Effect of homogeneous climatic zones on fertility traits in the Italian Holstein cattle breed

G. Bramante[1], R. Finocchiaro[1], S. Biffani[1], F. Canavesi[1], P. Coccimiglio[2], P. Menesatti[3], A. Vitali[4], M. Cappelloni[5]

[1] ANAFI, Research and Development, Via Bergamo 292, 26100 Cremona, Italy
[2] CNR-IBIMET, National Council of Research, Institute of Biometeorology, Italy
[3] ISMA-CRA, Sperimental Institute for Agricultural Mechanisation, Italy
[4] DIPAN, Animal Production Department, University of Tuscia
[5] AIA, Italian Animal Association

Abstract

Weather conditions are known to have effects on performance and well-being of livestock animals. The Italian Biometeriological Institute identified six homogeneous climatic zones. These were defined based on level of Temperature-Humidity Index (THI) in the summer period (June-August). The aim of this study was to examine the effect of different weather conditions on reproductive performances in the Italian Holstein cattle population. For this study we used four fertility traits including angularity (ANGO), calving interval (CI), nonreturn rate at 56 d (NR56), and days to first service (DTFS). Data consisted of reproductive records and several fixed effect models on for each trait were used. Fixed effect included age at calving, lactation stage, month of calving-year of calving, month of insemination-year of insemination and zone. Furthermore to each model the breeding value of the trait was added as covariate. THI zones were significant on all traits and the results show that it might be important to improve investigation on that topic with future aim of to include weather information in the genetic evaluation model for the Italian Holstein cattle breed.

Introduction

Heat stress occurs when any combination of environmental conditions cause the effective temperature of the environment to be higher than the animal's thermoneutral (comfort) zone. Four environmental factors influence effective temperature, including air temperature, relative humidity, air movement and solar radiation. The heat load accumulated by the cow is the sum of environment heat, metabolic heat and heat produced by physical activity. Over thermoneutral conditions maintenance expenditures increase and the cow's energy expenditure is, often, at the expense of milk yield. During heat stress cow exhibit reduced feed intake, decreased activity, seek shad and wind, increase respiratory rate, and increase both peripheral blood flow and sweating. These responses have a deleterious effect on both production and physiologic status of the cow (Bianca W., 1965). The Temperature-Humidity Index (THI) commonly is used to indicate the degree of stress on dairy cattle as extensively demonstrated from many literature that investigate on effect of heat stress on productive and reproductive trait (Ingraham *et al*., 1979, Peggy *et al*., 1993, Ravagnolo and Misztal, 2000; Ravagnolo and Misztal, 2002; Ravagnolo *et al*., 2000; Bohmanova *et al.,* 2006; Bouraoui *et al.*, 2002).

In order to study the effect of heat stress on the Italian Holstein population a national project "Climanimal" started. This is a preliminary study on reproductive performances with the aim to investigate the behaviour of some reproductive traits under different weather conditions in the Italian Holstein population.

Materials and Methods

The Italian Institute of Biometeorology (IBIMET-CNR) developed a model to identify different climatic zones in Italy. Using quality controlled meteorological observations from 100 stations, covering the period 1971-2000 Ibimet computed the daily maximum Temperature-Humidity Index (THI) in the summer period (June-August). Applying a hierarchical cluster analysis and the Ward's method to the frequency of summer THI maximum falling in four risk classes (THI <72,72-78,78-84,>84), the stations were grouped in six different clusters, and therefore regions with homogeneous bio climatic characteristics were individuated. For each cluster IBIMET analysed the average bio climatic features. Moreover, using the Multiple Discriminant Analysis, the whole national territory was mapped into six homogeneous climatic regions (Figure 1). Zone 1 and zone 2 and zone 5 and zone 6 were merged because we had few data for those zones and they had similar weather conditions. The heat stress has a growing trend from zone 1 to zone 6. Direct fertility traits were used such as, CI (calving interval), NR56 (non return rate at 56 d) and DTFS (day to first service) and ANGO (angularity) that is a correlated fertility trait, data comprised 776435 records of primiparous calving from 2002 to 2007 all data were pre-adjusted per herd-year-season effect. The statistical model used was a fixed effect model (GLM, SAS ®), we used different model for each traits and in all models the EBV of the trait was consider as a covariate.

