Implementation of Automatic Cooling System for Cattle Shed and Its Effect on Milk Production

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Paper Received on March 16, 2021, Accepted on April 17, 2021 and Published Online on May 01, 2021

ABSTRACT

Automation and robotics play a major role in human life; we can't picture a future without them. So, without these innovations, how will livestock/cattle survive? During the summer, the temperature in Rajasthan's north western area varies greatly (approx 50° C). The health of animals and cattle is affected by the high temperatures. It lowers milk production. This has an influence on both life and the economy. Many initiatives have been created to escape these kinds of sensitive circumstances by using technology such as integrated, wireless sensor, and IOT. The wireless temperature sensor detects the environmental temperature of the cattle/ livestock shed in this temperature-based cooling system for livestock and cattle farm in the western area of Rajasthan using Arduino system, and if the temperature goes high, the cooling system Fogger system begins, and if the temperature goes down, the fogger system goes off automatically. Arduino is in charge of this device. On the LCD display, the temperature is also shown. Additionally, the owner may use Bluetooth mobile communication to set the high-low temperature threshold value.

***Key words**: Arduino uno; Bluetooth; Fogger; Livestock; Sensor; Temperature;*

Rajasthan's economy is heavily reliant on livestock and cattle rising. This account for ten percent of the state's overall GDP. According to the 2011 Population Counting, Rajasthan's rural population is 75.13 per cent. The majority of the rural population relies on livestock farming to support themselves and their families. Milk demand is steadily growing. The high temperature of summer days is a very dangerous situation for the wellbeing of livestock and cattle. It has an effect on the wellbeing of livestock. Humans are unable to envision their lives without animals. In the north western part of Rajasthan, where the temperature rises dramatically during the summer, this high temperature becomes a major issue for livestock and dairy farming. As a result, high temperatures in dairy cattle pose a variety of health problems. Often has an effect on milk production during the summer months. Bathing them in a pond or pool and leaving them there for a few hours is an easy way to keep them cool on these sunny summer days.

Because of their thick skin, buffalo take 4-5 hours to bathe. However, due to the lack of a pond or lake near all livestock/cattle farms this is not feasible. It has an impact on Rajasthan's livelihood and economy, especially in the north-western part of the state. Nowadays, a person cannot imagine his or her life without the use of robotics and technology.

As a result, we must apply robotics and technologies to livestock as well. Using Arduino, we developed a temperature-based automatic cooling system for livestock/cattle sheds/farms. On hot summer days, farm owners can sustain milk yields by using this method in livestock sheds. Many diseases caused by heatstroke can be prevented in livestock.The consistency and quantity of milk yields are also affected by the rising temperature.

Heatstroke is a common cause of death in cattle. For example, a cow's normal body temperature is 38.5° to 39.5°C, so if the temperature rises past 41° – 42°C, they are susceptible to two diseases: influenza and anthrax. If the temperature raises so much, they will perish. As a result, we can increase milk production and mitigate diseases by using this technique of cooling livestock/cattle sheds in the summer.

METHODOLOGY

The Arduino and Temperature Sensor are the key components of this device. The UNO Arduino version is used in this system, along with an LM35DH Factory Calibrated Temperature / Humidity sensor.

Main contents of this system

Arduino : This system makes use of the Arduino UNO variant. Arduino is a board that holds a microcontroller. It's a free and open-source electronics website for both hardware and applications. This Arduino can be pre-programmed to work for our project. Arduino can read a variety of inputs, such as light on a sensor or a finger on a button, and respond with an appropriate output.

Temperature/ humidity sensor : In this device, a factory-calibrated temperature/humidity sensor is used to calculate the ambient temperature. LM35DH is an abbreviated form of LM35DH. This temperature/ humidity sensor's output voltage is directly proportional to the temperature. This sensor can detect temperatures ranging from -55 to +150 degrees Celsius. This sensor is ideal for use in remote locations.

Bluetooth module : This machine makes use of a Bluetooth Module. By using a serial Bluetooth terminal android application, the owner can set the low-high temperature threshold values and monitor them. It acts as a medium for contact between the owner and the controlling device. It has the capacity to receive and send data.

Relay module : The Arduino/Microcontroller is used to attach the relay module. It functions as a key for the Fogger/Mister pump.

Power supply module : The Arduino or Embedded System is powered by this power supply module. This power supply module transforms 220V AC to 5V DC.

Fogger/mister : In this temperature-based automatic cooling system for livestock sheds and cattle farms, foggers and misters are used. Evaporative cooling is the foundation of their work. The results of water droplets evaporating in warm air are similar to normal cooling.

