Volume 12 Nomor 01, Juni 2024
https://doi.org/10.31949/Agrivet/v12i1.9458
E-ISSN : 2541-6154 P-ISSN: 2354-6190

Comparisons and influence temperature humidity index to dairy cow productivity based on farm altitude

Bambang Kholiq Mutaqin[1]*, Didin Supriat Tasripin[2], Lia Budimulyati Salman[2], Iin Susilawati[1], Ujang Hidayat Tanuwiria[1]

[1]Department of Animal Nutrition and Feed Technology, Faculty of Animal Husbandry, Universitas Padjadjaran
[2]Department of Animal Production, Faculty of Animal Husbandry, Universitas Padjadjaran
Jl. Raya Bandung-Sumedang Km. 21, Sumedang 45363, Indonesia
*Corresponding author: kholiq@unpad.ac.id

ABSTRACT

This study aimed to determine the differences and effects of the Temperature Humidity Index (THI) on dairy cows' productivity in West Java based on differences in farm altitude. Categorization based on area altitude can be divided into low altitude (<700 m asl), moderate (700-1000 m asl), and high (> 1,000 m asl). The parameters observed were body size, body weight, and milk production which were supplemented by environmental conditions namely temperature and humidity. The method used is a survey and direct observation by simple random sampling of animals. The results showed differences in environmental conditions, namely temperature and humidity in each dairy farm with different altitudes. Meanwhile, the performance of milk production is relatively the same even though variations in the performance of body measurements and weight of dairy cows in each region. It can be concluded that heat environmental conditions with high THI can cause cows to suffer from heat stress so that productivity decreases.

Keywords: Altitude, Dairy Cows, Productivity, THI

INTRODUCTION

The type of dairy cow that is mostly raised in Indonesia is Fries Holland (FH). Fries Holland dairy cows are also known in English as Holstein Friesian or Holstein. Based on the history of FH, it originated from the temperate Netherlands, with four seasons, namely spring, summer, autumn, and winter (Pane 1986).

Dairy productivity is a multidimensional process. Various factors that affect livestock productivity include genetic, environmental, and management factors. Environmental factors such as temperature and humidity cause dairy cows' discomfort (West et al. 2003). Besides, high temperatures also affect ration consumption which, consequently, determines dairy cows' productivity level and health (Ensminger 1971; Sudono 1999; West et al. 2003).

Fries Holland's productivity is greatly influenced by environmental factors. Cows originating from temperate climates are sensitive to high temperatures but in contrast, Indonesia is a humid tropical country. Dairy cows' threshold of heat pressure above the performance that has been identified with THI can vary in production systems, nature, climate, dairy cows' productivity, and weather. Cage environment temperature and humidity also affect the productivity of dairy cows as a result of heat stress (Whittier 1993; Kadzere et al. 2002; Troxel et al. 2016; González et al. 2018; Li et al. 2018). Fries Holland dairy cows that are raised in Indonesia are spread in different ecological areas. The difference in the area

of animal husbandry certainly determines the productivity of dairy cows. Each region in Indonesia has an ambient temperature and humidity that is affected by altitude.

Comparison and influence THI on dairy cow's productivity based on area altitude is low (<700 m asl), moderate (700-1.000 m asl), and high (> 1.000 m asl) is considered necessary to see the differences in each dairy cow's production performance condition. Heat stress is still a serious problem for the dairy industry despite the advances in cooling systems and management practices (St-Pierre 2016). Heat stress can disrupt metabolism, and decrease milk production and quality (Collier et al. 2017). Above the thermoneutral zone, cows experience changes in respiration rate and metabolite concentration (Bernabucci et al. 2010; Wheelock et al. 2010; Baumgard et al. 2011). Dairy cow production performance assessments can be done by observing the parameters of dairy cow's milk production, body size, and body weight. The body size of dairy cows tends to affect milk production level, and body size affects vitality.

MATERIALS AND METHODS

This study uses milk production records for dairy cows from three regions based on the altitude category namely Cijangkar Sukabumi (low), Tanjungsari Sumedang (medium), and Pangalengan Bandung (High). Dairy cow's data taken is productive cattle production performance that has a record of milk production from lactation one to lactation four each taken 20 samples. The research was carried out for eight months, from May to December 2019. The location of data collection is in Cijangkar Sukabumi Farmers Group, KUD KSU member of Tandangsari Tanjungsari Sumedang, and member of KPBS Pangalengan Bandung.

