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Influence of Feeding Management and Seasons on Yield and Composition of Milk Produced from Friesian Crossbred Cows Raised Under Hot and Humid Environment in Central Thailand

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ABSTRACT

A twelve-month on-farm experiment was carried out to investigate the effects of feeding management and seasons on yield and composition of milk from a total of 825 dairy cows with different Friesian crossbred levels raised under the hot and humid environment in central Thailand. Forty pre-selected farms were classified into two groups of twenty farms each (standard and substandard) according to feed and feeding management practices. The cows in first group received feeds that met the NRC's energy and protein daily requirments, whereas those in the second group were provided with substandard feeding practices. The % Friesian crossbred cows were classified into < 75, 75, 87.5, and >87.5 %. All cows were raised indoors throughout the three seasons (summer, rainy, and winter). It was observed that milk yield from cows fed the standard diet, averaging 15.90 kg/day, was 2.02 kg/day higher (P<.01) than those in the substandard group. The standard fed cows produced 0.25 % more (P<.01) milk fat (4.37 versus 4.12%), 0.16% milk protein (3.43 versus 3.27%), and 0.23 % SNF (8.81 versus 8.58 %) than the substandard ones respectively. Milk yield increased proportionally with increasing % Friesian crossbred levels, whereas milk components gradually decreased. The decline in milk composition was higher in the substandard fed group when compared to the group receiving the standard feed. In addition, the cows during the hot season produced milk with lower (P<0.01) milk protein and SNF than those in the remaining rainy and winter seasons.

Key words: milk yield, milk composition, Friesian crossbred, hot and humid environment

INTRODUCTION

One of the problems in dairy production in Thailand is the decline of milk composition, especially solid not fat (SNF). Swamiphak (1996) reported that SNF of raw milk from northern, north-eastern, southern and central Thailand averaged at 8.67, 8.43, 8.17 and 8.13 % respectively. According to Kaewkamcharn (2000) and Swamiphak(1996) a gradual decline of SNF from 1993 to 1999 in raw milk from collecting centers under the Dairy Farming Promotion Organization of Thailand was observed. Since SNF is one of the parameters in the milk price payment scheme for most dairy processors in the country, this economic loss has caused a major concern among the dairy farmers and the authorities.

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A number of factors affecting milk composition have been reported. The factors include feed and feeding practices, breed, seasons, lactation period, lactation number, milking technique and health conditions (Philpot, 1984; Collier, 1985; Sutton, 1989; Nickerson, 1995; Davison *et al*., 1996). However, the effects of feeding and the environment on yield and milk components in milking cows with various genetic potential under tropical conditions are limited. Therefore, the objective of this study is to investigate the situation.

MATERIALS AND METHODS

Animals and dairy farms

A one year on-farm experiment with a total number of 825 milking cows from 40 preselected dairy farms located around Saraburi province in central Thailand was carried out. The cows in studied area were Holstein Friesian cross breed with varying genetic levels of *Bos taurus*. The farms were equally divided into two groups (standard versus substandard) according to feed and feeding management practices. The cows in first group received feeds that met the NRC's (1988) energy and protein daily requirments, whereas those in the second group were provided with substandard feeding practices. All cows were normally housed in freestall barns all year round. Depending on accessibility, labours and seasons (summer, rainy and winter seasons), the cows were usually provided with fresh cut grasses and / or crop residues *ad libitum*. The animals also received commercially available 16 to 18 % crude protein concentrates with or without grains or agro-industrial by-products twice daily at milking time (about 06.00 and 16.00 h).

Data collection and statistical analysis

Farm visits were carried out at about 30 day intervals for a period of one year (March 2001 to February 2002). Daily milk yield as well as body score of individual cow was recorded during each farm visit. A composite of potassium dichromate preserved morning (30 ml) and afternoon (20 ml) milk from each milking cow was analyzed for milk composition (fat, protein and SNF) using Foss Electric MilkoScan 104. At the same time, roughages and concentrates provided to the cows were recorded and sampled for composition analysis following the procedures outlined by AOAC (1984). Feed analysis results were used to verify the consistency of the two feeding groups during the trial.