This temperature sensor tests the temperature and humidity of the atmosphere as well as the temperature and humidity of the livestock/cattle shed and sends the sensor's Analog data to an Arduino Analog to Digital converter board. This A/D converter transforms the sensor output to digital data, which is then sent to the

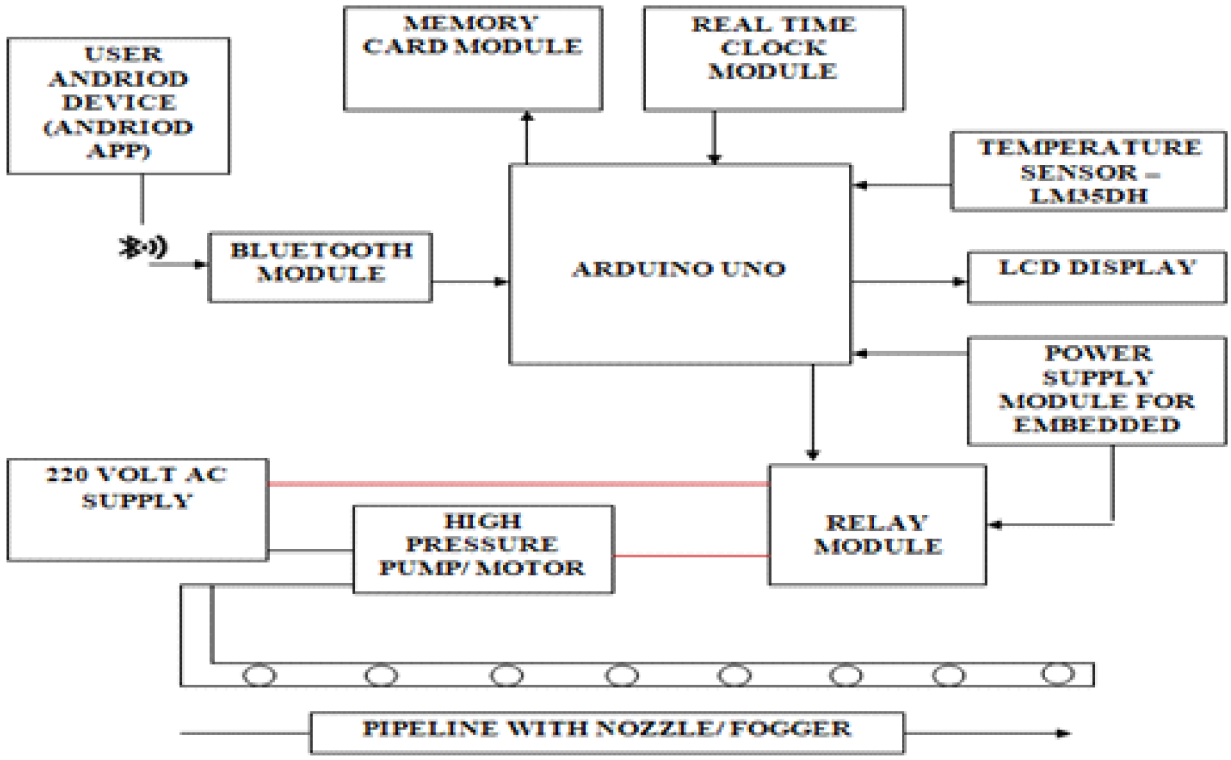

Fig. 1. Block diagram of proposed system

microcontroller. A microcontroller is also used to interface the real-time clock and SD card modules. The actual date and time are provided by this real-time clock module.

This SD card module is also used to store real-time temperature and humidity data from the environment. Arduino is also connected to a Bluetooth module. This Bluetooth module is used to communicate between the microcontroller and the user. An android app with a Bluetooth module allows users to set temperature and humidity thresholds. This Android app can also be used to retrieve all data related to temperature, humidity, and time. Data can also be accessed from an SD card that is attached to the Arduino board. The microcontroller is attached to the relay module. A high-pressure Fogger pump is regulated by a relay that acts as a switch. 220 Volt Analog Current is used to fuel this Fogger Pump/Motor. The Arduino Uno is used to switch on this relay.

