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# NON-INVASIVE MONITORING OF ABIOTIC STRESS IN LIVESTOCK

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## ABSTRACT

*Abiotic stress in the form of temperature, humidity, wind speed and solar radiation is a major deterrent to livestock productivity. Conventional stress detection methods in animals have their limitations; hence, the adoption of non-invasive monitoring methods has gained momentum. Various non-invasive methods like visual observation, Temperature Humidity Index, Infrared Thermography, Internet of Things (IoT), hormone analysis, etc., have been successfully employed to monitor livestock's abiotic stress. The suitable method should be selected based on the animal type, cost, time and manpower involved to get the desired outcome.*

## NON-INVASIVE MONITORING

A procedure is defined as non-invasive when it does not involve using tools that break down the skin, and there is no contact with the mucous membrane or internal body parts beyond a natural body opening. In addition, non-invasive monitoring involves observing animals without disturbing their normal behaviour, ecology or physiology.

## METHODS OF NON-INVASIVE MONITORING

### ANIMAL BEHAVIOUR (VISUAL OBSERVATION)

Several symptoms elicited by animals can be visually observed to identify various stresses. Animals have difficulty breathing or irregular breathing due to heat or cold stress. Frequent urination by affected animals is another indication of stress. The heart rate increase is normally observed in stressed animals due to the release of adrenaline to cope with the situation. Huddling together is a unique symptom exhibited by animals exposed to cold stress. Slobbering, a condition in which saliva can be seen drooling from animals' mouths, is a clear indication of extreme heat stress. The method of visually identifying focus in animals is effortless and costs nothing. They do not involve the use of sophisticated tools or instruments. Even marginal and resource-poor farmers can observe the animals and identify the symptoms visually. Still, they need to be appropriately trained before making regular observations else there will be a misinterpretation of symptoms resulting in severe consequences.

## TEMPERATURE HUMIDITY INDEX (THI)

It is a single value representing the combined effects of air temperature and humidity associated with the level of thermal stress (Bohmanova et al. 2007). THI has several merits; it is easier to derive since it involves only two parameters, i.e., temperature and relative humidity. Furthermore, the date required for THI is easily available through local weather stations. On the downside, they do not consider the influence of solar radiation and wind speed which plays a major role in altering the microclimate of the animals. In addition to that, the definitions of THI levels vary between indices and authors, leading to confusion as to which indices to be used for a particular species of livestock.

## IR THERMOGRAPHY

Infrared thermography (IRT) is a non-contact, non-invasive modality capable of detecting heat emitted from a body surface as infrared radiation (Stewart et al. 2005). When an animal becomes stressed, the Hypothalamus-Pituitary-Adrenaline (HPA) axis is activated. This high release of hormones like adrenaline causes considerable changes in heat production, which can be detected using IRT. Infrared cameras come in different form factors and sizes depending on their intended purpose. They help in detecting thermal changes before clinical signs occur in the onset of many diseases. There are some limitations, like the cost of IR cameras being high. The image must be captured from wind drafts and direct sunlight to avoid stray pixels. Also, the hair coats should be free from dirt and moisture, which may interfere with the accuracy.

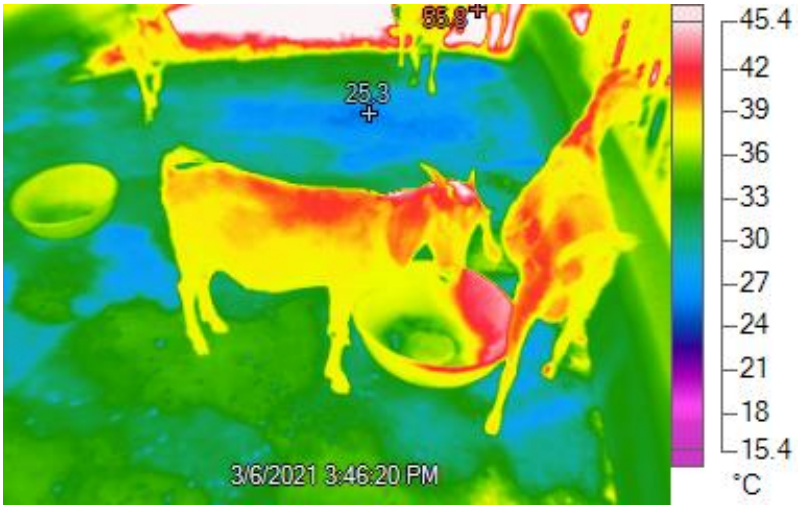


**Fig 1. Infra-Red Imagery of Goats**

## RADIO TELEMETRY

It involves the process of recording and transmitting signals from a radio transmitter to a receiver for monitoring animals. It has three components: a transmitter, a radio receiver and an antenna system with a connected cable. Low to very high-frequency transmitters are used for monitoring animals that are

confined in a small area. Radio telemetry devices can effectively monitor livestock's body temperature, body movement, heart rate and respiration rate. This technique is relatively inexpensive compared to sophisticated tools and provides for continuous or real-time monitoring of animals. On the other hand, it requires training for the installation and operation of the setup. In addition, data processing and interpretation need some expertise to make meaningful inferences.

