Methane yield from pregnant heifers grazing natural veld and forage sorghum as measured with a LMD

S.M. Grobler, M.M. Scholtz, H.J van Rooyen

ARC • LNR

Excellence in Research and Development

Importance of measuring CH_4

- Agriculture is responsible for 5% - 10% of global methane production of which 80% - 90% comes from livestock
- Enteric methane is produced by methanogenesis or biomethanation due to anaerobic fermentation in the rumen and large intestine.
- The animals release methane into the atmosphere by exhaling the gas mainly through the mouth and nostrils

Importance of measuring CH_4

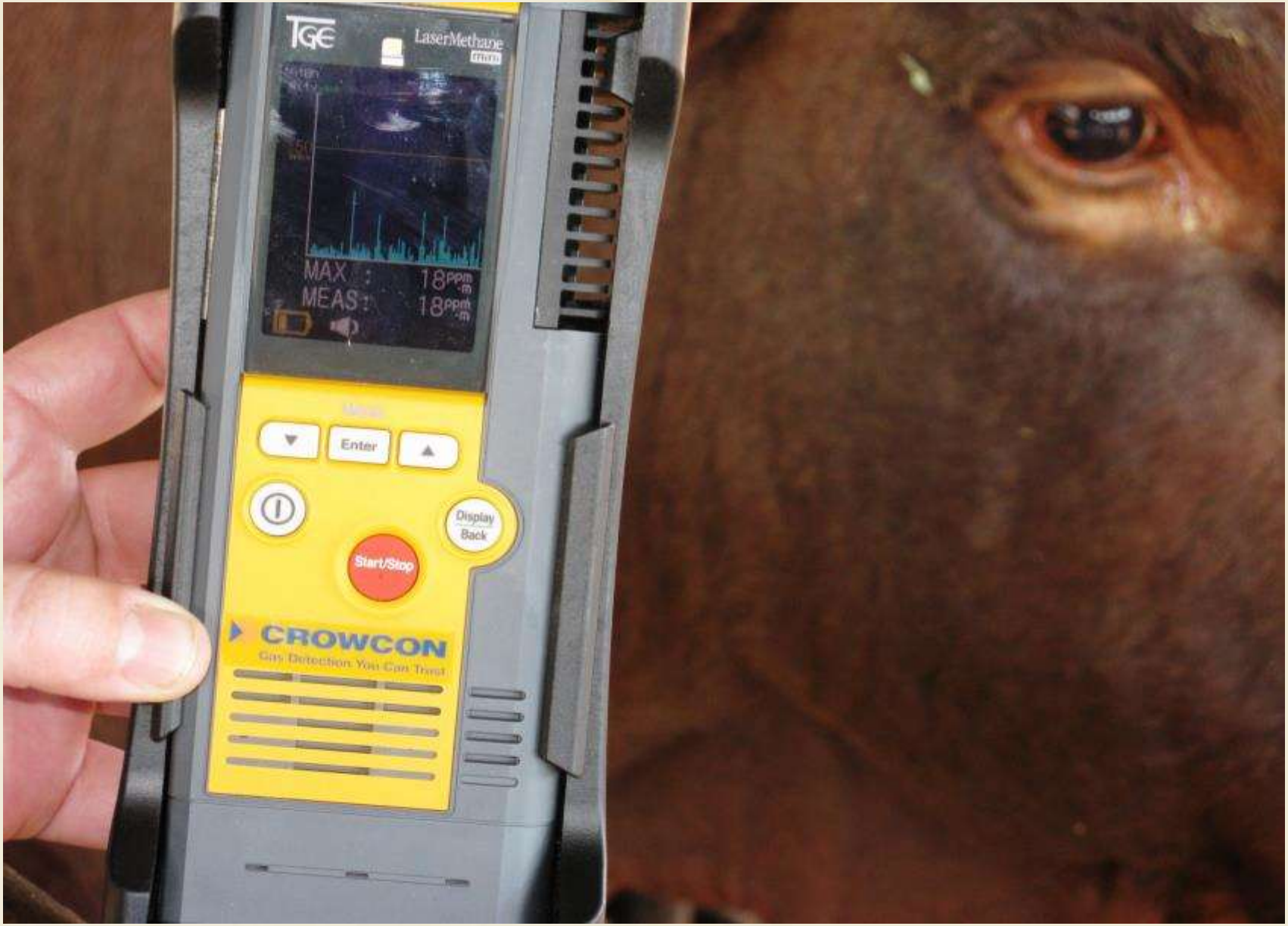
- The global warming potential of CH4 is known to be 23 times more than that of carbon dioxide, resulting in it being a significant role player in the greenhouse gas family.
- Methane can affect climate
  - Directly: through its interaction with long-wave infrared energy
  - Indirectly: through atmospheric oxidation reactions that produce CO_2 , a potent greenhouse gas