Working methodology : When a temperature sensor checks the humidity and temperature in the atmosphere and sends the data to the Arduino module. Arduino unlocks the relay module if the temperature exceeds the fixed-point or threshold value set by the operator. This relay module also activates the high-pressure pump and the fogger/mister. These foggers and misters are mounted under the shed's or animal house's roof. Fogger/Misters create small water droplets that resemble fog/mist. These small water droplets evaporate before reaching the shed's surface. As a result, the temperature of the shed and animal house begins to drop. The temperature in the shed exceeds the lower set-point temperature. The temperature is captured by this sensor and sent back to the microcontroller module. This period, the friction pump is switched off by the relay. And the Fogger/Mister is turned off by these friction pumps. This Fogger machine Pipeline is usually made of PVC pipe with a diameter of 20 mm. This tubing has a thickness of 2.5 mm. These pipelines have Foggers and Misters installed. A distance of 8 to 10 feet should be held between each Fogger/Mister. For This research we have observed two group of cow for almost 90 days from May to July. Total 8 lactating cow were selected having similar weight, parity, breed and milk yield. They were divided into two groups of 4 in each group. One group is provided microclimate alteration (Automatic Cooling system) using high pressure fogger pumps. Another group was without any cooling system. The daily THI (Temperature Humidity Index) were measured using thermometer. Milk sample

Photo 1. Fogger system in livestock shed

were also analyzed for their milk quality and chemical composition. This research was conducted for approx 90 days during April to June (Hot Humid Season). In this experiment Group 1st is without any cooling system and Group 2nd provided this cooling system from 10 A.M. to 5 P.M. Daily. The body temperature of various cattle/livestock is shown in table below.

Table 1. Normal Body Temperature of Various Cattle/ Livestock (Data from Internet)

Various Animal	Temp. in °C	Temp. in °F
Calf, Young	38.5- 40.5	101.3-104.9
Young cattle up to 1 year	38.5 - 40.0	101.3-104.0
Buffalo	37.5 - 39.0	99.5 - 102.2
Kid (goat)	38.5-41.0	101.3-104.9
Goat, Adult	38.5 - 40.5	101.3-104.9
Lamb (sheep)	38.5 - 40.5	101.3-104.9
Sheep over 1 year	38.5 - 40.0	101.3-104.0
Camel	35.5 - 38.6	95.0-101.5

Table 2. Details of Experimental Cow (for group I and group II)

Animal No.	Stage of Lactation	Milk Yields (in kgs)
C-1	82	6.5
C-2	91	6.8
C-3	110	7.0
C-4	97	6.9
C-5	112	7.1
C-6	87	6.4
C-7	79	6.3
C-8	105	6.9

Effect of climate change on livestock : Climate change has a strong impact on human wellbeing. It's because of rising temperatures or heat waves. As a result of these changes, heat stress symptoms develop. Heat stress has a detrimental effect on livestock welfare. This can result in metabolic changes, immune suppression, oxidative stress, and even livestock death. It has a strong effect on the owner's life and economy.

RESULTS AND DISCUSSION

We observed in this research work that drastic increase in temperature affects milk production and animal heath especially in western region of Rajasthan where temperature goes vary high in summer. We have also discussed various previous research work relate to cooling system for livestock farms. But this system is much reliable then previous implemented system. *Meenakshi et. al. (2016,)* created a cattle health control system for cows. Sensors detect a variety of health parameters such as temperature, respiration, and humidity. Sensors are connected to Arduino in this system, and a graph of all parameters is shown on a hand-held screen via Bluetooth or Wi-Fi. It takes the place of manually detecting these parameters. It is specific and helpful to both doctors and growers. *Rajalaxmi et. al. (2020),* have reported study the Temperature Humidity Index and its association with Dairy Cattle and Buffalo Production Traits. The animal's reproductive rate is influenced by the temperature-humidity index. It may also have an effect on milk yields.

