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Environmental effects on production and fertility traits in Northern Thai dairy cattle

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Introduction

Dairy production is going to play an important role in Thailand's agriculture, although the present dairy industry in Thailand is still fairly small but growing. Many milk factories were established in the recent years and an increasing number of farmers have changed from plant to milk production, which was encouraged by the government extension policy since 1962. Currently, milk production in Thailand is mainly performed on small holder farms in the northern area with about 5 to 10 cows and a very limited area for raising cattle. In the effort to improve milk production, in the last two decades dairy cattle management has been orientated towards increasing milk yield per animal. Two elements in this process have been the dependence on the breeding policy on Holstein Friesian bull semen from the temperate, continental regions of Europe or North America and the selection of sires based on milk yield only. In this respect the term environment does not only comprise the physical and climatic factors but also the production and health management, the economic constraints, the prevailing agricultural policies and their combinations. The aim of the study was to identify significant environmental effects on production, reproduction and conformation traits of Holstein Friesian upgrade cows, because adjusting records for known causes of variation is essential for efficient selection procedures.

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Material and Models

Data for the current study were collected from 252 farms with in average 8,6 cows per farm in three regions within Northern Thailand. The data set comprised 2764 first lactation production and 1623 reproduction records including body conditioning scoring from cows calving between 1997 and 2002. In addition, body measurements and weights in different age groups in a sample of cows were recorded. Tables 1 gives an overview of collected data. Because of the high costs of investigations of milk contents in laboratories, a collected sample of progeny groups was drawn. In this sample, only daughters of sires with 20 offspring and more were considered. The HF – breeding status of cows could be taken directly from the ear tag identification system which in principle has not changed since its introduction in 1966 by the German – Thai project.

Table 1: Descriptive statistics of the investigated production and reproduction records

Trait	Number of cows	Mean	SD
Milkg-kg 100 d	2764	1267	418.9
Milk-kg 305 d	2764	3867	1257.6
Fat-%	391	3.81	0.075
Protein-%	391	3.22	0.028
Total solid-%	391	12.88	0.25
Somatic cells	391	267228	30000
Age of first calving (in month)	1623	28.6	0.07
Services per conception for second parity	1623	2.81	2.4
Days open	1623	129.5	64.3
Calving interval	1623	462.6	98.3
Body condition Score (BCS)	1623	3.32	0.77

To start with, data were subjected to analysis of variance in order to determine the non genetic factors affecting production, reproduction and conformation traits. The general analysis was done using the GLM procedure of SAS (Model 1).

$$Y_{ijklmn} = \mu + H_i + Y_j + S_k + HF_l + (Y*S)_{jk} + b(AC)_{ijklm} + e_{ijklm}$$

Y_{ijklmn} = production, fertility and conformation traits of cow n in parity 1

μ = overall population mean

H_i = fixed herd effect

Y_j = fixed effect of calving year

S_k = fixed effect of season of calving (k=1,2,3)

HF_l = fixed effect of percent of Holstein Friesian genes (k=1...5)

$(Y*S)_{jk}$ = interaction between year and season of calving

$b(AC)_{ijklm}$ = age at first calving as covariate with b being the linear coefficient

e_{ijklm} = random residual effects

Classes of percent HF were created beginning with 50 up to 100 % in increments of 10 %. The seasons of calving were defined as rainy (June – October), winter (November – February) and summer (March – May). Because of practical feasibility, it wasn't possible to determine weights of all cows using an electronic weighting machine. A random sample of 254 weights was used to calculate regression coefficients from body measurements on body

weights. Applying a linear stepwise regression model (SAS, 2001), regression coefficients were 3.73 for heart girth, 3.37 for body length, and 0.95 for rear height, respectively.
To reveal the detailed impact of management practices within farms on production and reproduction traits, farms were characterized by its farm size, number of cows and roughage sources as indicators for feed quality. The model 2 was:

