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The Impact of Structure and Cage Climate on Productivity of Dairy

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ABSTRACT: *There are four microclimate elements that can directly affect livestock productivity, namely temperature, humidity, radiation, and wind speed, while the other two elements, evaporation and rainfall, affect livestock productivity indirectly. The purpose of this study was to determine the impact of building structure and temperature of the cage on the level of milk production of dairy cows. The research location in Enrekang Regency which included in the highlands in South Sulawesi Province. The number of samples used is 35 samples from 50 existing cattle pens with purposive sampling technique. Data collection through direct measurements, observations, questionnaires and interviews. The results obtained there is no significant difference in temperature and humidity of the air in the cage and outside the cage. Temperature shifts from the comfortable range in cattle are sure to experience both hot stress (hyperthermia) and cold stress (hypothermia). Dairy cows need a place to live according to their needs. The cows cannot place in the same cage building because it will affect their health. The cage made primarily as a building for the management of dairy cows and its security against theft and predators.*

Keywords: *Animal Husbandry, Construction, Climate, Facilities, Humidity, Temperature.*

I. INTRODUCTION

Current technological developments have an essential role for farmers. In developed countries, the adoption of modern breeding patterns shows significant results[1]. It is different from the way of traditional dairy cattle which in the end cannot compete in the global market. The management of the cage is one of the factors that influence the level of milk production[2]. Cage construction that is not following technical standards and natural conditions such as air temperatures makes livestock productivity less than the maximum[3]. Another factor is the use of labor that is inefficient and has an impact on the surrounding environment. The standard model for cow sheds is related to the shape and type of roof, ventilation, wall and floor arrangements. A suitable enclosure is one that can open and closed. During the day the wall can be opened so that it exposed to sunlight and good air circulation. At night the walls are closed so that the air temperature is not too cold. Stables in low-lying areas should be higher than the ground around the stables[4].

The construction of dairy cows should be designed to be effective, energy-efficient and use of tools and comfortable for workers. The structuring along with the equipment will make it easier for officers to provide food, drink, waste disposal, and handle animal health. Building construction planning must be appropriately designed, built with construction materials that are strong, safe, non-humid, easy to clean, and equipped with sewage collection facilities and a proper drainage system[5].The design of the cage building construction which built in the highlands is endeavored to be more closed to protect livestock from extreme cold weather and temperatures. Construction design in low-lying areas, the shape of the cage can make with a more open model. Dairy cages must meet livestock health and comfort requirements that are adjusted to health regulations to increase milk production[6].

Dairy farms in Indonesia generally still use conventional cage forms. In conventional cages, dairy cows are placed in one or two rows and usually limited by insulation. The reason for the limited land, this model cage more widely used. Recommend that use conventional forms, no need to use insulation. Enclosure with a bulkhead will make it difficult for officers to milk[7].

Most of the dairy cows in Indonesia are Fries Holland (FH) cows imported from European countries that have moderate climates with a low thermo neutral temperature range (13-25degrees Celsius). Based on the original climatic conditions, dairy cows are susceptible to changes in high temperatures. If cows placed in locations that have high temperatures, the cows will experience continuous heat stress which results in a decrease in cow productivity. Heat stress received by cows can reduced by wind at a certain speed. Other efforts that need to be made to reduce the heat stress of cows are the modification of the livestock environment through the provision of shade, the selection of roofing material and the height setting

Livestock will provide an initial response in the form of behavioral changes, increased activity of the respiratory and cardiovascular systems. If the initial response has not reached homeostatic conditions, there will be a follow-up

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response in the form of changes in the hormonal, enzymatic and metabolic systems. If this homeostatic situation has not yet achieved, the livestock will experience various symptoms of the disease accompanied by low production and reproductive efficiency [8].

Mount [9], found that there are some noticeable behavioral changes in mammals that experience heat stress is: reducing ration consumption, increasing water consumption, decreasing bodily activity, accelerating respiratory frequency. This condition causes the energy needs for basic living to increase and the use of energy for growth to be lower.

Climate is one of the environmental factors that directly affects livestock and also indirectly influences through its influence on other environmental factors, besides being different from other environmental factors such as food and health, the climate cannot be regulated or fully controlled by humans, to obtain livestock productivity that is efficient, humans must adapt to the local climate [8]. The climate suitable for breeding areas is in semi-arid climates. Areas with this climate characterized by extreme seasonal conditions, with relatively low rainfall and long dry seasons. Temperature fluctuations at the start and season are considerable, the humidity throughout the year is mostly very low, and there is a high intensity of solar radiation due to the dry atmosphere and clear skies [10].