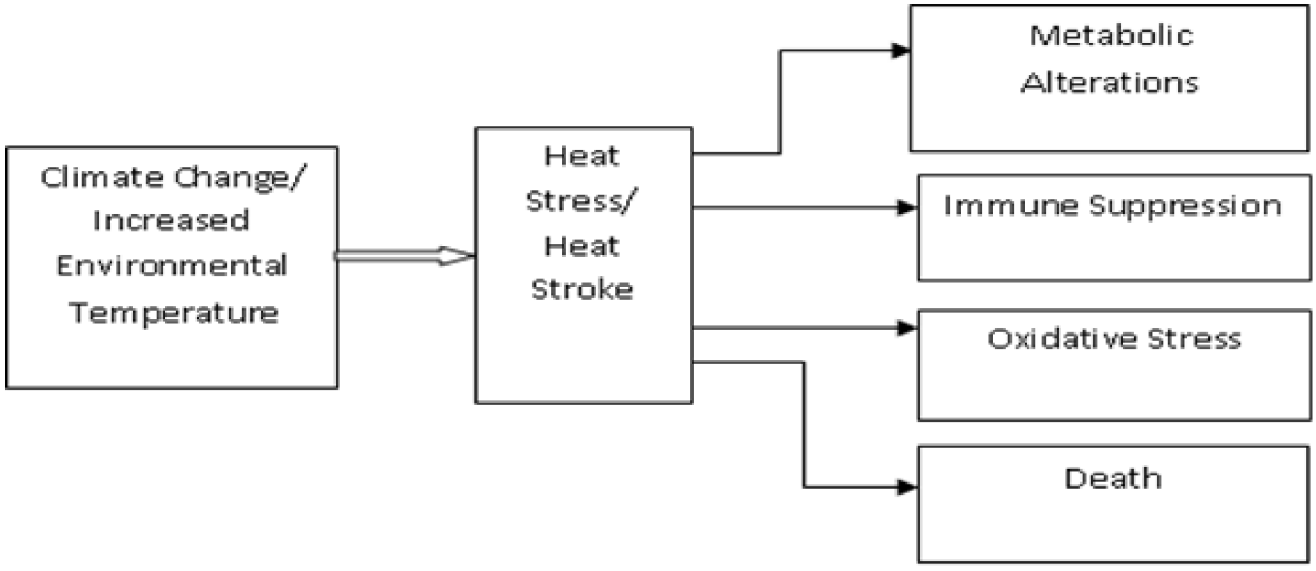

Fig. 2. Effect of climate change on cattles life

Proper ventilation and cooling systems, according to this review article, will help to minimise heat stress. In this high-temperature, high-humidity days, a proper cooling management system will reduce the effects of heat stress and sustain milk output. *Narayan et. al. (2015),* The Raspberry Pi and Wireless Sensor technologies are used in this paper to track the health of cattle. This machine keeps track of things like the temperature, humidity, heartbeat, and rumination of cattle. People used to study their animals for a long time to find out what was wrong with them or use a thermometer to monitor their temperature. Wireless sensors, on the other hand, are now used to detect their temperature. Even, their wellbeing criteria can be easily diagnosed. *Gaikwad et. al. (2019),* they focused on a GPS/GSM-based livestock/cattle health tracking device. Various parameters of livestock/cattle are sensed by sensors in this device, and the feedback of these sensors is transmitted to a server system or the owner's mobile phone via GPS/GSM. It can also monitor the whereabouts of animals and their health status. *Srujan and Sinha (2020),* The temperature is automatically regulated in this research project using Arduino. In today's smart houses; automated temperature control systems play an important role. The Arduino Uno-based microcontroller system is used to monitor the temperature in this system. The temperature sensor LM 35 is used, and the CPU is connected to the sensor and Arduino UNO. On the LCD display, the temperature is reflected. *Akyuz et. al. (2010),* A Wi-Fi based Animal Health Monitoring System was used in this study. The sensor module in this framework is implemented using Wi-Fi equipment and the RL78 RENESAS microcontroller. This Wi-Fi-based health tracking device compares the temperature of the atmosphere to different physical measurements of animals, such as body temperature, rumination, and heart rate. The owner will use the Android app to keep track of these health indicators. *Armstrong (1994)* reported that, Heat stress affects dairy cattle in hot weather. While the symptoms are more extreme in hot climates, dairy cattle in more temperate climates are often subjected to heat stress. The resulting reduction in milk quality and reproductive productivity can be mitigated by implementing a cooling programme that includes curtains, airflow, and mist, as well as fans. Until installing appliances to mitigate heat stress, the economic gain should be assessed. *Meena et. al. (2019),* their research was carried out in the trans-Gangetic plains to evaluate the technical transition in dairy farming over a ten-year period. The development of a test on various aspects of scientific dairy farming activities (breeding, feeding, administration, and health care) was used to quantify technological progress. It was discovered that there was a major technological improvement in the implementation of scientific dairy farming methods, which rose from 61.37 percent in 2005-06 to 70.73 percent in 2007-08. (in 2015-16). Furthermore, adopting scientific dairy farming methods increased both of the productive and reproductive parameters of dairy animals. *Deepika et. al. (2021),* reported that The conclusion taken from this analysis is that only a small percentage of the eating, health-care, and management methods used by women dairy farmers were statistically proven. Although the rate of adoption of different breeding practises was low. Furthermore, indicators such as respondents' educational status, family wealth, and the amount of milk available for sale all had a substantial positive effect on their degree of acceptance of scientific dairy farming methods. Due to urbanisation and increased demand for animal protein, the outlook for dairy production is improving, giving farmers the ability to grow their own milk industries, largely through small-scale production. This would have a significant effect on various levels of cash income. As a result, now is the appropriate time to enter the industry as dairy entrepreneurs with the necessary entrepreneurial qualities and expertise to survive and aspire for success in the business world. *Sahu and Behara (2017* have reported that Heat stress in dairy animals will negatively impact the animals' reproductive and development capacity. Proper breeding schemes, field cooling strategies, and improved feeding programmes will also help to reduce the detrimental effects of heat stress. *Rashika and Pushpalatha (2018),* have reported method for measuring physiological parameters such as rumination, body temperature, and heart rate in relation to the surrounding temperature has been created for animals. The designed device can also assess the amount of stress associated with a thermal temperature sensor. A sensor module based on IEEE802.15.4 and IEEE1451.2 standards has been successfully established. The sensor module is implemented using a Wi-Fi interface and an RL78 RENESAS microcontroller. The android free software