This study uses a survey method in several locations of dairy cow' populations in the low, medium, and highlands in West Java. The population referred to here are breeders, cooperatives, or farm centers that have high-productivity cows and the potential to be superior cow breeds. Data is analyzed using descriptive analysis to describe qualitative and quantitative characters of the selected population, whereas in comparative analysis both parametric and non-parametric are used to distinguish between the populations.

Locations are chosen purposively, especially for cooperatives selected are cooperatives that have a large population of dairy cows and high in production compared to other cooperatives. Breeders selected as samples from the three cooperatives were selected purposively, with the criterion that the breeders have enough experience and their dairy cows have high milk production above the average population in the location where the animals were kept. This is based on information provided by the respective cooperatives. Dairy cow sampling was taken by the Simple Random Sampling technique. Real-time observations and quantitative measurements of the sample are then carried out.

Climatological data collection for 2019 in the region was carried out to determine the comfort level of livestock in certain livestock areas. Data was retrieved from the local meteorological agency of the research area. The area determined with THI measurement for heat stress determination is carried out in each center of dairy farming by recording environment temperature, cage temperature, and humidity, which is synergized with the care of selected livestock. Farm area height measurement was performed with a digital altimeter. Temperature Humidity Index follows the equation developed by NRC (1971):

$$THI = Td - (0{,}55 - 0{,}55\ RH)\ (Td - 58)$$

Note:

THI : Temperature Humidity Index

Td : Temperature

RH : Humidity

Cow's body size measurement (chest circumference, body length, shoulder height) is measured using a rondo measuring tape to determine cow's body weight. The measurement of cow body weight is calculated with the Schrool formula.

BW = [CC (cm) + 22]2/100

Note:

BW : Body Weight

CC : Chest Circumference

RESULTS AND DISCUSSIONS

The performance of dairy cows' production in each region is different from milk production. Cijangkar altitude of <700 m asl shows that low milk production (13,25±3,98 liter) compared to other areas. Tanjungsari with an altitude of 700-1.000 m asl with milk production (17,44±6,76 liter) and Pangalengan altitude of >1.000 m asl shows that milk production is not much different (17,63±3,80 liter).

Heat environmental conditions with high THI can cause cows to suffer from heat stress which the productivity of dairy cows. Cijangkar is included in low areas and classified as a severe stress zone. Tanjungsari included mild stress zone areas and conditions approaching the zone of severe stress. Pangalengan altitude of >1.000 m asl classified as a mild stress zone with a THI value (72,77 – 76,52) is shown in Table 1.

The region condition based on the categorization of altitude shows different temperatures and humidity. Cijangkar Sukabumi has a maximum temperature which is quite hot at 31,3 ^{o}C. Tanjungsari region has a high maximum temperature of 29,1 ^{o}C, while the Pangalengan region has a relatively lower maximum temperature compared to other regions of 26,8 ^{o}C. This shows that maximum temperature decreases along with area altitude increases. This is by thermal zones division which distinguishes the influence of temperature and humidity on dairy cows' productivity (Bernabucci et al. 2010; Wheelock et al. 2010; Baumgard et al. 2011; Collier et al. 2017).

Table 1. Environmental Conditions of Dairy Farms based on Altitude.

Area	Altitude (m asl)	Temperature (^{o}C)	RH (%)	THI	
				min	max
Cijangkar	664	27,5 – 31,3	74-76	78,09	84,28
Tanjungsari	798	28,7 - 29,1	49-66	76,37	79,38
Pangalengan	1.190	24,5 - 26,8	67-70	72,77	76,52