II. MATERIAL AND METHODS

2.1. Location

The research carried out in Cendana Sub-district, Enrekang Regency located at coordinates between 03 14' 36" to 03 50' 00" Selatan South Latitude and 119 40' 53" to 120 06' 33" East Longitude. Enrekang Regency, in general, has varied topographic areas in the form of hills, mountains, valleys and rivers with a height of 47 meter - 3,293 meters above sea level so that it included in the highland category. In general, the topography of the region is dominated by hills/mountains, which is around 84.96% of the total area of Enrekang Regency while the flat area is only 15.04% [11].

1.2. Sample and Data Collection

The number of dairy farmers in Cendana Sub-district is 50 people so that there are 35 samples taken, consisting of 33 dairy farmers and two extension agents responsible for the area in this district. Data collection using information-gathering tools, namely observations, interviews, questionnaires, and documentation. The selection of livestock samples was carried out by purposive sampling in this case based on established criteria [12], namely parity dairy cows two to four, each parity consisting of two to four lactation months which has a complete record, with variables observed through appearance livestock reproduction during observation.

III. RESULT AND DISCUSSIONS

3.1 The Selection of Cage Roofing Materials

All materials will reflect, carry on and absorb shortwave and longwave radiation in different proportions depending on the type of material. This difference caused by differences in the absolute temperature of materials, physical and chemical properties of materials and the conductivity of heat energy (heat) and the wavelength of solar radiation. Therefore, the selected roofing material for cow drums are materials that can reflect and absorb radiation to reduce the delivery of heat into the cage.The building of dairy cattle pens in Enrekang Regency, especially in the Cendana sub-district, is still conventional, even made according to the condition of the surrounding location. Cement sand flooring, using walls and roof height do not meet health requirements. This condition thought to be the cause of the low or 9-liter average dairy milk production per day/head when compared with 10-15 national cow's milk production per head.

Solar radiation absorbed by the material will converted into heat, then delivered to the cooler parts or re-emitted as longwave radiation. The ability to conduct heat (conductivity) of each material from the lowest to the highest successively is asbestos, concrete, steel, zinc, aluminum [13]. Thin materials like most metals have a significant conduction coefficient so that the temperatures above and below are almost the same. Hahn [14], states that dry grass or straw roofing material is most effective at blocking direct radiated radiation, while solid materials such as asbestos, zinc-coated iron or aluminum are less effective unless they are painted white. Other ingredients that are effective in blocking solar radiation are reeds and coconut leaves. Both materials have low conductivity values. Rumbia (Sago leaves) has a conductivity value of 0.0001 cal./sec degrees Celsius. The low conductivity value of the cage roofing material shows the low ability of the material to deliver the heat radiation it absorbs, so it is excellent to reduce the amount of radiation reaching the livestock. Gatenby & Martawijaya [15], stated, the temperature in the cage whose roof was made of asbestos, zinc, and thatch respectively 26.5; 27.0 and 26.4 degrees Celsius. The

physiological response of dairy cows is perfect for thatch roof cage material compared to tile and zinc.

Cow shelter is affected by air temperature, humidity, radiation, and wind speed. The higher the temperature of the environment, the cow will shelter longer to maintain body heat so as not to rise due to heat stress from the ambient temperature. The higher the air humidity and solar radiation around the cow, the cow will shelter longer with a lower intensity. The higher the wind speed, the cow will reduce the intensity of the shelter for a long time because the wind can reduce the body's heat.

3.2 Determination of the Height of the Cage

In addition to choosing a low conductivity roofing material, another effort undertaken to modify the microenvironment inside the cage is to increase the size of the cage. One way is to raise the roof of the cage so that the volume of air and the flow of air that enters the cage becomes more significant and the air changes faster so that the temperature in the drum decreases [16].

In sunny areas with full sun, the height of the roof of the cage should be between 3.6-4.2 meters; while the area is slightly cloudy the height of the cage roof is between 2.1-2.7 meters. The height of the cage is quite effective in limiting the diffusion of solar radiation received by animals in the cage [14]. The height of the enclosure roof for wet tropical areas ranges from 2-3 meters and for dry hot climates between 4-5 meters [17], and between 3-4 meters for semiarid areas [18]. The height of the cowshed roof for hot areas with moderate rainfall to high rainfall is 175 cm measured from the lowest roof side to the cage floor [19].

Types of cages that can use in tropical countries are open and closed cages. Each type has advantages and disadvantages. The advantages of open cages include: under construction and operational costs, and are not dependent on electricity. Lack of protection against disease, environmental influences, and predators is not good.