A multifactor factorial model was used in analyzing the data. The fixed effects were two feeding management (standard and substandard feedings), three seasons (summer, rainy, and winter seasons) and four genetic levels of crossbred Friesian (< 75, 75, 87.5, and >87.5 %). Daily milk yield and milk components were taken as random variables. Complex analysis using day in milk (DIM), lactation number and body condition scores as covariates was performed and variations among cows were also included in the following model.

$$Y_{ijkl} = \mu + F_i + S_j + (FS)_{ij} + HF_k + (FHF)_{ik} + (SHF)_{jk} + (FSHF)_{ijk} + ID(FSHF)_{ijk} + \beta(DIM_{ijkl} - \overline{DIM}) + \beta(LNO_{ijkl} - \overline{LNO}) + \beta(BS_{ijkl} - \overline{BS}) + \varepsilon_{ijkl}$$

where Y_{ijkl} = trait of cow associated with all covariates; m = mean intercept; F_i = fixed effect of i th feeding management; S_j = fixed effect of j th season; HF_k = fixed effect of k th % crossbred Friesian cows; $(FS)_{ij}$ = interaction between i th feeding management and j th season; $(FHF)_{ik}$ = interaction between i th feeding management and k th % crossbred Friesian; $(SHF)_{jk}$ = interaction between j th season and k th % crossbred Holstein; $(FSHF)_{ijk}$ = ijk fixed factor interaction; $C(FSHF)_{ijk}$ = random effect of ijk th cow subjected to all fixed factors; $b(DIM_{ijkl} - \overline{DIM})$ = regression effect of days in milk; $b(LNO_{ijkl} – \overline{LNO})$ = regression effect of lactation number; $b(BS_{ijkl} – \overline{BS})$ = regression effect of body condition score; e_{ijkl} = random residual error.

RESULTS AND DISCUSSION

Effect of feeding management and levels of Friesian crossbred

1. Milk yield

The effects of nutrition and levels of Friesian crossbred on milk yield of the dairy cows are illustrated in Table 1. The cows under proper feeding program produced an average of 15.90 kg/day milk as compared to 13.88 kg/day from those receiving the substandard feed. In addition, dairy cows for the <75, 75, 87.5, and >87.5 % crossbred groups yielded an average of 12.85, 12.92, 15.17, and 17.76 kg/day of milk respectively. Within the same crossbred group, dairy cows subjected to under feeding management consistently gave less (P<0.01) milk than those receiving proper feeding. However, the decline of milk yield was more (P<0.01) pronounced in the high Friesian crossbred groups. These findings agree with the reports of Gibson (1989) and Intharatul (1996) that cows with high genetic merit tended to provide more milk and that poor nutrition could alter the situation. Maximum energy intake and utilization had been reported to be crucial for optimal health and production of high yielding dairy cows (Heuer *et al*., 2000). In addition, Collier (1985) also reported that nutrients required by cows were directly related to the changes in yield and composition of milk.

2. Milk composition

Table 2-4 illustrate the influence of feeding management and levels of Friesian crossbred respectively on fat, protein and SNF content in milk. The cows receiving optimal feeding when compared to those fed the substandard feed produced milk with higher (P<0.01) contents of fat (4.37 versus 4.12 %), protein (3.43 versus 3.27 %), and SNF (8.81 versus 8.58 %) respectively. In addition, dairy cows for the <75, 75, 87.5, and >87.5 % crossbred groups provided milk with lower (P<0.01) fat (4.43, 4.19, 4.18, and 4.07 %), protein (3.61, 3.43, 3.34, and 3.26 %) and SNF (8.93, 8.81, 8.68, and 8.64 %) composition, respectively. Genetics is believed to partially contribute to the declining trends for the three milk components in high Friesian crossbred . On the same token, dilution effects from high milk secretion in these cows also play a role. However, it is evident from this study that proper feeding, to a certain extent, can alleviate the situation. Similar results were evident in the studies of Akerlind *et al*. (1999) and Sandoval-Castro *et al*. (2000) who observed that proper feed supplementation resulted in more fat and protein contents in milk from dairy cows.

