https://doi.org/10.61308/GOEI2940

Study of farmer perception about the impact of climate variability and change on dairy farming for adaptation strategy

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Prima, A., Harjanti, D. W. & Setiatin, E. T. (2023). Study of farmer perception about the impact of climate variability and change on dairy farming for adaptation strategy. *Bulgarian Journal of Animal Husbandry, 60*(4), 49-55

Abstract

This study aims to examine the perception of farmers on climate variability and change and what aspects were most affected by climate variability and change as well as what adaptation strategies can be carried out by farmers. This study was conducted in July – September 2021 at the dairy farm of a livestock farmer group in the city of Salatiga, Central Java Province, Indonesia. A total of 286 farmers from a total of 11 groups were used as respondents in this study. Each group had 26 ± 10.94 dairy cows. Data were obtained through interviews and filling out questionnaires. Descriptive statistical analysis and Friedman's test (K-related sample test) with SPSS version 25 were used to analyze the data. The percentage of farmers who believe in the phenomenon of climate change was higher than those who do not. In general, farmers know about climate change through personal observations. Most farmers feel that the temperature continues to increase every year, but during the rainy and dry seasons, there was no change. Based on the farmer's perception, the biggest impacts caused by climatic conditions were the availability of forage and water and milk production. Adaptation strategies that can be carried out by farmers to overcome the availability of feed were making silage, using agricultural waste and the role of the government was needed to provide concentrated subsidies. Drilling wells and rainwater storage can be used as a strategy to overcome restrictions on water availability.

Keywords: climate variability change; adaptation; dairy farmers

Introduction

For the last few decades until now climate change was still an important issue for the global community. It was because, climate change can have a negative effect on human life. The negative impact that arises was related to food availability and supply due to disruption of the livestock sector by climate change (Godde *et al.* 2021). Livestock products such as agricultural commodities were important for global food security, Kamorek *et al.* (2021) reported that in 2050 there will be an increase in the need for food from livestock by 38% compared to 2022, especially in developing countries. One of the demands for products from livestock that continues to increase is milk. Since 2012 the worldwide demand for milk is expected to increase by 20.9% by 2050 (Henchion *et al.* 2021).

With the threat of climate change to the livestock sector, it was necessary to an adaptation strategy for farmers to be able to maintain livestock productivity so that the food products produced can meet human needs. In response to these conditions, various studies related to adaptation efforts for the livestock sector in the tropics have been reported by several previous researchers. Rojas-Downing *et al.* (2017) report on the impacts and efforts of adaptation and mitigation on livestock in general, and Escarcha et al (2018) report on policy efforts that can be made related to adaptation strategies for buffalo farming. However, studies related to adaptation strategies in dairy farming in the tropics were still limited. Although Montcho *et al.* (2022) have reported on adaptation strategies for dairy farming in Sub-Saharan Africa, this study is only limited to assessing farmer perceptions related to climate variability but has not determined the important points regarding the negative impact of climate variability and change on dairy farming. To develop an adaptation strategy, it was better to determine the critical points of the negative impact of climate change so that the adaptation strategy that has been prepared can be applied by farmers (Akinnagbe and Irohibe 2015).

Based on study a reported by Banik *et al.* (2015) the impact of climate change on the livestock sector as a whole will be more pronounced in tropical countries than in temperate countries, mainly due to the structure of the production system and economy. Seeing these conditions, Indonesia, which was in a region with a tropical climate will face increasingly severe challenges in fulfilling the needs of milk. Based on the explanation above, it was important to conduct this study with the aim of examining 1) how farmers perceive climate variability and change, 2) what aspects were most affected by climate variability and change in dairy farming, and 3) what adaptation strategies can be implemented by farmers.

Materials and Methods

This study was conducted in July – September 2021 at the dairy farm of a livestock farmer group in the city of Salatiga, Central Java Province, Indonesia. Based on statistical data, the population of dairy cattle in the city of Salatiga in 2018 was 3413 heads or the 4th largest in Central Java Province. A total of 286 farmers from a total of 11 groups were used as respondents in this study. Each group of farmers had on average 26 ± 10.94 in dairy cows of Frisian Holstein crossbreed. For feeding management all of farmers group fed the cows with a concentrate that was containing palm kernel cake, rice bran, cassava meal, and soybean meal and roughage. The average daily milk production of each cow was 10.5±1.36 liters.

Collecting data using a structured questionnaire given through face-to-face interviews with farmers. Interviews were conducted by surveyors who had been previously trained. The questionnaire consisted of two parts with closed questions: 1) perceptions of climate change in general, 2). Perceptions of the impact of conditions of climate variability and change on dairy farming. Perception data were collected by asking respondents whether they knew about climate change and how the climate conditions were, they were asked about perceptions of changes in seasonal climate event patterns in the last 10 years (2010-2019) with categorical answers ("no change", "changed"). Effects of climate variability and change on dairy cattle on a 5-point scale from 1 (no impact at all) to 5 (very strong impact). Descriptive statistical analysis was used to analyze farmer perceptions of climate change and its impact on dairy farming. To find out what has the most impact due to climate change on dairy farms, it was analyzed using the Friedman test (K-related sample test) followed by the Wilcoxon-signed rank test for paired post hoc comparisons if appropriate by the SPSS version 25.