The potential productivity of livestock influenced by genetic factors, the environment, and interactions between genetics and the environment [20]. Genetic factors that influence is livestock nation, while environmental factors include: feed, climate, altitude, body weight, disease, pregnancy and birth spacing, lactation month and parity [21]. One effort to increase the productivity of dairy cattle can be made by developing a maintenance business. This alternative is based because the development of dairy farming businesses has so far been centralized in the medium to high altitude environment, thus limiting the increase in livestock productivity because most regional conditions also consist of lowland environments.

3.3 Temperature and Humidity

The results of measurements of the average temperature and humidity of the environment from the location of cattle drums in Enrekang Regency obtained as follows:

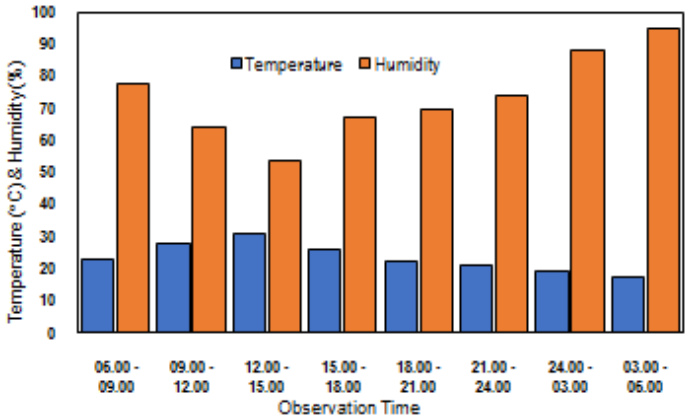

Figure 1. Temperature and Average Humidity of Cow Cages in Enrekang Regency.

Air temperature and humidity are two weather or climate factors that influence the production of dairy cows, because they can cause changes in heat balance in the body of livestock, water balance, energy balance and balance of livestock behavior [8], [22]. Measured air temperature in the cage comes from shortwave radiation and longwave radiation from direct solar radiation, reflections, and mixed radiation from the atmosphere.

Solar radiation on the cage roof material will be changed by the top layer of the roof into a long wave (heat),

delivered to the inner layer by conduction and emitted into the cage room. This longwave radiation is the most dominant part affecting the measured temperature in the cage room. The amount of relative humidity measured in the drum depends on the source of water in the cage, the wind speed that blows in the cage and the temperature of the air as a controlling factor for evaporation.

Air temperature and humidity at low altitude locations above the comfort conditions needed for live performance and livestock production, this can cause stress or heat stress on the body of the livestock [23].McDowell [24], states that for life and production, livestock requires optimum environmental temperatures. The thermo neutral zone of comfortable temperatures for European cattle ranges from 17–21□C [22]; 13–18□C [17]; 4–25□C [25]; 5–25□C [26].Changes in temperature in the cage can affect changes in heart rate and respiratory frequency of cows. The heart rate of a healthy cow in a comfortable area (body temperature 38.6□C) is 60-70 times/minute with a breathing frequency of 10-30 times/minute [27].

The change in temperature seen from the respiratory response and heart rate is a mechanism from the body of a cow to reduce or release heat received from outside the animal's body. Increased heart rate is a response from the body of livestock to spread the heat received into the fresher organs [28].Different results obtained by Meyer [29], [30], the humidity of the air around the caged cattle (76.5%) was not significantly different from the humidity of the air where the cattle were grazed (75.6%). This difference in data is due to measurements made on the same farm area, with the same altitude.

Environmental temperature is very influential on the survival of livestock. An increase in the temperature of the microenvironment (around the cage) by 5□C cancause a marked change in the animal's diet even if it cannot can cause stress. It will result in further aspects of production in livestock, both ruminant and non-ruminant livestock [31]. Inappropriate temperature and humidity will significantly affect the level of productivity of dairy cows because the process of evaporation from the body of dairy cows will hampered so that the cattle experience heat stress. Heat stress experienced by livestock can cause a decrease in energy intake available for increased productive function, as well as loss of sodium and potassium [32]. This physiological response can see from body temperature, rectal temperature, skin temperature, heart rate, and breathing frequency which is lower in cattle that are given thatch roof compared to those that given zinc or roof tiles [33].

Environmental factors can be modified to get the comfort of livestock itself. Modification of the microenvironment can be done by providing shade in the form of the roof of the cage with the right height, giving shelter around the livestock building, providing cold drinking water, providing wind speed by installing a fan, ignition through a sprinkler in the cage, giving an insulator on the roof of the cage. Modification of the microenvironment above requires a low cost so that it requires alternative environmental modification by using cage materials (roofs, walls, poles) and cheaper technology.

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