Enteric Methane emission

- Emission from cattle is influenced by
  - Level of feed intake
  - Type of carbohydrate in the diet
  - Feed processing
  - Addition of lipids or ionophores to the diet
  - Alterations in the ruminal microflora
  - Different activities

Measuring techniques

- Respiration calorimety chambers
- Sulfur hexafluoride (SF_6) tracer techniques
- Mass balance/micro-meteorological techniques
- Prediction equations based on fermentation balance or feed characteristics
- Recently developed, proprietary, Laser Methane Detector (LSD)



ARC • LNR

Excellence in Research and Development

Laser Methane Detector

- Hand-held gas detector for remote measurements of column density of methane containing gases (Tokyo Gas Engineering).
- Based on infrared absorption spectroscopy (Tokyo Gas Engineering).
- The measured value is expressed as methane concentration in parts per million-meter (ppm-m).
- Widely used in detection applications such as gas transmission networks, landfill sites and other areas where methane leakage or build-up is a risk (Crowcon, 2006).
- The use of the laser methane detector in dairy cows was first suggested and explored by Dr Chagunda Scotland (Chagunda *et al*, 2008)

Laser Methane Detector

- Chagunda and Yan (2011) tested the level of agreement between the LMD and the indirect open-circuit respiration calorimetric chamber
- 2 different methods were tested:

  Pearson correlation and analysis of agreement based on the
  - Bland methodology
  - Altman methodology.
- Both Bland and Altman methodology demonstrates high level of agreement between measurements of the LMD and the calorimeter chamber.
- The correlation coefficient of the LMD and the calorimeter chamber was high (r=0.8) and positive.

Laser Methane Detector

- Previous studies concentrated on testing the LMD under indoor conditions and Teeranavattanakul (2010) studied the effect of different environmental factors on the LMD measurements carried out under outdoor conditions.

- Taken into account all the environmental factors explored by
- Teeranavattanakul (2010), the current study was aimed at examining the ability of the laser methane detector under grazing conditions.

Materials and Methods

- Natural veld (Sourish mixed bushveld)
- Forage sorghum under irrigation
- Used 20 month old pregnant heifers (2nd trimester)
- Animals were adapted for 14 days on the specific grazing before the measurements were taken.

- Bonsmara
- Brahman
- Jersey
- Nguni
- Red Poll

ARC • LNR

Excellence in Research and Development

Materials and Methods

- Measurements were taken on individual animals with a min radius of 3m away from any other animal
- The 3m distance was used in order to
  - Not disturbing animal activity
  - Prevent methane interference from other heifers

- Note: The LMD does account for the plume effect assuming that the plume density in the animal's breath has a 1m radius from the point source giving a concentration in ppm-m (ml/m^3).