Y_{ijkl} = $\mu + F_i + C_j + R_k + e_{ijkl}$
Y_{ijk} = production and fertility traits of cow l in first parity
μ = overall population mean
F_i = fixed effect of farm size
C_j = fixed effect of no. of cows per farm
R_k = fixed effect of feed quality
e_{ijklm} = random residual effects

Results
In the initial analysis of variance (Model 1), which was aimed at investigating the effect of some important environmental factors on production records, the fixed factors of calving year, calving season and percentage of HF – genes had no significant influence ($p < 0.05$) on milk yield in the first 100 days of lactation and over a period of 305 days. Despite these findings, there is a strong interaction between years and seasons of calving ($p<0.05$). Least squares means of lactation milk yield by year and season of calving are presented in table 2. Age at first calving, witch was fitted as a covariate in the mixed model, was significant ($p<0.01$) on first lactation milk yield. In all analyses, there is no significant influence of fixed effects on protein and fat contents.

Table 2: LSQ-Means for lactation milk yield (100 and 305 days) of Holstein Friesian upgrade cows for different calving years and calving seasons

Calving Year	Calving Season	Milk-kg 100-d		Milk-kg 305-d	
		Mean	SE	Mean	SE
1997	Rainy	1067[b]	25.6	3254[b]	162.7
	Winter	1015[b]	23.8	3271[b]	170.0
	Summer	925[b]	23.2	2821[b]	154.1
1998	Rainy	1201[c]	31.6	3662[c]	186.9
	Winter	1090[b]	30.0	3325[b]	172.3
	Summer	1325[d]	34.5	4041[d]	210.3
1999	Rainy	1182[c]	31.1	3606[c]	188.8
	Winter	1184[c]	31.8	3612[c]	190.9
	Summer	1169[c]	31.6	3564[c]	187.7
	Winter	1184[c]	32.0	3612[c]	190.1
2000	Winter	1169[c]	30.4	3567[c]	187.5
	Summer	1282[d]	33.9	3910[d]	201.2

Different superscripts within mean groups indicate significant difference ($p<0.05$), t-test

For fertility traits including services per conception, days of heat return and calving interval, fixed effects of the calving season and the genetic group of the sire characterized by levels of percentages of Holstein genes show significant impact applying analysis of variance ($p<0.05$). Within all calving years, a distinct advantage could be found for cows calving in the winter season followed by summer calvings. Least square means of services per conception by groups of sires with different levels of Holstein genes show an advantage within a range from 50 % till 80 % HF genes. But there is a favourable trend between the amount of Holstein Genes and the days of heat return after first insemination resulting in nearly the same calving interval for all groups of sires.
Insemination with purebred Holstein sires tends to result in taller and heavier cows with more body length and heart girth than cows stemming from sires with only 50 % of Holstein genes. Results of genetic groups of sires on fertility and conformation traits are shown in table 3.

Table 3: LSQ-Means for fertility and conformation traits of Holstein Friesian upgrade cows stratified by groups of sires with different percentages of HF genes

% HF	Services per conception	Days of heat return (days)	Calving interval (days)	Rear height (cm)	Heart girth (cm)	Body Weight (kg)
50 – 60	1.23[a]	109.4[b]	447.7[a]	114.6[a]	175.2[c]	397.1[a]
61 – 70	1.43[a]	115.5[b]	425.3[a]	124.8[b]	181.3[ab]	427.3[b]
71 – 80	1.10[a]	89.5[a]	437.3[a]	125.1[b]	180.8[ab]	423.4[b]
81 – 90	2.23[b]	83.5[a]	383.0[b]	125.2[b]	179.5[a]	414.7[b]
91 – 100	2.14[b]	109.9[b]	445.9[a]	125.9[b]	183.9[b]	420.3[b]

Different superscripts within mean groups indicate significant difference ($p<0.05$), t-test

Farm size and roughage sources and the number of cows within farms have no significant influence ($p<0.05$) on production traits. However there is a distinct dependence between the roughage basis and the success in fertility ($p<0.05$). Feeding Total Mixed Rations respectively fermented rice straw in addition to fresh grass result in significant better conception rates leading to less days open and an improved calving interval of about one month compared with those farms using untreated straw or various by products from vegetable farming as roughage sources in their feeding rations (Table 4).