ANGO = age*stage + class + angebv + zone + e

DTFS = yc*mc + age + class + dfsebv + zone + e

CI = yc*mc + age + class + ciebv + zone + e

NR56 = yi*mi + age + class + nrebv + zone + e

stage = lactation stage

age = age at calving (insemination)

yc (i)= calving year (c), insemination year (i)

mc(i) = calving month (c), insemination month (i)

_ebv = EBV of the trait (covariate)

class = production class

zone = climatic zones based on THI values

Reference zone was the zone 4, because this is the area with highest number of the cows.

Results and Discussion

All models were significant, for angularity (Figure 2) there are significant differences between zone 4 and zone 1 and zone 4 and zone 3, in other words in zone 4 there are less angular cows than zone 1 and zone 3. For days to first service in zone 6 it is shorter than zone 4, this is an unexpected result because zone 6 is warmer than zone 4 (Figure 3). There is shorter calving interval in zone 4 than in zone 1, unexpected result, because zone 1 is colder then zone 4 (Figure 4). For non return rate in zone 6 we can see that it is lower in zone 4 than zone 6, this is another unexpected result because the zone 6 is warmer than zone 4 (Figure 5). These unexpected results could have origin in the statistical analysis scheme, because the reference zone is the biggest and it contains many regions that differs about management, although the data were pre-adjusted by herd-year-season effect. Another aspect that perhaps needs to be taken into account is the period used in the climatic study for geographical zonization, that does not contain the last 7 years. The period of the last seven years could be more significant, instead of the period ranged from 1971 to 2000, for studying the reproductive performances of the cows that ranged from 2002 to 2007.

Conclusions

This is the first study to evaluate the climatic effect on reproductive traits and to include a zone effect based on THI parameter. Results showed that the THI zonization has a slight effect on the analyses of reproductive traits. There are some contradictory results for day to first service, calving interval and non return rate, that appear better in warm zones. It is possible that using climatic data of the last seven years, using a more complex model as animal model and using a THI value for each herd the estimation of heat stress effect on reproductive traits might be estimated in a better way.

References

Bohmanova *et al.,* 2006. Temperature-Humidity Indices as indicators of milk production. J. Dairy Sci. 90: 1947 – 1956.

Bouraoui *et al.,* 2002. The relationship of temperature–humidity index with milk production of dairy cows in a Mediterranean climate. Anim. Res. 51: 479 – 491.

Ingraham *et al*., 1979. Seasonal effects of tropical climate on shaded and non shaded cows as measured by rectal temperature, adrenal cortex hormones, thyroid hormone and milk production. Am. J. Vet Res., Vol. 40, No. 12 – 1979.

Peggy *et al*., 1993. The potential effects of climate change on summer season dairy cattle milk production and reproduction. Climatic Change 23: 21-36, 1993.

Ravagnolo and Misztal, 2000. Genetic component of heat stress in dairy cattle, parameter estimation. J. Dairy Sci. 83: 2126 – 2130.

Ravagnolo and Misztal, 2002. Effect of heat stress on non return rate in Holstein: Fixed-Model analyses. J. Dairy Sci. 85: 3101 – 3106.

Ravagnolo *et al*., 2000. Genetic component of heat stress in dairy cattle, development of heat index function. J. Dairy Sci. 83: 2120 – 2125.