allows for real-time tracking of physiological and behavioural parameters. The system is extremely useful for providing low-cost livestock health care. A concept model is created and tested, producing highly accurate results. *Singh, R.J. et. al. (2019),* they implemented IVRS based farmer specific agro-advisory system. This design included exploratory and confirmatory factor analysis In the report, 363 registered farmers were considered as respondents. According to the findings, m4agriNEI's "Cell Phone Agro-Advisory Services Acceptance Model" is a promising model for empowering tribal farmers in Meghalaya in climate change adaptation and mitigation in agriculture by providing the right knowledge at the right time through a mobile-based agro-advisory framework.

Table 3. Effect of Cooling System on THI (Group 1st and Group 2nd)

Experiment Period	Group I (without fogger)	Group II (fogger)
1st	73.57	67.15
2nd	73.50	67.59
3rd	73.62	67.98
4th	74.12	68.15
5th	74.43	68.46
6th	74.59	68.61
7th	75.69	68.76
8th	75.98	68.96
9th	76.35	69.03
10th	77.85	69.35
11th	78.15	69.52
12th	78.95	69.72
Average	75.56±0.18	68.60±0.156

Temperature humidity index : The environmental parameters temperature and relation humidity is recorded during 12 weeks. These parameters are used to calculate the THI (Temperature Humidity Index) of group 1st and group 2nd. The peak temperature humidity index (THI) was reached at the 12th week during June in all cattle shed, there were significant difference is observed in temperature humidity index in Group 2nd with Group 1st. This difference in THI is due to automatic cooling system (Foggers) for the Group 2nd. THI is presented in Table 3.

Milk production : The effect of cooling system in the experimental cow houses on milk production (kg) in cows are presented in Table 4. The average milk production (kg) in experimental cows was 5.76±0.03 and 7.13±0.12 kg/day, respectively, in Groups 1st and 2nd.

Table 4. Effect of Cooling System on milk yield (kg) (Group 1st and Group 2nd)

Experiment Period	Group I (without fogger)	Group II (fogger)
1st	6.28	7.14
2nd	6.17	7.12
3rd	6.11	7.15
4th	6.09	7.14
5th	6.01	7.13
6th	5.94	7.10
7th	5.81	7.13
8th	5.73	7.12
9th	5.58	7.15
10th	5.32	7.13
11th	5.15	7.13
12th	5.02	7.15
Average	5.76±0.03	7.13±0.12

CONCLUSION

Automatic cooling system by the use of foggers in the dairy cattle shed/houses increased feed intake in dairy cattle resulting increased milk production, fat and SNF yield which was due to decreased heat stress in dairy cattle. The most common way to relieve heat stress of dairy cattle and their environment is by evaporative cooling. This study provides information regarding effectiveness by the use of evaporative cooling system through foggers is an efficient method for reduction of heat stress in cattle sheds. The results also indicated that reduced physiological parameters mainly rectal temperature, respiration, and pulse led to increased feed intake and higher milk yield and milk composition in with fogger system groups during summer. Therefore, supplementation of foggers for 6-7 h/day from 10.00 am to 5.00 pm can be recommended in hot humid season to battle against heat stress and improve the performance. A factory calibrated temperature/humidity sensor is used in this device to detect the ambient temperature and humidity of the livestock shed. The sensor has a high degree of accuracy. This system automatically switches on and off the fogger. This method is ideal for both small and large dairy farms. This machine can be used to replace the manual method of cooling livestock sheds, or it may be used to minimise water pollution. This machine is effective in places where the summer temperatures are very high. This

machine has the potential to mitigate diseases caused by excessive heat or heat stress. This device also preserves milk yields during the hot summer days. Using this method, farmers can preserve milk quality and quantity. This method is simple to use and dependable. Users may use an Android programme to monitor and manage temperature set points using a Bluetooth module connected to a microcontroller.

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