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Suitable Percentage of Holstein in Crossbred Dairy Cattle in Climate Change Situation

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Abstract: The investigation of a suitable level of Holstein of crossbred Holstein in climate change situation was the aim of this study. The exceeded 8,000 records of milk yield from 2007-2009 were used. Temperature and relative humidity of each day from 2007-2009 were the weather data. Temperature and Humidity Index (THI) was calculated and compared by t-test. Milk production was divided into 3 groups followed by the different percentages of Holstein, G1 = % Holstein<80%, G2 = % Holstein from 80-89%, G3 = % Holstein≥90. Ordinary least square was used to estimate the effect of all fixed effects which included lactation, day in milk and the combination between the years and breed groups. The stability of the effect of combination between the years and breed groups were used to detect the ability to stand in climate change situation of each group of Holstein. THI was significantly increased each year from 86 in 2007 to 91 in 2009. The consistent effect on milk production was shown in only G2. The results of this study suggested that climate change situation obviously affected the production of dairy cows and that the suitable level of Holstein was in the range of 80%.

Key words: Climate change, crossbred Holstein, percentage of Holstein, milk production, Thailand

INTRODUCTION

It is undeniable that the global climate change situation which the world is confronting in the 21st century is having a serious impact on the agricultural industry around the world. This crisis will continue in a long time (Leary *et al*., 2009). The quick adoption and adaptation should be done, particularly on the part of agricultural industry.

Dairy cattle production is the one industry which is impacted by the crisis, since it induces the heat stress to animals (Nardone *et al*., 2010). Heat stress is one of the main causes that decreases dry matter intake, reduces the efficiency of milk yield (West, 2003; Bohmanova *et al*., 2008) and reduces the fertility (Jordan, 2003).

On the part of milk production, the study of Berman (2005) indicated that increasing milk yield decreased threshold temperature since, higher milk production had higher metabolic heat. Holstein Friesian is one of the major breeds of dairy cattle, they were selected for high milk production thus, it is high possibility that this breed will confront with milk decreases when the climate temperature increases. Even there are some suggestions that evaporative cooling system can cope with this problem but it is not the final answer for the developing countries which are dispersed in some part of the tropical zone. Crossbred Holstein which crosses between Holstein, *Bos taurus* and *Bos indicus* has been used as the main strain in this area since they are well adapted to the tropical environment (Milazzotto *et al*., 2008; Tadesse and Dessie, 2003; Freitas *et al*., 1998). However, the question is; which level of Holstein in crossbred is suitable for the situation of global warming crisis?

The objective of the present study was to investigate the suitable level of Holstein in crossbred dairy cattle in climate change situation.

MATERIALS AND METHODS

Data and animals: The study was conducted in Nakhon Ratchasima province, the major area of dairy cattle raising in Thailand. The exceeded 8,000 records of milk yield from 2007-2009 were used in this study. The data was divided into 3 groups followed by the different percentage of Holstein, <80, 80-89, >90% were G1-G3, respectively. All cows have been raised in an opened-house system.

Weather information: Temperature, percent relative humidity of Nakhon Ratchasima province from 2007-2009 in each day were collected by Meteorological station in

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this province. Temperature and Humidity Index (THI) were calculated in equation. Temperature, percent relative humidity and THI in each year were shown in Table 1. When Td, RH are dried temperature and relative humidity:

$$THI = Td - [(0.55 - 0.55RH) \times (Td - 58)]$$

Statistical analysis: The average of THI in each year was compared and test the significant difference with t test at 95% level of confidence. Least square mean and Standard Error (SE) of milk yield (kg/cow/day) in each group and year were calculated and shown in Table 2. General linear model and ordinary least square were the model and method used to estimate the effect of all fixed effects in this study which included lactation, day in milk and the combination between years (2007-2009) and breed groups (G1-G3). The stability of the effect of combination between years and breed groups in each class and the direction on milk yield were used to detect the ability to stand in climate change situation of each group of Holstein. Duncan 's new multiple range test was used to compare mean between breed groups and years at 95% of level of confidence. SPSS for window (Release 10.0) (SPSS INC. Chicago, IL) was used in the analysis.

Table 1: Average Temperature Humidity Index (THI) in each month from 2007-2009 of Nakhon Rachsima province in Thailand

	THI		
Months	2007	2008	2009
January	80.16	82.39	85.83
February	86.64	80.77	92.24
March	90.10	87.94	93.40
April	91.23	90.55	95.08
May	86.58	87.88	92.91
June	90.90	88.42	91.83
July	88.84	88.07	90.53
August	86.61	87.52	93.07
September	86.91	86.61	92.95
October	82.87	86.31	89.28
November	79.56	81.14	89.72
December	82.69	78.79	87.78
Average	86.09^{A}	85.53^{A}	91.22^{B}

$^{A, B}$mean are significant difference at $p<0.01$

Table 2: Least square mean, Standard Error (SE), the no. of record of milk yield in each breed group (G1 = <80% Holstein, G2 = 80-89% Holstein and G3 = ≥90% Holstein) and each year

Breed groups	years	LS-mean	SE	No.
G1	2007	12.60^{bcd}	0.21	482
	2008	10.04^{a}	0.29	189
	2009	11.71^{bc}	0.32	164
Average		11.84^{A}		
G2	2007	12.49^{bcd}	0.19	634
	2008	13.16^{e}	0.31	170
	2009	13.17^{e}	0.42	85
Average		12.68^{B}		
G3	2007	12.80^{de}	0.14	3413
	2008	11.95^{bcd}	0.16	1713
	2009	11.56^{b}	0.17	1196
Average		12.34^{B}		

