Abstract T40

Association between milk production and Holstein fraction of upgraded dairy cattle in the Thai tropics

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SUMMARY

Upgrading local dairy cattle to Holstein (H) has been used as a strategy to increase milk production in many tropical countries. The expectation is that milk production will increase alongside increments in H fraction of upgraded animals. However, lack of adaptation of high percent H cattle to tropical conditions may prevent them from achieving their expected production potential. The aim of this study was to evaluate the association between milk production and H fraction of high percent upgraded cattle in Central Thailand using 305-d milk production (**MY**) of 3,222 first lactation cows from 304 farms. Data were gathered between 1990 and 2011. Eight high fraction groups were defined: **BG1** (H < 0.625), **BG2** (0.625 ≤ H < 0.6875), **BG3** (0.6875 ≤ H < 0.75), **BG4** (0.75 ≤ H < 0.8125), **BG5** (0.8125 ≤ H < 0.875), **BG6** (0.875 ≤ H < 0.9375), **BG7** (0.9375 ≤ H < 1) and **BG8** (H). The model included herd-year-season subclass, calving age (month) and breed group as fixed effects, and residual as a random effect. Least squares means (LSM) of **MY** were estimated for each breed group and then used to fit a second degree polynomial function to explain the change in **MY** for every 0.0625 H fraction in cows 62.5% H and above. Milk production differed across herd-year-seasons, calving ages and breed group subclasses (P<0.01). Cows with H fraction from 0.8125 to less than 0.875 had the highest **MY** of all breed groups. The LSM of **MY** tended to increase as H fraction increased from **BG1** (4,075 ± 109 kg) to **BG5** (4,285 ± 47 kg) and then it decreased towards **BG8** (4,120 ± 76 kg). This association between **MY** and H fraction can be explained (R^2 = 0.61) with a second degree polynomial equation: **MY** = 2,055 + 5,082 (H fraction) – 2,957 (H fraction)². The quadratic association between **MY** and H fraction found in Central Thailand stressed the limitations of upgrading adapted local dairy cattle to H as a means of increasing milk production under tropical conditions.

INTRODUCTION

Dairy production has increased in many tropical countries. Upgrading of local breeds and crossbred cattle to Holstein (H) has been used as a strategy to increase milk production. However, agricultural areas in tropical countries usually have high temperatures and humidity levels. These conditions could be limiting factors for milk production of dairy cattle (Bohmanova *et al.*, 2007). Furthermore, H is a dairy breed that originated and has been improved under temperate environmental conditions. Increasing the H fraction of crossbred dairy cattle under tropical conditions would increase their stress level and limit milk production. It is likely that the association between milk production and H fraction is not linear in Thailand. Understanding the association pattern between milk production and H fraction of dairy cattle raised under various tropical conditions using accumulated field records would help the dairy producers to make suitable decisions on management and genetic improvement. Milk production in dairy cattle groups of various H fractions has been compared under experimental conditions in the tropics, which limited the range of environmental conditions cattle were exposed to. ***Thus, the objective of this research was to study the association between milk production and H fraction of upgraded dairy cattle under field conditions in the Thai tropics.***

MATERIALS AND METHODS

Animals and Data. The dataset consisted of 305-d milk production (**MY**) of 3,222 first lactation cows recorded from 1990 to 2011. These first lactation cows were raised and milked in 304 farms located in Central Thailand. Pedigree and milk production of these cows were gathered individually by staff of the Dairy Farming Promotion Organization of Thailand (DPO). The average of **MY** of cows in this population was 4,145 kg (SD = 1,115 kg; Table 1).

