



The Correlation of Heat Tolerance Coefficient (HTC) and Temperature Humidity Index (THI) with Milk Production of Dairy Cows in Bangun Lestari Farm, Tulungagung

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Abstract. *Determining the relationship between environmental adaptability and milk production across various parities using HTC and THI values was the aim of this study. Purposive sampling was employed to choose thirty dairy cows of parity 1 and 2, for the study. For this investigation, a case study was employed. The temperatures and humidity of the barn environment were used to measure the THI value, which was determined by the HTC value, the milk production of mothers with varying parities, and the rectal temperature and respiratory frequency. Research results demonstrated a negative connection between the two independent variables—the THI and HTC values—and milk production at parities 1 and 2. This suggests that either environmental stressors or higher HTC or THI values resulted in lower milk production. At parity 1, there was a poor correlation, and at parity 2, a moderate correlation between the HTC value and milk production. The correlation coefficients for parity 1 and parity 2 were, respectively, $r = 0.410$, $R^2 = 0.168$, and $r = 0.370$, $R^2 = 0.137$. There was just a slight association observed between the THI value and milk production at parities 1 and 2. The correlation coefficient for parity 1 was ($r = 0.220$; $R^2 = 0.049$), but the correlation coefficient for parity 2 was ($r = 0.227$; $R^2 = 0.51$). According to the study's findings, milk production in parities 1 and 2 is only marginally correlated with HTC and THI values.*

Keywords: *HTC, THI, Milk production, Parity*

INTRODUCTION

Dairy cow farming is one of the agricultural industries in Indonesia that has experienced significant development. As the country's population rises and more people become aware of the need for fresh milk to fulfill their animal protein requirements, the country's milk needs only expand. In 2019—Aminah et al. High plains with elevations exceeding 800 m sea level above are typically home to agricultural dairy cows (Jannah et al., 2023). The dairy cows raised in these regions are content, which allows for excellent milk production. On the island of Java, there is still a strong push to raise the number of dairy cows on farms. East Java is one of the provinces with a large population of dairy cows. According to data from the Central Statistical Agency (BPS) for 2021, there were 301,780 dairy cows in Eastern Java, which accounts for 52.16% of the 578,579 dairy cow population nationwide.

One type of dairy cow that is commonly bred in Indonesia is the Friesian Holstein Crossbreed (PFH). According to Astiti (2013), PFH cows are cows that come from the crossbreeding of native Indonesian cows with native Dutch Friesian Holstein (FH) cows. Since most dairy cow farms in Indonesia are found in lowland areas, the superiority of this PFH cow is particularly supportive of the country's dairy cow farming endeavors. Temperatures and humidity are typically rather high in the lowlands. Environmental and genetic variables affect dairy cow production. Within and outside the body are the two categories of environmental variables. Factors like parity, length of lactation, and dry time are biologically significant aspects of the parrot's internal environment, whereas temperature and air humidity are factors that impact the parrot's productivity outwardly (Ahmud *et al.*, 2020). By evaluating the ambient temperature and humidity in the surroundings of the livestock being housed, the Temperature Humidity Index (THI) can be used to determine the degree of environmental appropriateness for dairy cows. The productivity of animals and milk production can be decreased by maintaining dairy cows in tropical regions with high humidity and temperatures (Novianti et al., 2013) In general, Indonesia has temperatures between 24 to 34°C and a moisture rate of 60 to 90% (Widyobroto *et al.*, 2020). Since the optimal temperature range for dairy cows is between 5 and 15°C, the climate in Indonesia makes them vulnerable to heat-related precipitation. The effects of heat precipitation on dairy cow reproductive cycles include reduced fertility, extended calving intervals or breeding distances, and lower-

quality and lower-production milk. During the heat shock, the dairy cow makes physiological adjustments to ensure its life. Analysis of the Heat Tolerance Coefficient (HTC) parameter in dairy cows is necessary to determine how well-adapted the cows are to their surroundings. The level of adaptation of livestock has a significant impact on the productivity of dairy cows in terms of milk production, feed consumption, and reproduction. Raising ambient temperatures and humidity can stress animals to the point where it has a direct or indirect impact on their physiology and productivity, which can include decreased dairy production and reproduction.

The district of Tulungagung is among the lowland locations where dairy cow farms are developing. According to the Central Statistical Agency for 2021, the air temperature in the Tulungagung area is relatively high, ranging from 21 to 30°C, with a humidity of 80 to 90%. Due to the local climate and temperature, PFH cows housed here are frequently vulnerable to heat stress; therefore, dairy cows raised here need to have a high degree of environmental adaptability. The productivity of animals is greatly influenced by the environment. The best outcomes can be achieved if the environment is managed well through rearing. As a result, in addition to monitoring other elements like the assessment of environmental and genetic factors to the degree of livestock productivity, it is essential to measure heat tolerance values or HTC. The productivity of animals is greatly influenced by the environment. The best outcomes can be achieved if the environment is managed well through maintenance. As a result, in addition to monitoring other elements like the assessment of environmental and genetic factors to the degree of livestock productivity, it is essential to measure heat tolerance values or HTC.