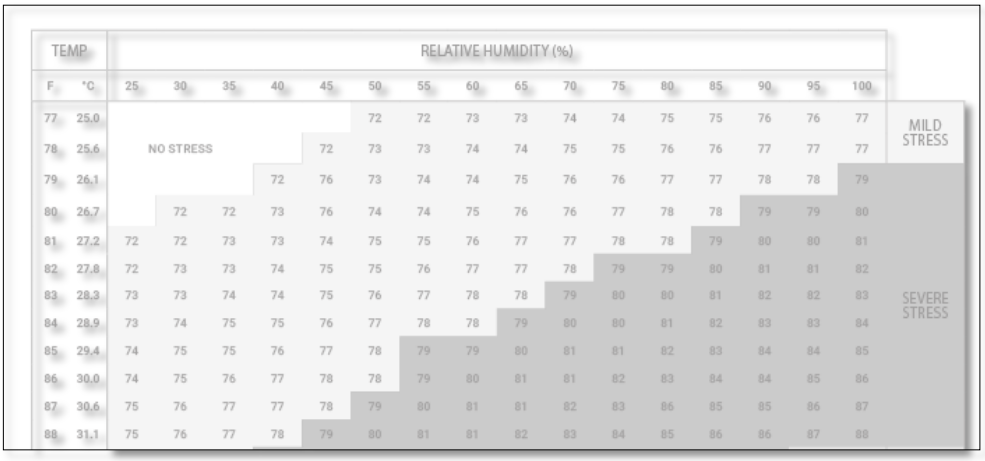
Humidity levels of each region have differences compared to temperature. Humidity in each region is not influenced by altitude level, as shown in the Tanjungsari region the humidity level is quite high compared to other regions. This makes differences in THI value in each region (Mader and Davis 2014).

Table 2. *Temperature Humidity Index* (THI) 2019

	January	February	March	April	May	June	July	August
THI maximum	79,896	80,87	79,463	79,76	79,896	78,908	78,776	79,788
THI minimum	66,612	65,91	66,103	66,656	64,48	61,577	60,448	59,306

Note: Climatology Data of Tanjungsari Sumedang Space and Atmosphere Observation Observatory, 2019

Table 2 shows the THI level of the Tanjungsari region which represents the range of high and low-altitude regions. Climatology observations data show the maximum THI value which is relatively the same from January to August 2019. Results of the THI calculation, when related to the environmental conditions of dairy farms, can be obtained a comfortable time for dairy cows. Comfortable environmental conditions for dairy cows based on THI values indicate that they are still in the mild stress range. However, this condition may change into the condition of severe stress when the temperature rises. While for other areas no climatological data is obtained from observation agencies. Environmental conditions based on THI are shown in Figure 1.



Figures 1. Temperature Humidity Index (THI) Stress Level (Whittier 1993)

Based on Figures 1, Dairy cows in comfortable conditions are at an environmental temperature of no more than 26,7^{o}C, therefore these dairy cows are suitable to be kept in areas above 700 masl. However, it is not uncommon for dairy cows to be raised in the lowlands, given that milk as the main product consumed by urban communities to facilitate distribution access to milk production.

Table 3. Dairy Cows Production Performance

Area	CC (Cm)	BL (Cm)	SH (Cm)	BW (Kg)	MP (L)	Significance	
						BW	MP
Cijangkar	181,63 ±10,66	154,08 ± 7,08	132,46±6,66	415,72±43,72	13,25±3,98	ns	*
Tanjungsari	182,34±10,66	139,31±13,21	136,80±13,21	418,25±34,45	17,44±6,76	ns	**
Pangalengan	188,70 ±8,25	161,90 ±8,92	139,25±5,46	440,38±34,87	17,63±3,80	ns	**

*Notes: CC = Chest Circumference; BL = Body Length; SH = Shoulder Height; BW = Body Weight; MP = Milk Production; Cm = Cetimeter; Kg = Kilogram; L = Liter; **= highly significant (P<0.01); * = significant (P<0.05); ns = nonsignificant (P>0.05)*

The results of production performance observations in each region showed results that were not too different from body measurements including chest circumference, body length, shoulder height, and body weight. However, the difference is shown in terms of milk production from areas with high altitudes, namely the Pangalengan area which is classified as high category, and Tanjungsari which is classified as medium, showing higher production compared to the Cijangkar area which is a low altitude region. However, the other dairy cows' production performance is relatively different are shown in Table 3.

These results indicate that differences in the region altitude and THI values effect of influence dairy cow's productivity especially in dairy cow's milk production, although there may be other factors that influence the level of dairy milk production including management. That is because the three regions implementing different management. Cijangkar Sukabumi area is a community farms group while the Pangalengan and Tanjungsari areas are members of the Cooperative. This can be a determining factor in the productivity of dairy cows in West Java.