Seasons were winter (November to February; 17ºC to 32ºC, 73%RH), summer (March to June; 21ºC to 36ºC, 71%RH), and rainy (July to October; 24ºC to 33ºC, 80%RH). All cows were kept in open-barns and milked twice a day; firstly in the morning (beginning at around 5am) and secondly in the afternoon (beginning at around 3pm). Feeding was mainly based on concentrate (1 kg of concentrate per 2 kg of milk), and fresh grass (30 to 40 kg/d; e.g., *Penicum maximum*, *Brachiaria ruziziensis, Pennisetum parpureum, and Brachiaria mutica*). When fresh grasses were insufficient, especially during dry seasons (winter and summer), rice straw, crop residues and agricultural by products were provided as supplement. Minerals were available as free choice.

Dairy farmers used a H upgrading scheme to improve milk production in subsequent generations. All cows were artificial inseminated. Semen of H and crossbred H bulls was chosen primarily based on catalog sire information and semen availability and price. Dairy cows were assigned to 8 breed groups according to their H fraction: **BG1** (H < 0.625), **BG2** (0.625 ≤ H < 0.6875), **BG3** (0.6875 ≤ H < 0.75), **BG4** (0.75 ≤ H < 0.8125), **BG5** (0.8125 ≤ H < 0.875), **BG6** (0.875 ≤ H < 0.9375), **BG7** (0.9375 ≤ H < 1) and **BG8** (H = 1).

Data Analysis. The model considered herd-year-season subclass, calving age (month) and breed group as fixed effects, and residual as a random effect. Least squares means (LSM) of **MY** were estimated for each herd-year-season and breed group subclass. The **MY** LSM for herd-year-seasons were averaged across herds and seasons to compute LSM of **MY** for each year, and then used to estimate the regression coefficient of **MY** LSM on year. Similarly, the **MY** LSM for herd-year-seasons were averaged across herds and years to estimate LSM of **MY** for each season. The **MY** LSM for breed groups were used to fit a second degree polynomial function to explain the change in **MY** for every 0.0625 H fraction in cows 62.5%H (0.625H) and above. Significant differences were considered at α = 0.05.

Table 1. Descriptive statistics for 305-d milk production of cows in the population

BG	Holstein Fraction	n	Mean	Standard Deviation	Minimum	Maximum
1	H < 0.625	76	3,678	1,075	1,324	6,253
2	0.625 ≤ H < 0.6875	44	3,691	1,106	1,314	8,224
3	0.6875 ≤ H < 0.75	89	3,980	1,149	1,746	6,801
4	0.75 ≤ H < 0.8125	351	3,842	1,023	713	7,549
5	0.8125 ≤ H < 0.875	412	4,095	1,058	1,204	8,600
6	0.875 ≤ H < 0.9375	1,026	4,157	1,073	1,391	9,089
7	0.9375 ≤ H < 1	1,050	4,347	1,185	378	9,173
8	Holstein	174	3,992	979	1,500	8,028
	Total	3,222	4,145	1,115	378	9,173

RESULTS AND DISCUSSION

Milk production differed across herd-year-seasons, calving ages and breed group subclasses (P < 0.01). Herd-year-season LSM for **MY** ranged from 1,513 ± 550 kg to 8,683 ± 450 kg. The regression of **MY** LSM on year indicated that cows in this multibreed population increased their **MY** at a rate of 30 ± 6 kg/yr (P < 0.001). This positive rate of increase in cow **MY** per year may be partly due to higher average genetic ability of replacement cows due to selection of superior parents (particularly sires), and partly due to improvement in feeding, management, and health practices in Central Thailand. The **MY** LSM per season across years indicated that cows that calved in winter had higher **MY** (4,354 ± 57 kg; P < 0.001) than cows that calved in the summer (4,007 ± 55 kg) and rainy seasons (4,130 ± 55 kg).

Differences in **MY** LSM for herd-year-seasons indicated the environmental effects differed among seasons in particular years and herds. Cows that calved in the summer and rainy seasons generally had higher stress levels due to higher ambient temperatures (21ºC to 36ºC) and humidity (71% to 80% RH) than those that calved in winter (21ºC to 32ºC and 70% RH). Individual sensitivity to heat stress was found to have a larger environmental than a genetic component in crossbred H raised in Thailand (Boonkum *et al.*, 2011). To reduce the impact of these stresses on cow **MY**, famers need to improve their management practices (e.g., housing and feeding) to better match the genetic production ability of their cows. In addition, genetic selection for heat tolerance should be considered to reduce costs of production under high temperature and humidity conditions.