## INTERNET OF THINGS (IOT)

It is a combination of a network of sensors, software and other technologies that connect and exchange data with other devices and systems over the internet or other communications networks (Shinde 2017). The IoT sensors can be programmed separately using a software IDE and can be connected to a microcontroller unit. The communication network can be either through the internet or a Local Area Network (LAN). The most popular hardware manufacturers for IoT-based systems are Raspberry Pi, Arduino, Espressif, etc. Some popular IDEs are Arduino IDE, Eclipse, Netbeans, etc. IoT-based systems allow for real-time monitoring with minimal interference to animals. Furthermore, since there is a provision for storing the data in the cloud, there is a minimal risk of data loss.

On the other hand, IoT systems can get expensive depending on the components used. The sensors and microcontrollers are sensitive and fragile and must be handled with care. The setting up and operation of IoT systems require some knowledge of basic programming languages.

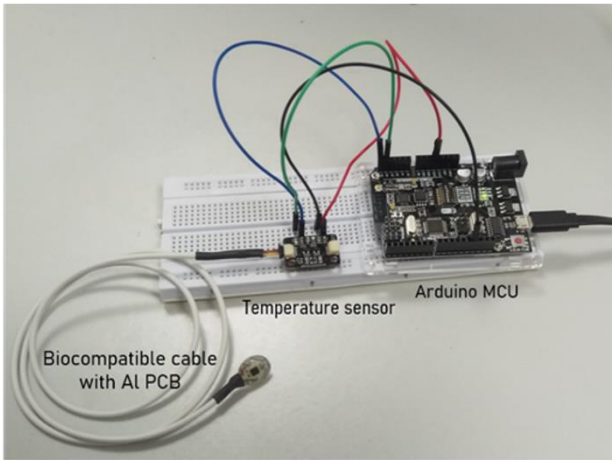


**Fig 2. Arduino MCU connected to a temperature sensor**

### HORMONE ANALYSIS

Cortisol, a product of the hypothalamic-pituitary-adrenal axis, is released when the animals are subjected to stress. Hair Cortisol Concentration (HCC) is a retrospective marker of integrated cortisol secretion stress over long periods (Heimbürge et al. 2019). The effect of age on HCCs and cortisol incorporation into hair was found to depend on hair colour, body region etc. Faecal glucocorticoid metabolites (FGM) are widely used in controlled settings and is useful in detecting short-term stress response. Since gut microbial activity provides a direct glimpse of the interactions between the gut microbiome and its surroundings, this can be used effectively to monitor stress (Valerio et al., 2020). Hormone analysis has an easy and minimally invasive sampling procedure. They have an accurate, reliable and valid reflection of long-term cortisol secretion in animals. On the downside, it requires expensive instruments and chemicals for analysis. Also, scientific knowledge of the analytic procedure and instrument handling may restrict the usage to very few.

## CONCLUSION

Though several methods are available for observing animals, no single method can be the best for animal monitoring. The selection of suitable methods or instruments is based on several factors, such as the type of animal under investigation, the cost involved, manpower requirement and time. Accordingly, the most optimum method or tools should be employed to get the desired outcome with minimal interference to the animal.

## REFERENCES

Bohmanova J, Misztal I and Cole JB (2007) Temperature-humidity indices as indicators of milk production losses due to heat stress. J Dairy Sci 90(4): 1947–1956.

Heimbürge S, Kanitz E and Otten W (2019) The use of hair cortisol for the assessment of stress in animals. Gen Comp Endocrinol 270: 10–17.

Shinde V (2017) IOT Based Cattle Health Monitoring System. Int J Eng Res Technol 5(1): 1–4.

Stewart M, Webster JR, Verkerk GA, Schaefer AL, Colyn JJ and Stafford KJ (2005) Non-invasive measurement of stress in dairy cows using infrared thermography. Physiol Behav 92(3): 520–525.

Valerio A, Casadei L, Giuliani A and Valerio M (2020) Fecal Metabolomics as a Novel Noninvasive Method for Short-Term Stress Monitoring in Beef Cattle. J Proteome Res 19(2): 845–853.

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