Results and Discussion

Farmer's perceptions of climate change

Farmers' perceptions of climate change are shown in Table 1. Based on the study results, the percentage of farmers who believe in the phenomenon of climate change was higher than those who do not. The more farmers in a community who already know about climate change, this was positive in mitigation and adaptation efforts to face climate change. Ahmed *et al.* (2015) report that farmers' trust was a strong driving factor in adopting technical factors for mitigation and adaptation efforts in the agricultural sector. In general, farmers know about climate change through personal observations (Table 2.) According to farmers, climate change was difficult to predict, hot temperatures during the day and very cold at night were signs that were believed to be climate change. The signs of climate change observed by farmers in this study were the same as those reported by Asrat and Simane (2018) that Ethiopian farmers stated that they believed that climate change was seen from increasing temperatures and shorter rainy seasons.

For most farmers, the temperature continues to increase every year, but for the rainy season and dry season, there was no change (Table 3). Based on data from the Climate Change Knowledge Portal (2022) reports that the temperature data for Central Java Province in 2000 was an average of 26.7°C and in 2020 the average was 27.1°C or multiplied by an increase of 0.4°C, while the rainfall data the average in 2000 was 2,843.74 mm and in 2020 it was 3,301.29 mm. Based on farmers' perceptions and climate data reported by the Climate Change Knowledge Portal, it can be said that farmers' observations about temperature changes were quite good, but related to the rainy season, farmers still need to be educated further, because when rainfall increases the rainy season will also be longer (Loo *et al.* 2015), this is also supported by the results of the research reported by Avia (2019) which reported that rainfall on the island of Java increased significantly in 2010-2018 compared to 1981-2010.

Farmers perceived of climate impact on dairy farming

Based on the farmer's perception, the biggest impacts caused by climate variability and change were forage availability, water availability, milk production, dairy cow health, reproduction, feed costs, milk quality, and feed quality (Table 4). It was also in accordance with what Rojas-downing *et al.* (2017) reported that in the tropics climate change has an impact on the quantity and quality of feed, water availability, and heat stress which has an impact on feed consumption, live-

Table 2. Sources of information on climate change by farmers.

Sources	Percent of respondents (%)
News and social media	11.76
Extension officers	38.24
Personal observation	50.00

Table 3. Farmers perceptions of changes in climate and temperature.

Parameters	Percent of respondents (%)
Temperature	
decrease	12.07
no change	34.48
increase	53.45
Wet season	
decrease	24.14
no change	39.66
increase	36.20
Dry season	
decrease	31.03
no change	37.93
increase	31.04

Table 1. Farmers perception of climate change.

Parameters	Signs	Percent of respondents (%)
Believe in climate change	Extreme increase and decrease in temperature, unpredictable shifting season	86.21
Not believe in climate change	No change in temperature and season	13.79

stock productivity, reproduction, health, mortality, biodiversity, agro-ecological zones, and food security.

The availability of feed and water was the biggest impact due to the long dry season. The long dry season causes the supply of forage water needs to be unmet so that the production of forage biomass was low (Dumont *et al.* 2014). Forages have an important role in maintaining rumen function and milk production in dairy cows (Molavian *et al.* 2020), as well as water, water hasd an important role for dairy cows in the digestive process, metabolic processes, maintaining cell function, digestion, and metabolism (Giri *et al.* 2020). Therefore, when the availability of water and feed is disrupted, it will have an impact on milk production and also the health of dairy cows.

In addition to the impact of the availability of feed and water, milk production can also decrease due to the effects of increase temperatures. When the environmental temperature was high and exceeds the thermoneutral limit of dairy cows, the cows will respond to this by decreasing feed intake which will then affect milk production. This ws in accordance with what was reported by Liu *et al.* (2019) that when high environmental temperatures will trigger heat stress in dairy cows, if cows experience heat stress, feed intake tends to be low and will affect milk production.

When the rainy season lasts long enough, according to farmers, cases of diarrhea and bloating in cattle were increasing. It was consistent with Olmo *et al.* (2019) in tropical countries such as Laos, cases of diarrhea increase in cattle during the rainy season. Likewise with bloat cases, according to Sivaprakash *et al.* (2021) bloat cases in cattle in India can increase 3 times during the moonson season.