Table 1 Least square means (±SE) of milk yield (kg/day) from Friesian crossbreds receiving different feeding management.

Feeding management	Friesian crossbred , %				Main effect
	< 75	75	87.5	> 87.5	
Standard	13.08±0.21 f	14.09±0.09 e	16.27±0.10 c	19.08±0.18 a	15.90±0.09 x
Under standard	12.32±0.26 g	11.89±0.12 h	14.49±0.09 d	16.92±0.19 b	13.88±0.10 y
Main effect	12.85±0.24 o	12.92±0.12 o	15.17±0.11 n	17.76±0.21 m	

abcdefgh Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
mno Means with different superscripts in the same row for main effects are different (P<0.01).
xy Means with different superscripts in the same column for main effects are different (P<0.01).

Table 2 Least square means (±SE) of milk fat (%) from Friesian crossbreds receiving different feeding management.

Feeding management	Friesian crossbred , %				Main effect
	< 75	75	87.5	> 87.5	
Standard	4.47±0.02 [a]	4.36±0.02 [b]	4.32±0.02 [b]	4.08±0.04 [c]	4.37±0.02 [x]
Under standard	4.39±0.06 [ab]	4.01±0.03 [c]	4.06±0.03 [c]	4.05±0.04 [c]	4.12±0.03 [y]
Main effect	4.43±0.05 [m]	4.19±0.02 [n]	4.18±0.02 [n]	4.07±0.05 [o]	

[abc] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mno] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Table 3 Least square means (±SE) of milk protein (%) from Friesian crossbreds receiving different feeding management.

Feeding management	Friesian crossbred , %				Main effect
	< 75	75	87.5	> 87.5	
Standard	3.68±0.02 [a]	3.53±0.01 [b]	3.39±0.01 [c]	3.31±0.02 [d]	3.43±0.01 [x]
Under standard	3.52±0.02 [b]	3.34±0.01 [d]	3.27±0.01 [e]	3.26±0.02 [e]	3.27±0.01 [y]
Main effect	3.61±0.02 [m]	3.43±0.03 [n]	3.34±0.01 [o]	3.26±0.05 [p]	

[abcde] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mnop] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Table 4 Least square means (±SE) of milk SNF (%) from various Friesian crossbreds receiving different feeding management.

Feeding management	Friesian crossbred , %				Main effect
	< 75	75	87.5	> 87.5	
Standard	9.03±0.02 [a]	8.95±0.01 [b]	8.79±0.01 [c]	8.76±0.02 [c]	8.81±0.01 [x]
Under standard	8.80±0.02 [c]	8.69±0.01 [d]	8.58±0.01 [e]	8.57±0.02 [e]	8.58±0.01 [y]
Main effect	8.93±0.02 [m]	8.81±0.01 [n]	8.68±0.01 [o]	8.64±0.02 [p]	

[abcde] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mnop] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Effect of feeding management and seasons

1. Milk yield

Seasonal changes had a significant effect (P<0.01) on milk production. As shown in Table 5, cows during the rainy season gave lower (P<0.01) milk yield than those during the summer and winter (14.52, 15.07, and 15.27 kg/day, respectively). Since green forages are normally avilable during the rainy season, low average milk yield is not expected. This reflect the accessibility problems to green forages by the dairy farmers in the area either from water lodging situation and/or limited pasture area However, milk production from dairy cows under the three climatic conditions varied dependently with the feeding practices. Collier (1985) and Sandoval-Castro *et al*. (2000) reported that the availability and quality of roughage feed under a tropical dairy system were normally variable and consequently could influence the level of milk output as well as its components.This situation could be somewhat alleviated with proper supplementation. It is evident from this study as shown in Table 5 that the cows receiving proper nutrition produced 13.3, 14.2, and 16.3 % more (P<0.01) milk when compared to those receiving substandard feed during the summer, rainy, and winter seasons,respectively.