CONCLUSION

Based on the analysis results and discussion, it can be concluded that hot environmental conditions with high THI can cause cows to suffer from heat stress so the productivity of FH dairy cows is lower because the height level can affect the productivity of dairy cows.

CONFLICT OF INTEREST

A statement that there is no conflict of interest with any party regarding the material discussed in the article, funding, and differences of opinion between the authors.

ACKNOWLEDGEMENT

This research was supported by Universitas Padjadjaran within the Academic Leadership Grant (ALG) 2019 framework No: 3111/UN6.J/LT/2019. The authors thank all those who participated in this research, namely the KPBS Pangalengan Bandung, the KSU Tandangsari Tanjungsari Sumedang, and the Cijangkar Livestock Farmers Group Sukabumi.

REFERENCES

Baumgard LH, Wheelock JB, Sanders SR, Moore CE, Green HB, Waldron MR, Rhoads RP. 2011. Postabsorptive carbohydrate adaptations to heat stress and monensin supplementation in lactating Holstein cows 1. J Dairy Sci [Internet]. 94(11):5620–5633. https://doi.org/10.3168/jds.2011-4462

Bernabucci U, Lacetera N, Baumgard LH, Rhoads RP, Ronchi B, Nardone A. 2010. Metabolic and hormonal acclimation to heat stress in domesticated ruminants. Anim Int J Anim Biosci [Internet]. 4(7):1167–1183. https://doi.org/10.1017/S175173111000090X

Collier RJ, Renquist BJ, Xiao Y. 2017. A 100-Year Review : Stress physiology including heat stress 1. J Dairy Sci [Internet]. 100(12):10367–10380. https://doi.org/10.3168/jds.2017-13676

Ensminger ME. 1971. Dairy Cattle Science. Animal Agr. Daville, Illionois.: The Interstate, Printers and Publishers, Inc.

González LA, Bryan M, Silasi R, Brown F. 2018. Factors affecting body weight loss during commercial long haul transport of cattle in North America 1. (June):3630–3639. https://doi.org/10.2527/jas2011-4786

Kadzere CT, Murphy MR, Silanikove N, Maltz E. 2002. H eat stress in lactating dairy cows : a review. 77:59–91.

Li C, Dai S, Lu J, Zhao B, Wang J, Li P, Wu Z, Mu Y, Feng C, Dong Q. 2018. Methylglyoxal: A newly detected and potentially harmful metabolite in the blood of ketotic dairy cows. J Dairy Sci [Internet]. 101(9):8513–8523. https://doi.org/10.3168/jds.2018-14448

Mader TL, Davis MS. 2014. Environmental factors influencing heat stress in feedlot cattle 1 , 2. :712–719.

Pane I. 1986. Pemuliabiakan Ternak. Jakarta: Gramedia.

St-Pierre NR. 2016. Comparison of model predictions with measurements: A novel model-assessment method. J Dairy Sci. 99(6):4907–4927. https://doi.org/10.3168/jds.2015-

10032
Sudono. 1999. Ilmu Produksi Ternak Perah. Bogor: Institut Pertanian Bogor Press.
Troxel TR, Gadberry MS, Beck PA. 2016. T and emperature , relative humidity , dew point of 6 commercial trailer compartments during summer transportations of beef calves in the mid-South. Prof Anim Sci [Internet]. 32(4):461–469. https://doi.org/10.15232/pas.2015-01470
West JW, Mullinix BG, Bernard JK. 2003. Effects of Hot , Humid Weather on Milk Temperature , Dry Matter Intake , and Milk Yield of Lactating Dairy Cows. J Dairy Sci [Internet]. 86(1):232–242. https://doi.org/10.3168/jds.S0022-0302(03)73602-9
Wheelock JB, Rhoads RP, Vanbaale MJ, Sanders SR, Baumgard LH. 2010. Effects of heat stress on energetic metabolism in lactating Holstein cows 1. J Dairy Sci [Internet]. 93(2):644–655. https://doi.org/10.3168/jds.2009-2295
Whittier JC. 1993. Hot Weather Livestock Stress. Columbia: Univ. Missouri Ext.