According to the description, further investigation into the correlation between the value of HTC and THI to milk production on the parity of various dairy cows in the Bangun Lestari farm was necessary to improve the management of dairy cow rearing and boost productivity, particularly in the Bangun Lestari farm located in Ariyojeding village, Rejotangan district, Tulungagung, Indonesia.

RESEARCH METHODS

In July and August of 2023, during the dry season, research was conducted in Bangun Lestari Farm, Tulungagung, which is located at a height of 118 meters above sea level. Fifteen cows of parity 1 and fifteen cows of parity 2 throughout lactation provided

the material for this investigation. The research used a case study methodology, gathering primary data through the assessment of HTC, THI, and milk production. Secondary data was acquired through interviews with data farmers. The variables observed in this study were:

1. Heat Tolerance Coefficient (HTC)

The HTC parameter is utilized to assess the degree of resistance or adaptation of cows to the surrounding heat conditions. Values ≤ 2.0 represented a high degree of adaptability of the animal to the environment (Benezra, 1954; Pribadi *et al.*, 2021). Cows will have a higher rate of resilience the higher the HTC value they achieve. The following formula is used to determine the HTC or Benezra's thermal comfort index (BTCD) value (Benezra, 1954):

$$HTC = \frac{RT}{38.3} + \frac{RR}{23}$$

HTC: Heat Tolerance Coefficient

RT: rectal temperature ($^{\circ}\text{C}$)

RR: respiratory rate (mov/min)

2. Temperature Humidity Index

The temperature and humidity levels that have an impact on cows are measured using a metric called THI. The following formula is used to determine the THI value (Rohman and Boer, 2000).

$$THI = T - 0.55 \times (1 - RH/100) \times (T - 58)$$

3. Cow parity is the number of times the cow graze partus and give birth to a cow. Parity can reflect the level of physical maturity of the cow in producing milk.

4. Milk Production

On one processing day, the morning and afternoon shifts account for the quantity of milk produced.

RESULTS AND DISCUSSION

The amount of milk production per day was the total milk production in one day of the morning and afternoon production after colostrum production ended.

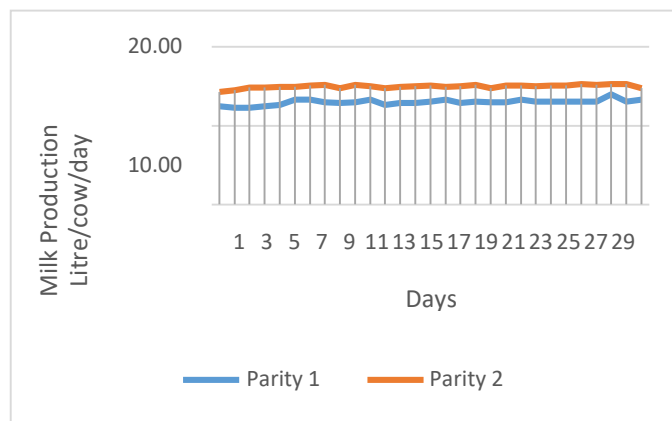


Figure 1. The milk production in Bangun Lestari Farm

The milk production in Bangun Lestari farm for 29 days showed a high production rate with average milk production of 13,01 liters/cow/day at parity 1 and 14,73 liters/cow/day at Parity 2. This is comparable to the study by Setyorini et al., (2020) that milk production in lowland cows produced milk with an average of 10.48 liters (per cow) per day. However, according to the Central Statistical Agency (BPS) in 2021, average milking production in East Java reached 18 liters/cow/day. The cause of high milk production in lowland areas can be due to superior seed selection and improved good maintenance management which can reduce the risks caused by temperature and humidity in high lowland environments. Rokhayati and Pateda (2022) add that high milk production and good quality are influenced by many factors, mainly genetic factors, good feed availability, and effective management, especially in lowland areas.

The Correlation of HTC With Milk Production

The value of HTC reflects the rate of adaptation of cows to the environmental heat conditions, the higher the HTC value obtained, the lower the dairy cows' resistance. The parity 1 value of the HTC is 3.55, while the parity of the 2 is 3.54. The HTC value obtained from the Bangun Lestari farm indicates a lower value from the Huda (2019) study than in the CV farm. The gift gets the HTC rating with an average of 4.12. However, it can still be concluded that the HTC value of the research results indicates that the heat resistance in the Bangun Lestari farm is low. The body temperature of the dairy cow and

the respiratory frequency are observed indicators for calculating the value of the HTC in the cows.