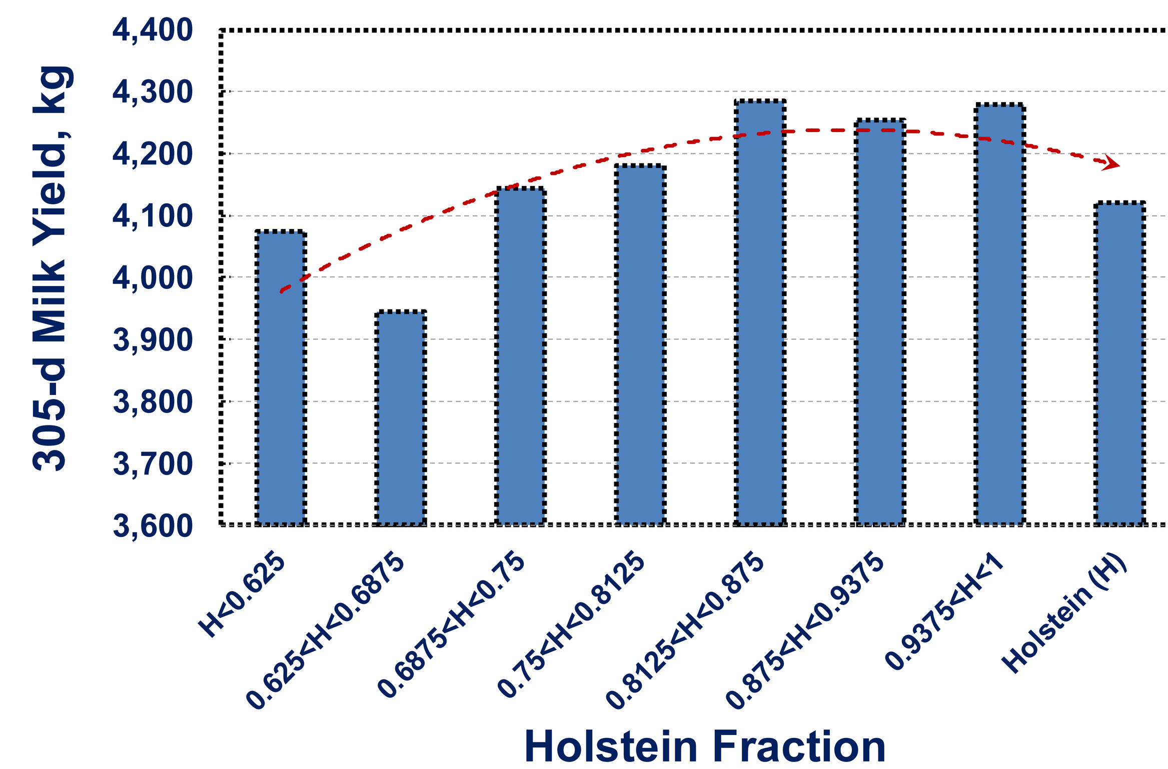

Figure 1. Milk production of dairy cows in different Holstein fraction groups

The LSM for **MY** across breed groups ranged from 3,944 ± 142 kg (**BG2**: 0.625 ≤ H < 0.6875) to 4,285 ± 47 kg (**BG5**: 0.8125 ≤ H < 0.875; Table 2). Cows with H fraction from 0.8125 to less than 0.875 (**BG5**) had the highest **MY** of all breed groups. However, **MY** LSM for cows in **BG5** was not significantly different from cows in other breed groups, except for **BG2** (P < 0.05). As H fraction increased, the **MY** LSM tended to increase from **BG1** (4,075 ± 109 kg; H < 0.625) to **BG5** (4,285 ± 47 kg; 0.8125 ≤ H < 0.875) and then it decreased towards **BG8** (4,120 ± 76 kg; H). This association between **MY** and H fraction can be described with a second degree polynomial equation (R^2 = 0.61; Figure 1): **MY** = 2,055 + 5,082 (H fraction) – 2,957 (H fraction)².

