

## Development of a low-cost gas sensors to measure methane emissions from grazing cattle

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Methane emissions from ruminants play an important role in global warming. Beef cattle account for 41% of greenhouse gas emissions from livestock (Taylor et al., 2016). Therefore, measuring methane emissions from individual animals can help developing mitigation programs (Hammond et al., 2015). Chemical sensors can be used as a cheap method to measure methane emissions because of low production and energy cost. The present study focused on MQ-4 sensors as a cheap sensitive sensor to measure methane concentration. The MQ-4 sensor has a high sensitivity to methane and the sensitive material of this sensor is SnO<sub>2</sub>.

The methane sensor, SD-Card module, RTC module, temperature and humidity sensor were connected to an ESP32 board and powered by an external battery with an approximate cost of AU\$100. Each sensor was set to read every 250 milliseconds and to record the data on an SD-Card every second. The sensor was connected to a GreenFeed system (C-Lock Inc., Rapid City, SD, USA; Hristov et al., 2015) for two days to assess the ability of the sensor to detect changes in the concentration of methane when grazing animals accessed the GreenFeed unit.

The raw data from the MQ-4 sensors showed similar changes in the concentration of CH<sub>4</sub> compared with the GreenFeed (Figure 1) suggesting high sensitivity to detect methane. The peaks from the sensor matched those from GreenFeed at the same time when cows were feeding (Figure 1a, b). A very strong correlation between the raw data from GreenFeed and sensor was found ( $R^2 = 0.99$ , Figure 2).

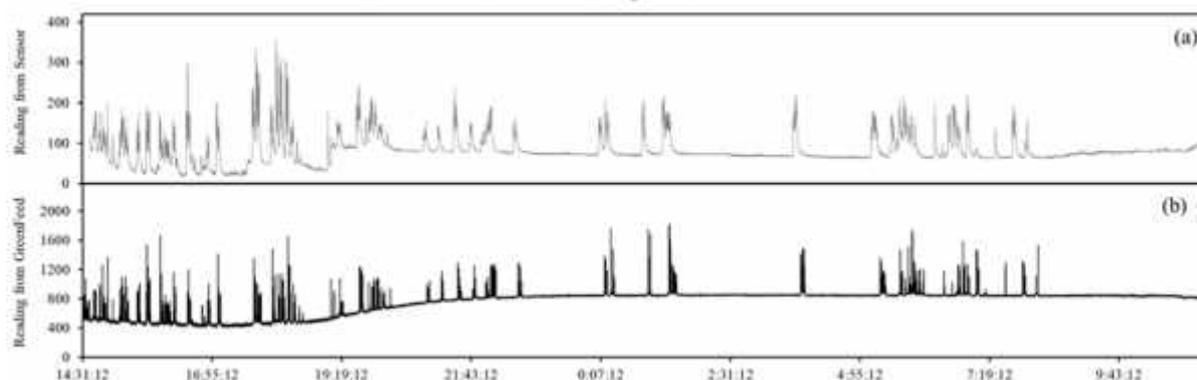


Figure 1. Raw data for methane from sensor (a) and GreenFeed (b).

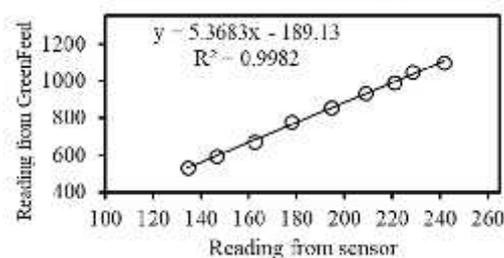


Figure 2. Correlation between raw data from sensor and converted data from GreenFeed.

The results showed that the MQ-4 sensor may be a reliable device to monitor methane emissions from grazing cattle. In addition, the equation derived from the correlation between the sensor and GreenFeed can be used for prediction to estimate emissions. The low-cost sensor could be used to measure methane emissions on farms with low energy requirement and low cost to scale up the number of measurements.

### References

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