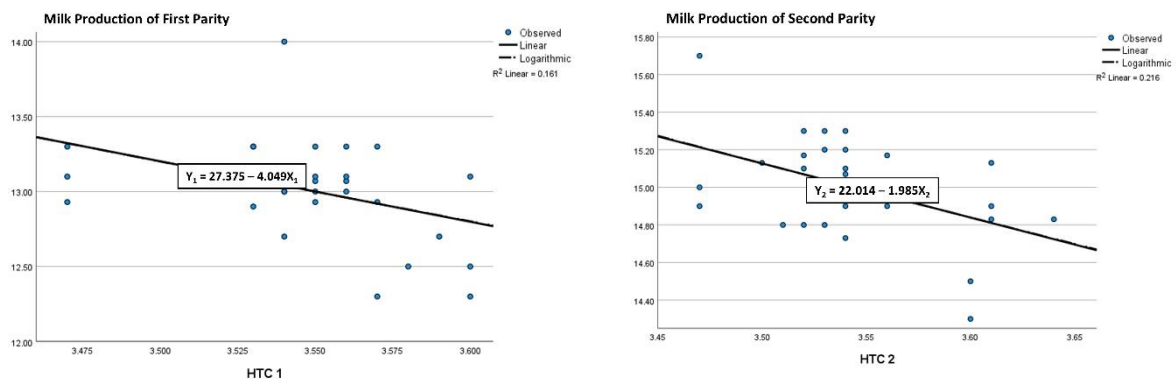


Figure 2. Graphic correlation of HTC with milk production in parity 1 and 2

According to figure 2, there is a negative correlation between the relationship of HTC to milk production with the obtained line equation between HTC and milk producing parity 1 is $Y_1 = 27,375 - 4,049X_1$ that means every increase in 1 value of HTC then the production of milk will decrease the number of 4.049 liters, whereas, at the parity 2, the equation of the line $Y_2 = 22,014 - 1,985X_2$ means that every increase of 1 value HTC then milk Production will decline an amount of 1.98 liters.

Based on the statistical test parity 1 has a negative correlation value of 0.410 whereas correlations on the analysis of parity 2 have a negativity of 0.375. Based on the correlation coefficient obtained, it can be interpreted that HTC's value of milk production at parity 1 has a weak relationship, whereas HTC's value of dairy production at parity 2 has a moderate relationship. Astuti (2017) states that a weak correlation has a range of values of 0.20 to 0.40, while a moderate correlation has a value range of 0.40 to 0.60. In Sagita's study (2023) the weak or moderate correlation between the value of HTC and milk production does not interfere with livestock productivity, other factors affect cow's production. The weak correlations between THI and dairy production will not interrupt cow production, but it is worth noting because according to much literature, it is mentioned that environmental factors have a considerable influence on the survival of cattle. Based on a statistical test on parity 1 determination coefficient (R²) value obtained at 0.168 which means that HTC influences the production of parity 1 milk by 16.8 % and 83.2% was influenced by other factors, such as feeding, feed ingredients, and maintenance.

The Correlation of THI with Milk Production

The temperature and humidity conditions of the cage appear to be very high at the time of the study. Different ambient temperature variations can affect livestock life and milk production. Environmental factors such as seasons, rainfall, and humidity have a high influence on milk production. Increased THI values tend to lead to heat stress responses in dairy cows. Dairy cows who experience heat stress may experience a decrease in feed consumption which will result in milk production. In addition, stress from heat will increase the body's response cause changes in hormonal regulation, and will inhibit milk production. High humidity can also affect the ability of the cow to thermoregulate the cow through the process of evaporating the sweat so that the cow will be easily exposed to heat.