Table 4: LSQ-Means for fertility traits of Holstein Friesian upgrade cows stratified by classes of roughage sources

Roughage source	Days open	Services per conception	days of heat return	gestation length	Calving interval
grass + TMR	128[a]	1.23[a]	107	279	398[a]
grass + by products	155[b]	2.31[b]	110	277	432[b]
grass + rice straw	168[b]	2.22[b]	120	280	423[b]
grass + fermented rice straw	133[a]	1.47[a]	117	278	412[a]

Different superscripts within mean groups indicate significant difference ($p<0.05$), t-test

Discussion and Conclusions
With an average production level of 3668 kg milk per lactation (305 days) the actual performance of Northern Thai dairy only reaches one half of the production level of Holstein cows in temperate zones indicating essential feeding and management reserves despite the

depressing effect of the humid and hot tropical environment. The milk contents (3.85 % fat, 3.15 % protein) are slight below performances of Holsteins in Western Europe or North America mainly due to environmental effects. In our analysis, the genetic group of the sire expressed in percentages of Holstein genes beginning with 50 % up to 100 % has no significant influence on milk performances. In contrary, REODECHA (2002) reported that there is a wide range of milk producing ability from 7 –8 kg to over 20 kg per cow and day mainly depending on the proportion of Holstein Friesian genes. But starting his analysis with 62.5 % HF proportions, an increase in Holstein genes leads in diminishing returns in response of production. Another explanation for our results could be that the positive effect of Holstein gene proportions on milk yield is superposed by the negative effect of higher percentages of white colour. Cows belonging to the lowest HF – class (50 – 60 % Holstein genes) have in average 14.3 % of white colour, cows in the highest HF – class (< 90 % Holstein genes) in contrary 36.6 % of white colour. The black areas of the coats of Holstein–Friesians absorb more heat. Cows with larger areas of black seek shade sooner than other cows on hot days. However, there has been a preference in the past for selecting cows with limited areas of white, because of the fear of skin cancer.

We found a strong dependence between milk yield and the interaction of calving season and calving years. In the summer season 1997, milk yield was significantly lower compared with rainy and winter month but in 1998, there is an advantage for cows calving in the summer period. Because within seasons, especially in Northern Thailand, the climate can be very variable because of changing Monsun winds. And even in the cold season from October until February, temperature decreases only to levels of 30 degrees in average which is not the optimum for Holstein cows favouring temperatures between 25°F and 77°F (KEOWN, 1991). The effect of heat stress on changes in body weight, milk production and services per conception in Holstein, Jersey and Australian Milking Zebu Cows was carried out by SKRIKANDAKUMAR and JOHNSON (2004) showing a significantly different breed x treatment interaction for production traits. The THI during the cooler month of December was 72 and THI increased to 93 in July. This explains an average daily milk production of the Holstein cows significantly higher than that of Jerseys and Australian Milking Zebus only in December. Cattle will automatically reduce their feed intake during hot weather. Typically, early lactation cows are most swiftly and severely affected. This decreased forage intake alters the composition of the rumen and leads to acidosis and reduced fat content of milk. If cows reduce their intake during heat stress, more nutrients need to be packed into a smaller volume of feed. In our study, improved roughage quality in terms of fermented rice straw leads to higher milk yield (3731.2 vs 3674.5), protein contents (3.22 vs 3.17) and fat contents (3.87 vs 3.80) compared with unfermented rice straw. But we found a significant difference in fertility traits stratified for different feeding strategies. There is an obvious disadvantage of feeding unfermented rice straw on days open, calving interval, days of heat return and services per conception in comparison to fermented roughages or TMR, respectively.

References

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