Figure 1

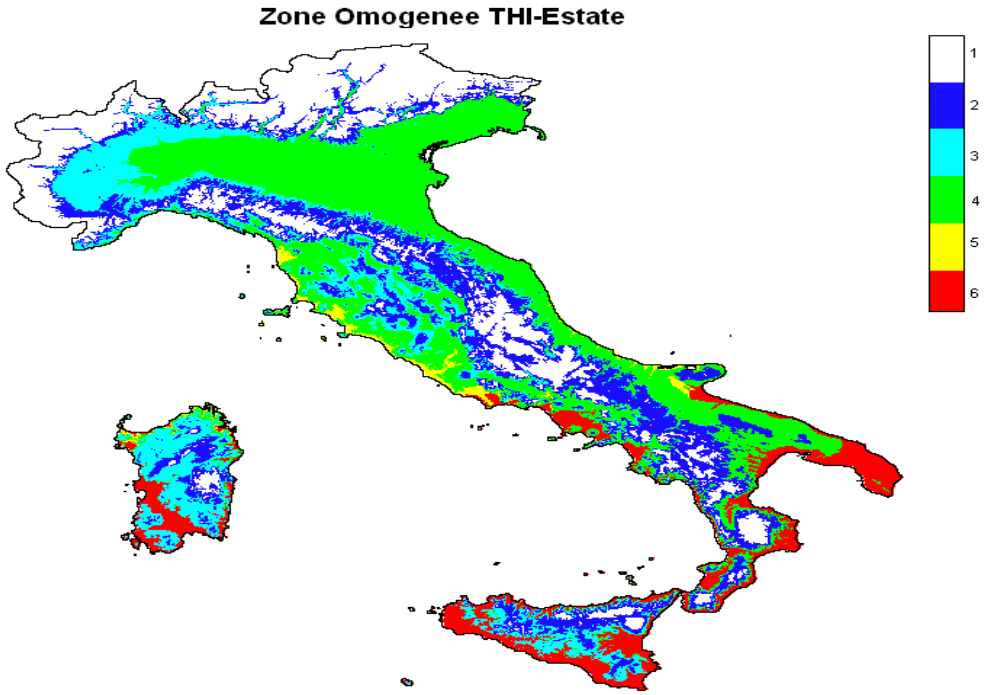


Figure 2

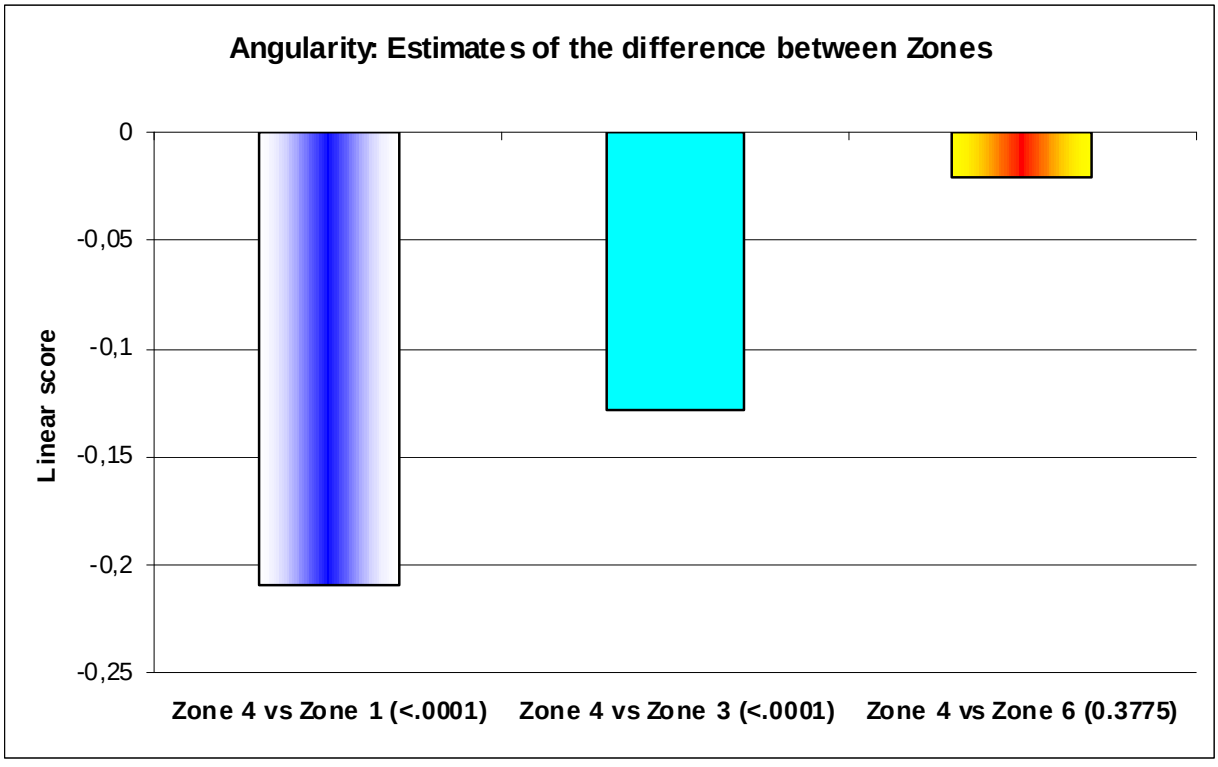


Figure 3

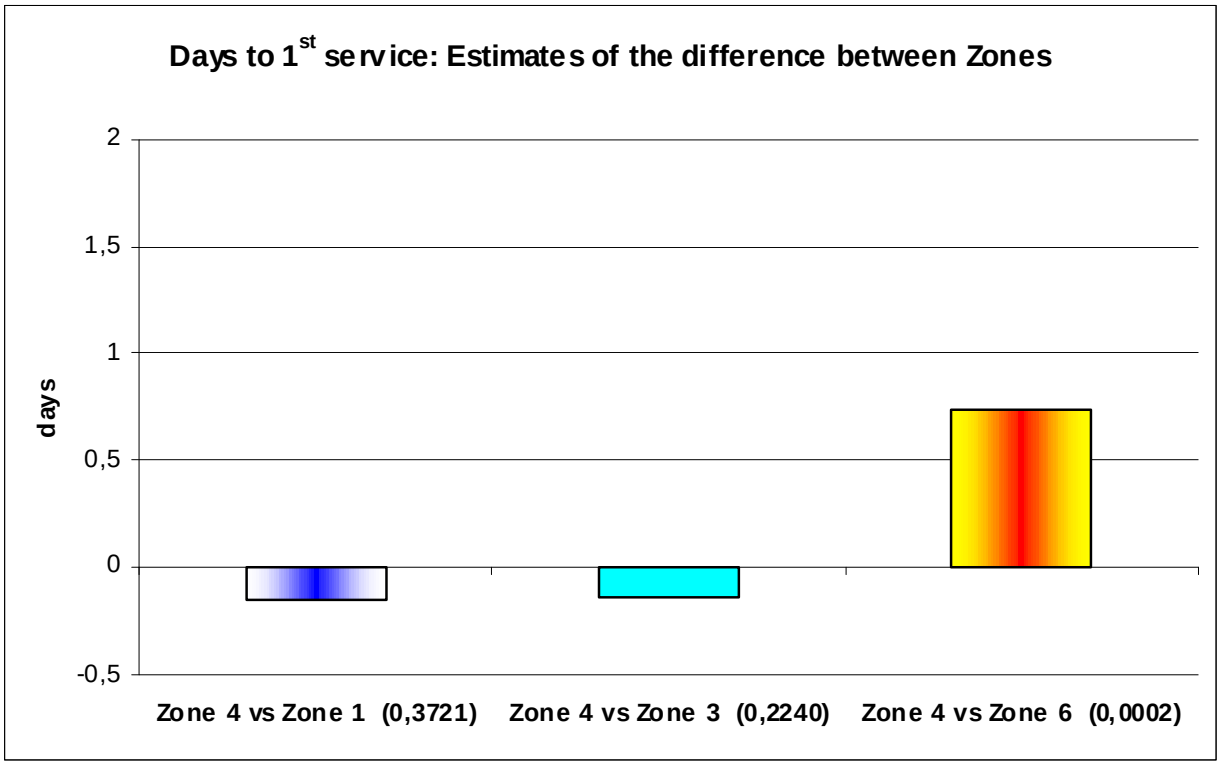