The farmers stated that if artificial insemination was carried out when the ambient temperature was high, it was likely that the cow would fail to conceive. High environmental temperatures can cause heat stress in dairy cows which then affects the development and maturity of follicles and decreases semen quality (Habeeb *et al.* 2018).When forage was difficult to obtain in the long dry season. This condition forces farmers to meet animal feed needs through the provision of more concentrate than usual, so that feed costs were increase (Schaub and Finger 2019).

High environmental temperatures cause the quality of milk to decrease. According to farmers, the milk produced becomes more dilute when the ambient temperature is high. When cows experience heat stress, milk fat, protein and total solid milk levels decrease (Pragna *et al.* 2016).

When the dry season occurs for a long period of time, it can reduce the quality of feed. Long sunlight during the dry season causes the lignin content in the feed to increase and the protein content to decrease (Sanz-Sáez *et al.* 2012).

Table 4. The level of impact climate change on dairy farming.

Parameters	**Impact**	**Climate conditions**	**Mean rank***	**Friedman test**
Forage availability	Restricted	Long dry season	6.43	$p < 0.000$
Water availabilty	Restricted	Long dry season	5.81	
Milk production	Decrease	High temperature	5.20	
Health	Increase case of diarrhea, and bloat	Long wet season	5.05	
Reproduction	Fail to conceive	High temperature	3.81	
Feed cost	Increase	Long dry season	3.67	
Milk quality	Decrease	High temperature	3.27	
Forage quality	Decrease	Long dry season	2.84	

**The higher the mean rank, the greater the level of concern as an impact on dairy farming.*

Adaptation strategy based on farmers perceived of climate impact

The long dry season and high environmental temperature were climatic conditions that have the most negative impact on dairy farming. According to farmers, the long dry season can cause the availability and quality of forage to decrease and the availability of water was also limited. Strategies that might be carried out by farmers to deal with problems during the dry season can follow the strategies adopted by dairy farmers in West African countries including Benin, Burkina Faso, Mali, and Niger as reported by Montcho *et al.* (2022). The strategies were making forage silage when forage production was abundant during the rainy season, making fodder, using agricultural waste as animal feed, making rainwater reservoirs and drilling wells. These strategies were proven to be able to maintain the productivity of dairy cow in West African countries with various climatic conditions. During the long dry season, to cover forage shortages, farmers at the study site reported that farmers increased the provision of concentrates to maintain milk production from dairy cows, but this had an impact on increasing feed costs. Therefore, the role of the local government and related agencies was needed here to provide subsidized feed concentrates to maintain the productivity of the dairy cattle in the dry season. As reported by Chen and Yu (2019) in China, the existence of a subsidy program was able to encourage farmers to increase business scale and productivity of dairy cattle.

High environmental temperatures can cause a decrease in milk production and quality and cows also fail to conceive. The strategy that might be done by farmers to deal with the problem of high environmental temperature was to use cooling devices such as fans equipped with sprinkles to keep the temperature of the cage environment in the comfort zone of the livestock. As reported by Qisthon *et al.* (2020) in lowland dairy farms in Indonesia, the use of fans equipped with sprinkles can keep the physiological conditions of cows in the normal range and keep milk production. Although the problems faced were mostly in the dry season, if the rainy season was long enough it will also have a negative impact on livestock health. Diarrhea and bloating in dairy cows can be caused by conditions in the cage that are not clean and humid, therefore the action that can be taken was prevention by keeping the house condition clean. Calves were prone to diarrhea, therefore giving colostrum at the beginning of birth was something that must be done by farmers (Meganck *et al.* 2014). The use of forage and legumes containing condensed tannins can also prevent bloating in cattle (Wanapat *et al.* 2013).

Table 5. Adaptation strategy to deal with climate impact.

Problem of climate impact	Adaptation strategy	Literature source
Restricted forage availability and forage quality	- Making of silage - Use of agricultural waste - Use of fodders - Concentrate feed subsidy	(Montcho *et al.* 2022) (Chen and Yu 2019)
Restricted water availabilty	- Rainwater storage - Drilling wells	(Montcho *et al.* 2022) (Ongandi *et al.* 2020)
Decrease milk production and quality, fail to conceive	Sprinkle dan fan	(Qisthon *et al.* 2020)
Increase case of diarrhea, and bloat	- Colostrum management for calves - Sanitation and maintaining the cleanliness of livestock and house - Feeding management	(Wanapat *et al.* 2013) (Meganck *et al.* 2014)

Conclusion

According to farmers, the temperature has increased but the rainy and dry seasons have not changed in recent years. The biggest impacts arising from climate variability and change were the availability of water and feed and a decrease in milk production. Adaptation strategies that can be carried out by farmers to overcome the availability of feed were making silage, using agricultural waste and the role of the government was needed to provide concentrate subsidies. Drilling wells and rainwater storage can be used as a strategy to overcome water availability.

Acknowledments

The authors would like to thank Faculty of Animal and Agricultural Sciences, Universitas Diponegoro for financing this study and thank to Food and Agriculture Department Salatiga City for facilitating this study.

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