2. Milk composition

Seasonal and feeding effects on milk fat, protein, and SNF are shown in Table 6, 7 and 8, respectively. Average milk fat (4.22, 4.30, and 4.23 %), protein (3.29, 3.41 and 3.36 %), and SNF (8.60, 8.77, and 8.73 %) for the summer, rainy and winter seasons were significantly different (P<0.01). The highest milk fat, protein, and SNF were observed in milk during the rainy season when roughages were supposed to be available in both quantity and quality. However, the low milk yield during this season indicated the influence rather from dilution effect not from roughages. In addition, during the rainy season, the cows recieving standard feeding when compared to those fed the substandard one produced milk with 6.39 % more fat (4.43 versus 4.17 %), 3.58 % more protein (3.47 versus 3.35 %), and 2.07 % more SNF (8.86 versus 8.68 %), respectively. The variation of milk components by seasons is in part related to the effect from climatic environment (Nickerson, 1995; Davison *et al*., 1996). In addition, Sutton (1989) and Davison *et al*. (1996) indicated that proper feeding management could improve not only milk components but also milk yield under adverse environment.

Table 5 Least square means (±SE) of milk yield (kg/day) from cows receiving different feeding management at different seasons.

Feeding management	Seasons			Main effect
	Summer	Rainy	Winter	
Standard	16.01±0.11 [a]	15.48±0.15 [b]	16.21±0.08 [a]	15.90±0.09 [x]
Under standard	14.13±0.11 [c]	13.56±0.13 [d]	13.94±0.11 [cd]	13.88±0.10 [y]
Main effect	15.07±0.10 [m]	14.52±0.12 [n]	15.07±0.07 [m]	

[abcd] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).

[mn] Means with different superscripts in the same row for main effects are different (P<0.01).

[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Table 6 Least square means (±SE) of milk fat (%) from cows receiving different feeding management at different seasons.

Feeding management	Seasons			Main effect
	Summer	Rainy	Winter	
Standard	4.36±0.03 [b]	4.43±0.04 [a]	4.33±0.02 [b]	4.37±0.02 [x]
Under standard	4.07±0.03 [d]	4.17±0.03 [c]	4.13±0.03 [c]	4.12±0.03 [y]
Main effect	4.22±0.03 [n]	4.30±0.03 [m]	4.23±0.02 [n]	

[abcd] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mn] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Table 7 Least square means (±SE) of milk protein (%) from cows receiving different feeding management at different seasons.

Feeding management	Seasons			Main effect
	Summer	Rainy	Winter	
Standard	3.38±0.01 [b]	3.47±0.01 [a]	3.45±0.01 [a]	3.43±0.01 [x]
Under standard	3.21±0.01 [e]	3.35±0.01 [c]	3.27±0.01 [d]	3.27±0.01 [y]
Main effect	3.29±0.01 [o]	3.41±0.01 [m]	3.36±0.01 [n]	

[abcde] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mno] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

Table 8 Least square means (±SE) of milk SNF (%) from cows receiving different feeding management at different seasons.

Feeding management	Seasons			Main effect
	Summer	Rainy	Winter	
Standard	8.72±0.01 [b]	8.86±0.02 [a]	8.87±0.01 [a]	8.81±0.01 [x]
Under standard	8.48±0.01 [e]	8.68±0.01 [c]	8.60±0.01 [d]	8.58±0.01 [y]
Main effect	8.60±0.01 [o]	8.77±0.01 [m]	8.73±0.01 [n]	

[abcde] Means with different superscripts within feed and % crossbred interactive effects are different (P<0.01).
[mno] Means with different superscripts in the same row for main effects are different (P<0.01).
[xy] Means with different superscripts in the same column for main effects are different (P<0.01).

CONCLUSION

Feeding management, seasons, and % Friesian crossbred as well as their interactions were found to have significant effect on yield and composition of milk. As the levels of Friesian blood in the dairy cows increased, milk yield also increased. Contrary to this, a decline of milk compositions was evident. Milk protein and SNF were higher during rainy season than the summer and winter seasons. Proper feeding significantly increased milk yield and, to a certain extent, could alleviate the decline in milk components. Hence, it is evident that under hot and humid environments, proper feeding management is important in dairy farming especially for those raising the high genetic merit cows.

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