Figura 4

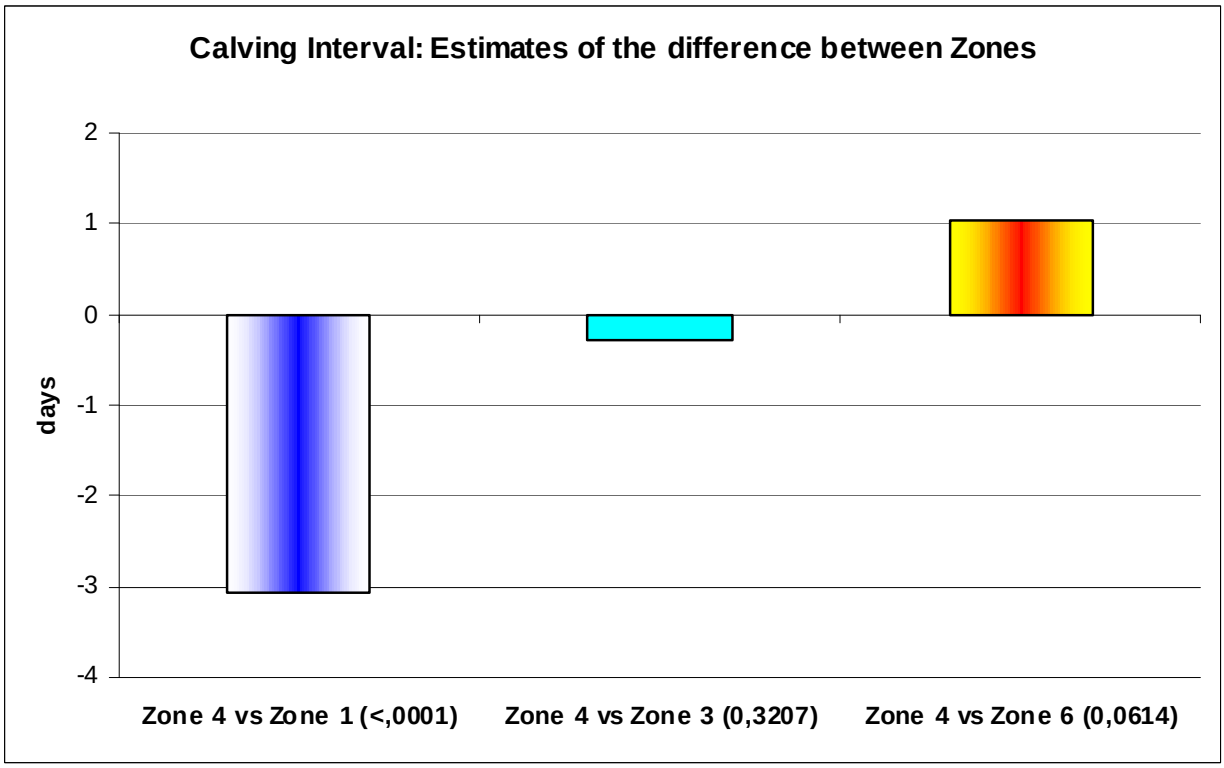
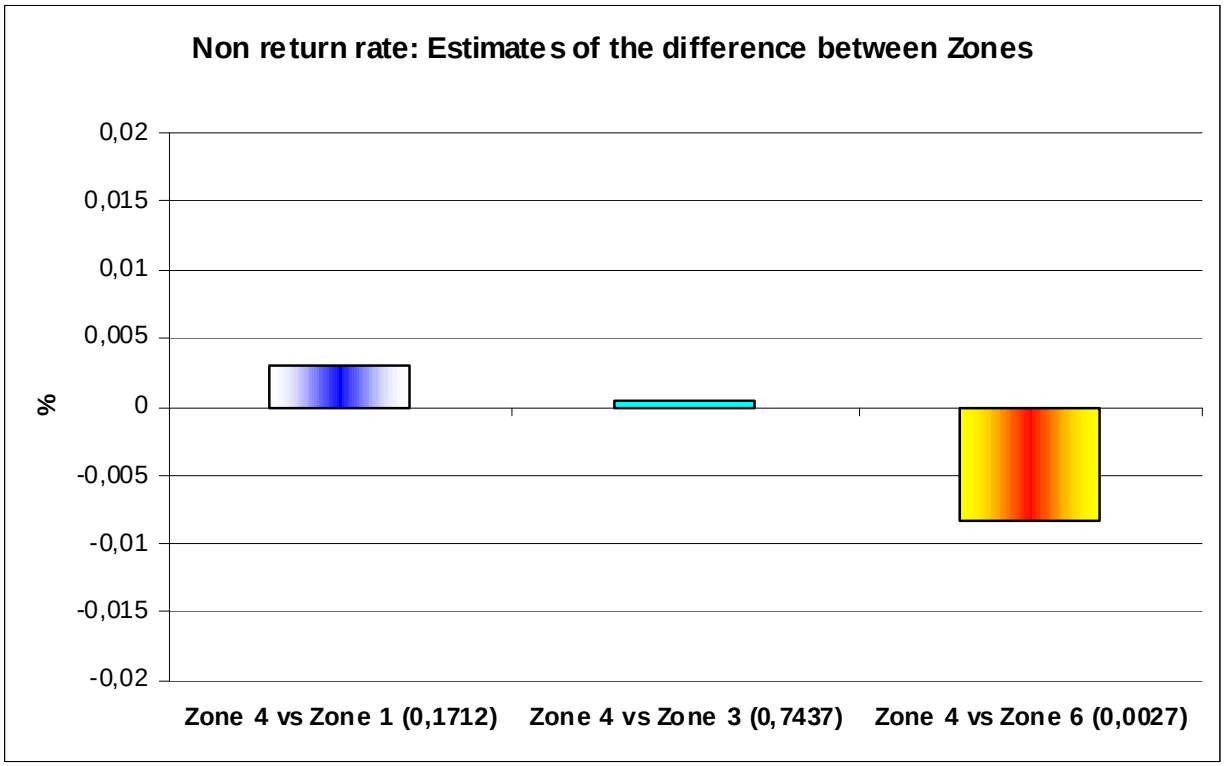


Figura 5


Non return rate: Estimates of the difference between Zones
0,02
0,015
0,01
0,005
0
-0,005
-0,01
-0,015
-0,02
%
Zone 4 vs Zone 1 (0,1712)
Zone 4 vs Zone 3 (0,7437)
Zone 4 vs Zone 6 (0,0027)