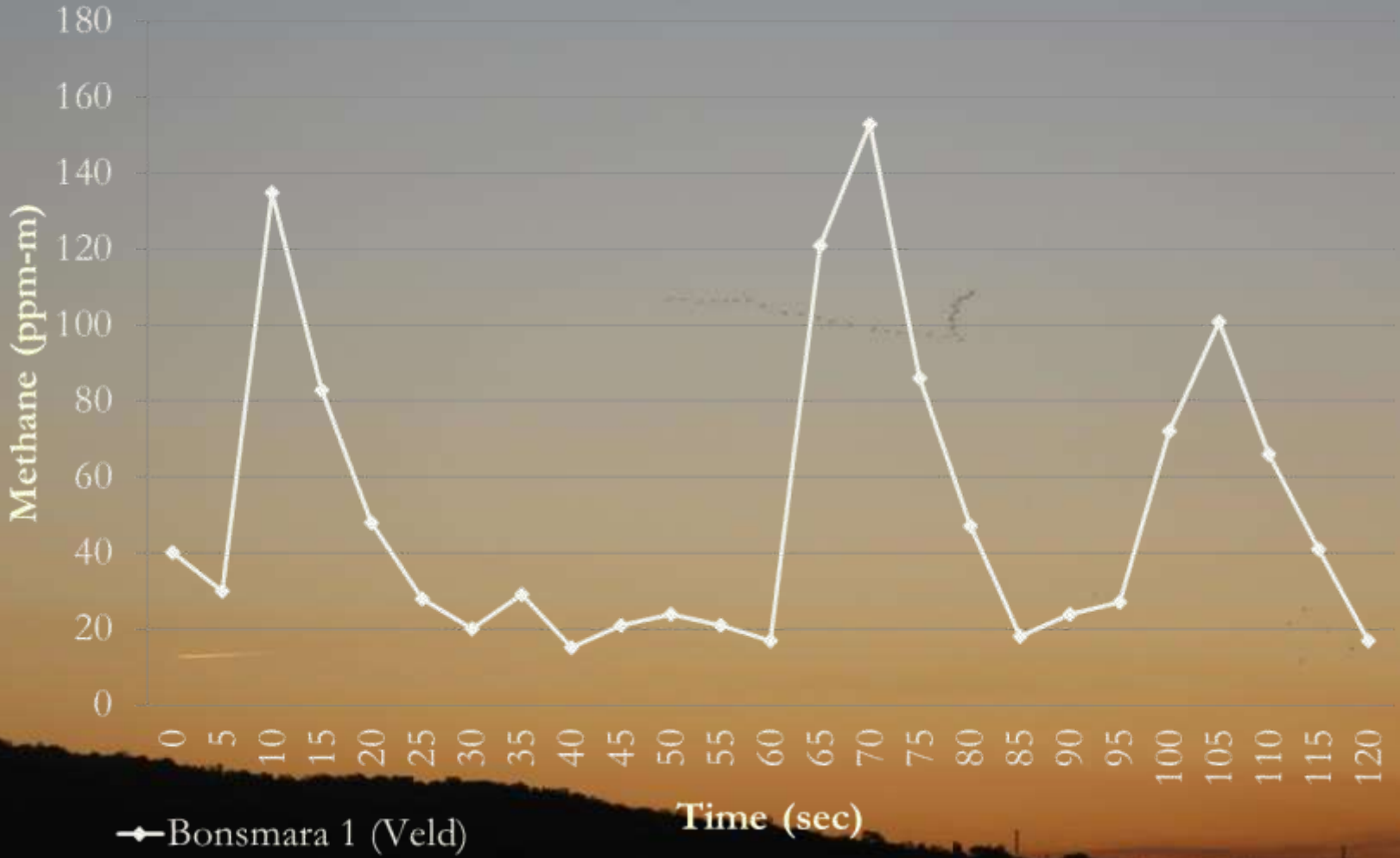
Materials and Methods

- All measurements were taken late afternoon (18:00) as it proved to be difficult to see the laser beam in direct sunlight and no- or very little wind is experienced this time of day
- The measurements for each individual heifer were taken every 5 seconds over a period of 60 seconds to include different stages of the respiratory tidal cycle
- Four 60 second repeated measurements were taken on 8 consecutive days on each of the grazing conditions