The quadratic association between **MY** and H fraction found in Central Thailand stressed the limitations of upgrading adapted local dairy cattle to H as a means of increasing milk production. High temperature and humidity conditions in the summer and rainy seasons (March to October) and low quality and quantity of roughage in winter and summer (November to June) likely created stressful conditions for dairy cows. Cows with different H and other breeds fractions will be affected differently by high ambient temperature and amounts of moisture in the air depending on their level of adaptation to tropical conditions. Cows with lower H fraction, especially those with a high fraction of a local Thai breed or *Bos indicus* will tolerate hot and humid conditions better than high H fraction cows. Under these high temperature and humidity conditions, cows with very high H fraction appeared to have been less adapted and perhaps consumed insufficient amounts of feed to meet energy demands, mobilized body reserves to maintain milk production levels. This may have contributed to their decrease in milk production.

Results here indicated that high percent Holstein cows failed to reach their production potential under the hot and humid climatic conditions in this tropical region (Koonawootrittriron *et al.*, 2009; Seangjun *et al.*, 2009). To achieve high milk production levels with very high H fraction cows, dairy producers would need to further improve their management practices to relieve stress due to heat and humidity and provide good quality forage to dairy cattle throughout the year. Selection for tolerance to hot and humid conditions should also be considered in addition to production and reproduction traits to reduce production costs.

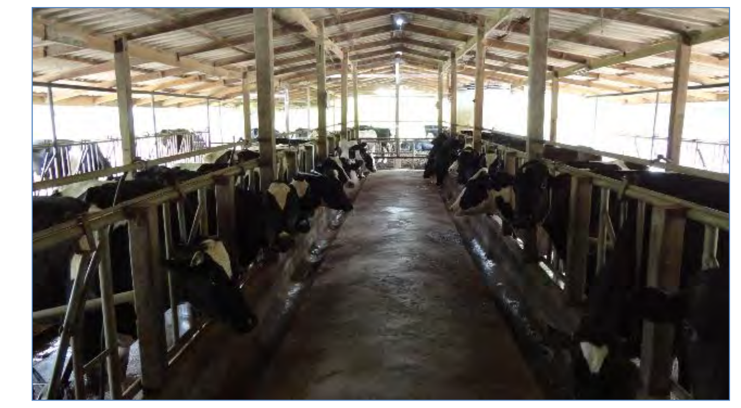

Table 2. Least squares means and standard errors for milk production by Holstein fraction group

BG	Holstein Fraction	Milk Production (kg)
1	H < 0.625	4,074.7 ± 108.5[abc]
2	0.625 ≤ H < 0.6875	3,944.2 ± 141.9[a]
3	0.6875 ≤ H < 0.75	4,144.3 ± 104.1[abc]
4	0.75 ≤ H < 0.8125	4,181.3 ± 50.7[abc]
5	0.8125 ≤ H < 0.875	4,284.9 ± 47.2[bc]
6	0.875 ≤ H < 0.9375.	4,254.4 ± 29.1[bc]
7	0.9375 ≤ H < 1	4,279.0 ± 30.8[c]
8	Holstein (H)	4,120.1 ± 75.9[ab]

FINAL REMARKS

- *Limitations of upgrading adapted local dairy cattle to H as a means of increasing milk production were found under Thai tropical conditions.*
- *Under Thai tropical conditions, milk production tended to increase as H fraction increased from **BG1** (H < 0.625) to **BG5** (0.8125 ≤ H < 0.875) and then it decreased towards **BG8** (H).*
- *Association between **MY** and H fraction could be explained with a second degree polynomial equation: **MY** = 2,055 + 5,082 (H fraction) – 2,957 (H fraction)².*

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