$^{A, B}$ and $^{a-e}$mean within a column followed by different superscripts are significant difference at $p<0.05$ when between breed group and combination between breed group and year were compared, respectively

RESULTS AND DISCUSSION

The significant differences of THI between 2007 vs. 2009 and 2008 vs. 2009 were detected ($p<0.01$) (Table 1). This result showed that the situation of climate change in the main area of dairy production in Thailand affected the increase of THI in each year. In additional, the average THI in each year was >80 which was uncomfortable for cows to produce their production since, heat stress would occurred and it will affect milk production (Bouraoui *et al*., 2002; Chase, 2005).

When the least square mean of milk production between breed groups was compared, G1 showed the lowest milk production while G2 and G3 had no significant differences between each other (Table 2). It is unquestionable result since, G1 has the most proportion of Thai native cattle with very low performance of milk production since, Thai native cattle is not the dairy cow. They were crossed with 100% Holstein since, they have the ability of heat tolerance which suitable for the tropical area (Pastsart *et al*., 2006).

This result is similar to the study of Perotto *et al.* (2010) which found that when the level of Holstein increased from 0.5-0.875, milk production would increase and would decrease thereafter. While the result showed slight differences by Tadesse and Dessie (2003) which found the highest level of Holstein could produce the highest milk production. The different breed which was composed with Holstein might be the cause of this inconsistency.

The combination of G2 and 2008, 2009 showed the highest milk production while the combination of G3 and years showed the reduction of milk production in each year (Table 2). When the stability of the effect of this combination on milk production was shown in Table 3, the

Table 3: The effect of breed group and year Standard Error (SE) when G1 = <80% Holstein, G2 = 80-89% Holstein and G3 = ≥90% Holstein

			Pairwise comparisons		
Breed groups	years	Effect (SE)	G1	G2	G3
G1	2007	0.96 (0.21)**	0	0.39	0.003
	2008	-1.03 (0.29)**	0	-1.34**	-0.72*
	2009	-0.18 (0.31)	0	-0.60	-0.18
G2	2007	0.57 (0.19)**	-0.39	0	-0.36*
	2008	0.31 (0.31)	1.34**	0	0.62*
	2009	0.42 (0.44)	0.60	0	0.42
G3	2007	0.93 (0.13)**	-0.003	0.36*	0
	2008	-0.31 (0.14)**	0.72*	-0.62*	0
	2009	0	0.18	-0.42	0

** and *mean significant difference at $p<0.01$ and <0.05, respectively result showed the consistent effect in G2 while unsteady effect was detected in the other groups. First explanation of this result are the ability of heat tolerance in different level of Holstein are not similar from the study of Pastsart *et al.* (2006) and Koatdoke *et al.* (2006) which they compared the ability of heat tolerance between different level of Holstein. They found that higher level of Holstein have lower ability to resist in the hot climate than lower level of Holstein. With the different ability should be mainly affected from genetic structure. From the review of Collier *et al.* (2008), they point that there is a network of genes which are indirect and direct responsibility of heat stress regulation. Heat shock proteins genes are one group of genes encode groups of proteins which mainly related with stress response. Pastsart *et al.* (2006) and Nuamchit (2010) investigated the polymorphism of heat shock protein 90 gene and heat shock protein 70-2 gene, respectively in different level of Holstein. The similar result was found in both studies, different genotype frequency or different SNPs were detected in different level of Holstein and the high frequent genotype in lower level of Holstein are associated with the high ability of heat tolerance. As the mentioned may be one of the reasons why the stability effect on milk yield was found in G2. The other explanation is thermoregulation, the mechanism of animal uses to keep their inner temperature to the normal range were functioned when the situation of THI exceed than 72, the comfortable for milking cows (Chase, 2005; Sanchez *et al.*, 2009; Nardone *et al.*, 2010), this mechanism will directly affect on feed intake reducing to decrease heat production, particularly in rumen fermentations (West, 2003; Morand-Fehr and Doreau, 2001). In additional, some previous studies such as Chase (2005), Kadzere *et al.* (2002), St-Pierre *et al.* (2003), Berman (2005) and Nardone *et al.* (2010), they found that high milk production increased metabolic heat production when they were raised in high THI zone, it caused the increase of respiratory rate and feed intake would decrease. Consequently, milk production would decrease. Therefore from this study, the possible reason to explain is G2 which is the lower level of Holstein than G3 gives lower production in normal situation which means that their metabolic heat should be lower than G3. Therefore in high THI situation (Table 1), it was possible that G2 might be better in maintaining the level of milk production.

CONCLUSION

Climate change situation obviously affect on production of dairy cows. From this study, the suitable level of Holstein was in the range of 80%. The suitable level of Holstein or the other breeds however, need to be investigated in each zone of the world. Since, it is highly possible that in the next 10 years purebred Holstein may be impossible to raise in the tropical and sub-tropical zone, particularly in the open-house while in temperate zone which in comfortable for Holstein and the other *Bos taurus* may change due to the global warming situation. The superior sires which have proved their genetic potential may not be suitable to produce their daughters. Selection and improvement of the genetic potential of crossbred sires which may be a serious mission of animal breeders, need to be achieved as soon as possible.

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