ARC • LNR

Excellence in Research and Development

Methane measured from Bonsmara heifer on natural veld

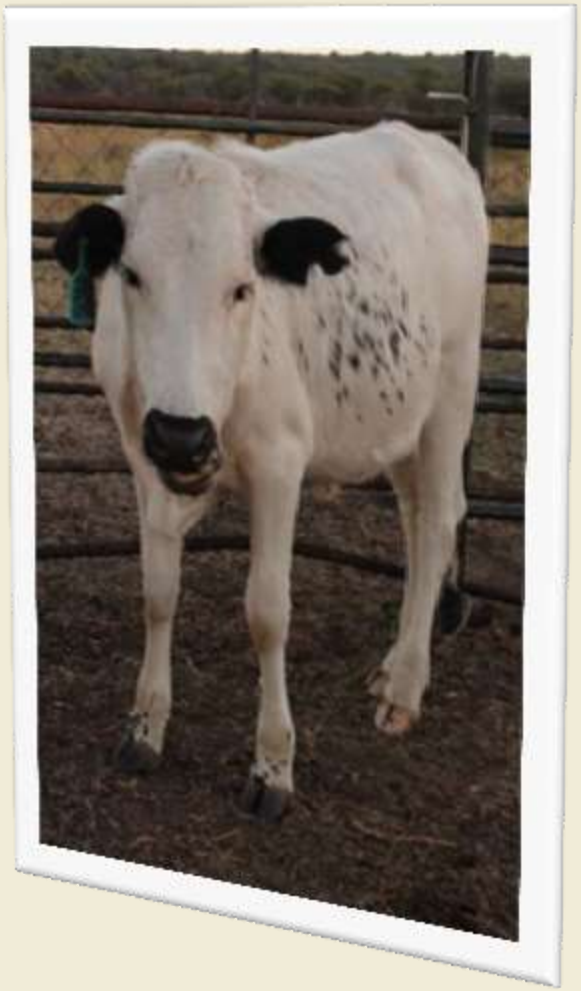


ARC • LNR

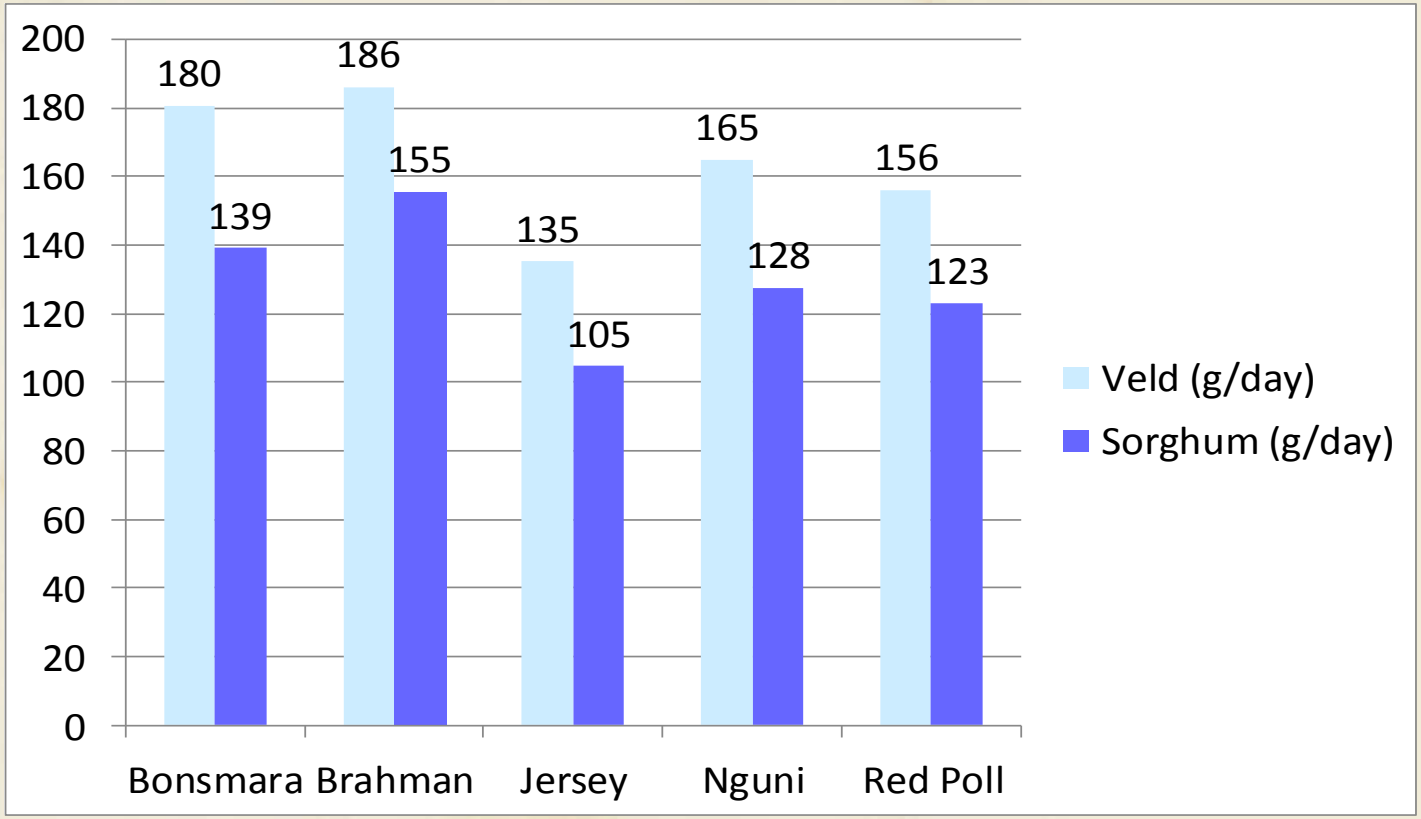
Excellence in Research and Development

Materials and Methods

- The LMD measure methane concentration in ppm-m
- Methane concentration (ppm-m) was converted to methane production (g/day) by making use of the currently available deterministic model (Chagunda *et a*l, 2009).



