows could also be related to a nutritional effect, as cows which yield more milk would be expected to have less nutrients available for reproduction, as reported by WILTBANK (1970), BUTLER and SMITH (1989), TERQUI et al. (1982) and TERVIT et al. (1977). However, SHORT et al. (1972) and MEJIA et al. (1998) showed that suckling increased the postpartum anoestrus interval independently of nutrient intake.
The cows used in this experiment were generally fed to meet their nutritional requirement as recommended by NRC (1989) in both pre-calving and post-calving

periods. However, a negative energy balance could have occurred during the first 2 months postpartum. This could have influenced their postpartum reproductive performance. ZUREK et al. (1995) indicated that postpartum changes in energy balance are a good predictor of when first ovulation will occur, because the nadir of energy balance usually occurs within the first 2 weeks postpartum, with first ovulation occurring approximately 10 to 15 days later.

Primiparous cows had a significantly longer calving to first oestrus interval and days open than multiparous cows by 17.8 and 28.2 days, respectively. Significant effects of parity number on calving interval have also been reported by KIWUWA et al. (1983) and NEGUSSIE et al. (1998), who suggested that calving interval decreased linearly as parturition number increased to fourth parity among crossbred cattle in Ethiopia. According to MUKASA-MUGERWA (1989) calving interval in Zebu was longest in first calf heifers and older cows and shortest in cows of intermediate age (6-9 years old). Age related delay of calving intervals is caused by lactational stress in young growing animals. Inability of older cows to withstand lactational and nutritional stress are due to the depletion of body weight (MUKASA-MUGERWA, 1989).

The HF gene proportion had a significant influence on days open until conception and calving interval, the 87.5 % HF cows exceeded the 75 % HF by 19.34 days. These results agreed with those of various other authors. KIWUWA et al. (1983), who evaluated reproductive performance of crossbred dairy cattle in Ethiopia, reported the longest calving interval among 87.5 % Friesian cows. OLSSON et al. (1986) concluded that the calving interval increased as the upgrading levels increased under farm condition. Higher grades need more maintenance feed than lower grades. However, AGYEMANG and NKHONJERA (1990) reported no differences in calving interval between 50 % and 75 % Friesian in Malawi.

Weight change and BCS of the cows

All cows in this study lost body weight during the first two months of lactation, maintained a BCS between 2-3 for a month, and thereafter slightly gained body weight until the end of study period. The results also showed that cows under the RS treatment tended to lose more weight than AR cows during the first two months of lactation and subsequently gained less weight than cows of the AR group. These results suggested a negative balance of energy during early lactation due to an increasing rate of milk production. Similar results are reported by UGARTE and PRESTON (1975) and GAYA et al. (1977) who detected no significant differences of cows' liveweight changes due to the calf rearing management were detected.

As reported by UGARTE and PRESTON (1973) and UGARTE and PRESTON (1975), using *Bos taurus* cows, the RS system did not have a significant effect on the liveweight of cows at weaning time (70 days). GAYA et al. (1977), using *Bos taurus* cows, found also no significant difference in weight change in the period from calving to 90 days post-calving among RS cows and non-suckled cows.

However, TEELUCK et al. (1981), using *Bos taurus* cows, found that RS cows gained significantly less weight per day in the period from calving to weaning time at 90 days than did non-suckled cows.

It seems that the weight change in restricted cows is correlated to the feeding intensity. Under situations of limited feeding there is a risk of increased weight losses in RS cows.

LITTLE et al. (1991) found no significant difference in weight gain in the 11 months after calving between crossbred dairy cows managed according to a variation of the Afro-Asian system and non-suckled cows.
GAYA et al. (1978), using *Bos taurus* cows, investigated the effect of suckling frequency on liveweight change. They found that there was no significant difference in liveweight gain in the period from calving to weaning time (90 days), between cows being suckled twice daily and milked once daily and cows being suckled only once daily. Only TEELUCK et al. (1981) found that the RS management significantly lowered liveweight gain of cows during the period up to the weaning of calves.

Conclusions and recommendations

Hand or machine milking of crossbred dairy cows with 75 and 87 % HF upgrading had no effect on reproductive traits and cow body weight change during lactation.
Restricted suckling significantly delayed the occurrence of first oestrus post partum by 17.5 days and increases days open by 27.7 days. Both of these traits were also affected by parity number, with primiparous cows take longer to first estrus (+178 days) and more days open (+28.2 days).
Cows were fed according to requirements but lost 4.5 % of their weight during the first two month of lactation, with no differences between treatment groups. It can be concluded that nutritional effects on reproduction performance can probably be excluded and that the delayed reproductive performance of cows due to restricted suckling is related to its interaction with the endocrine system.

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