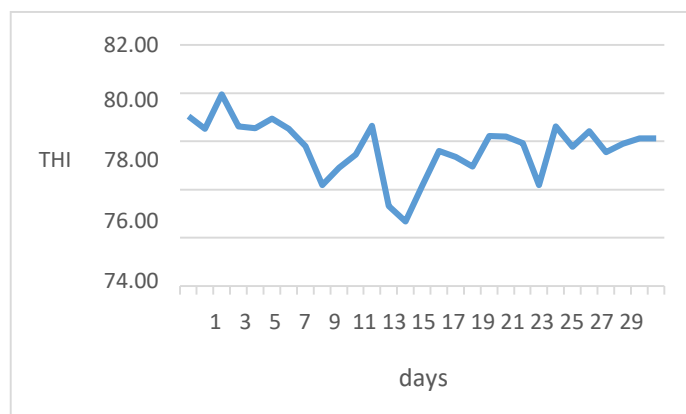


Figure 3. The THI in Bangun Lestari Farm

The dairy cows will feel comfortable when their THI is less than 72, the dairy cow will experience mild stress if their THI is more than 72 to 75, the cow may experience moderate stress when they have a THI of more than 75 dairy cow with more than 80 and cows would experience severe stress when the THI value is greater than 80 (Armstrong, 1994). Based on the results of the study showed that the THI value in the Bangun Lestari farm is 77.74, which means that THI above 72 indicates that dairy cows will be vulnerable to stress. A moderate level of stress in dairy cows will result in a decrease in the physiological condition of the cow and an increase in the hormone cortisol. The hormone cortisol is one of the indicators that the cow is under stress and can affect the reduction in milk production. Physiological conditions in the milk cows will affect the ability of cows to produce milk, when cows are in an uncomfortable environment, they cow are

under stress resulting in the processes of metabolism of nutrients/energy in the body that should be used as the production of milk will be shifted to keep homeostasis to normal.

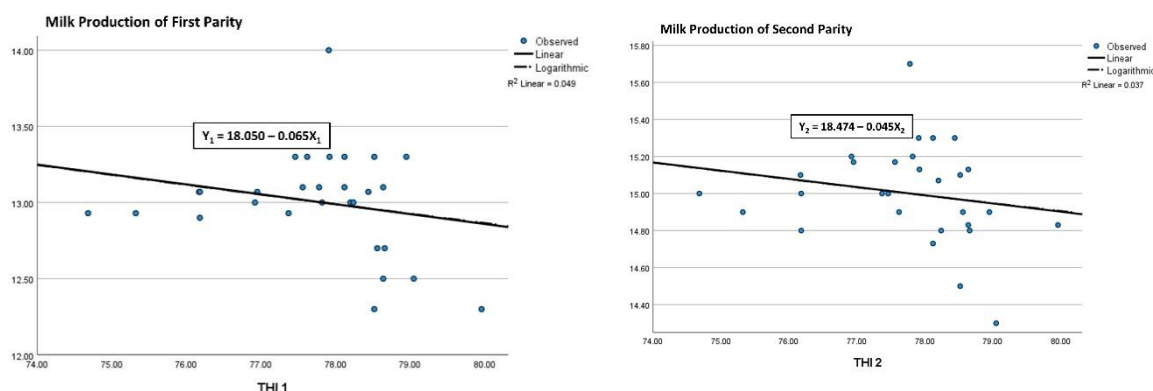


Figure 4. Graph of correlation THI with milk production in Parity 1 and 2

Based on Figure 4. shows there is a negative correlation between the relationship of THI to milk production with the obtained line equation between THI and the production of milk parity 1 is $Y_1 = 18,050 - 0,065X_1$ which means every increase of 1 value THI then the production will decrease by 0.065 liters. Correlation analysis at parity 1 has a negative correlation value of 0.251 whereas correlation analysis on parity 2 has a negativity of 0.227. Based on the correlation coefficients obtained, it can be interpreted that the THI value of milk production at parities 1 and 2 has a weak relationship. The weak correlation between THI and milk production will not interfere with livestock productivity, but it is worth noting because according to much literature, environmental factors have a considerable influence on the survival of cattle.

Maintenance management at this farm can be said to be good because it can minimize the environmental impact on the survival of the cow, so the production of milk at the farm can reach 15–16 liters per day. Maintaining management that is carried out in this farm is one of which is watering through a small hole that is on each roof of the pond which is done during the day or at a specific time as needed. Wind fans are also installed on this farm to reduce the hot air that enters the vault, wind fans on the farm are also lit every day from day to afternoon. Based on the statistical test on parity 1 the determination coefficient (R²) is obtained at 0.049 which means that the THI influences the milk production of parity 1, at 4.9%, and 95.1% is influenced by other factors. Another factor that can be used as an indicator of milk production is the lactation period. The ability of cows to produce milk will peak at the age range of 5 to 6 years. This is because cows will

experience increased growth of their bodies as well as alveolar cells, so milk production will be optimal at that age. (Siska dan Anggrayni, 2020).

CONCLUSIONS AND RECOMMENDATIONS

THI and HTC have a weak correlation with milk production in the Bangun Lestari farm, with the value of HTC to dairy production at parities 1 and 2 ($r = 0,410$; $R^2 = 0,168$) and ($r = 0,370$; $R^2 = 0,137$), whereas the THI value to the production of milk at parity 1 & 2 is equal to ($R = 0,220$; $R^2 = 0,049$) and ($R = 0,227$; $R^2 = 0,51$).

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