Results



- As expected significantly less methane was produced when the animals were grazing on the forage sorghum (average 130.4g/day) compared to the natural veld (average 164.8g/day) methane production(P=0.0074).
- On natural veld the animals produced 24% more methane

ARC • LNR

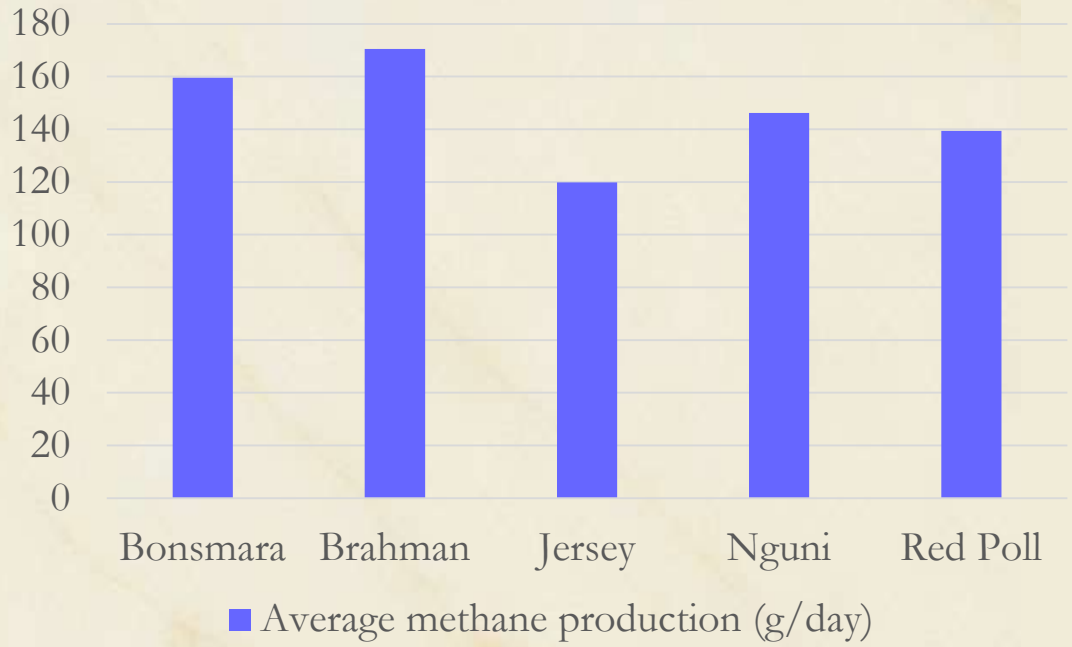
Excellence in Research and Development

Results

Breed	Veld (g/day)	Sorghum (g/day)
Bonsmara	180.4 ± 38.3^{ab}	139.0 ± 19.2^{abcd}
Brahman	185.8 ± 39.8^{a}	155.4 ± 30.7^{abcd}
Jersey	135.0 ± 16.0^{abcd}	104.6 ± 22.6^{d}
Nguni	164.6 ± 20.1^{abc}	127.6 ± 37.5^{cd}
Red Poll	155.8 ± 39.9^{abcd}	122.8 ± 35.6^{cd}

- The Jersey heifers produced significantly less methane than the other breeds on both natural veld and forage sorghum
- The Brahman and Bonsmara heifers produced significantly more methane than the other breeds

Results



- No interaction between different breeds methane production on veld or sorghum (P=0.9964)
- A significant difference was found between different breeds methane production (P=0.0692)

ARC • LNR

Excellence in Research and Development

Conclusion

- These results indicate that the LMD produce sensible measurements that can be interpreted in respect of methane production from cattle.

The way forward

- The next step will be to validate and build up baseline data on the use of the LMD to measure methane emissions from cattle under grazing conditions by increasing
  - number of breeds,
  - number per breed,
  - feeding strategies

  over all seasons from cattle under grazing conditions

ARC • LNR

Excellence in Research and Development

ARC • LNR

Excellence in Research and Development