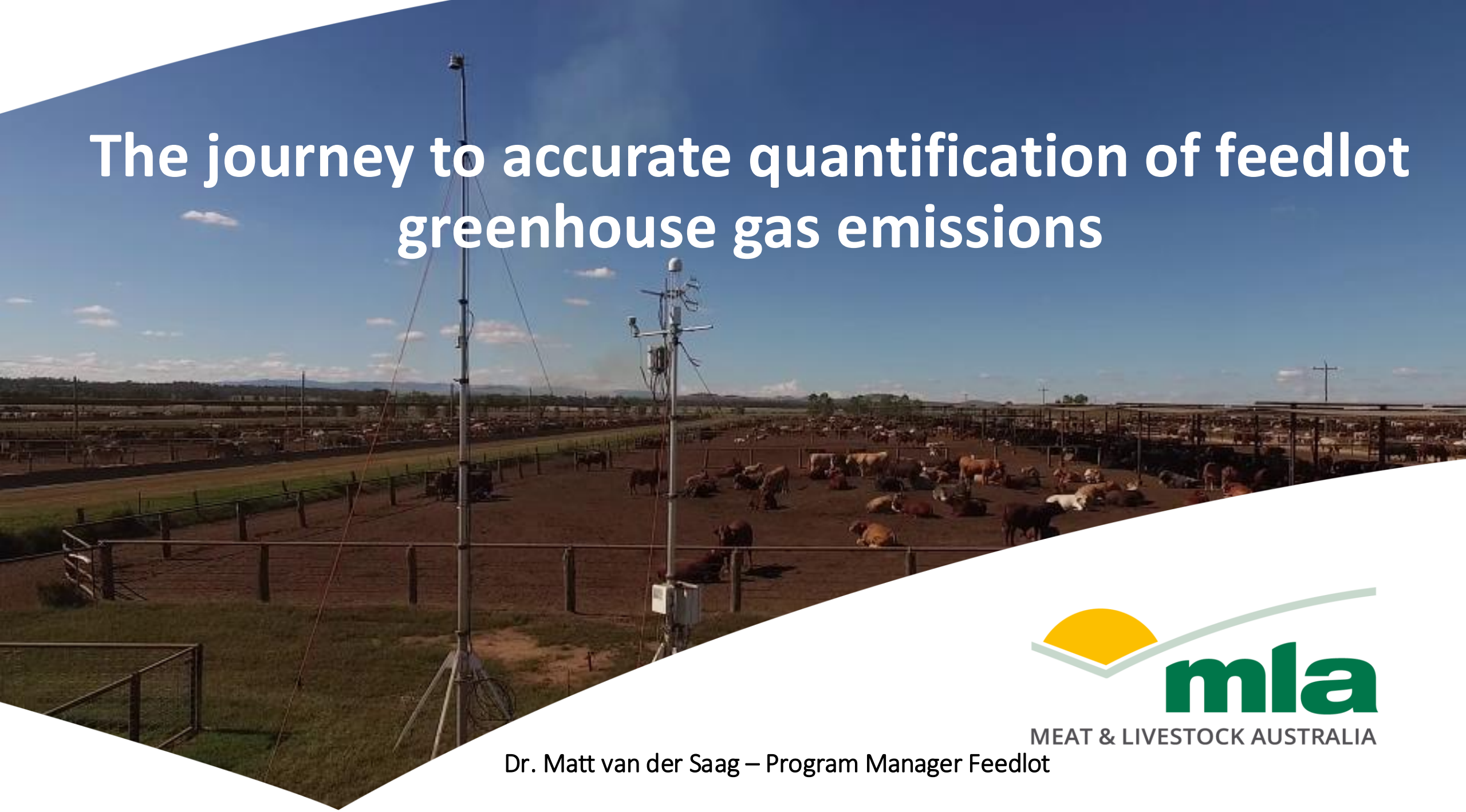
The journey to accurate quantification of feedlot greenhouse gas emissions



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Australian Lot Feeders' - setting the vision

- This journey starts with the vision of the ALFA board and R&D committee over many years.

'ALFA works towards delivering a profitable and sustainable feedlot industry recognised and valued by the community for producing quality grain fed beef to the highest ethical, environmental, humane and animal welfare standards'.

- At the start of the new millennia, the early 2000's, new challenges and issues began to emerge for the Australian red meat industry.
- Environment has always been at the forefront of Australian lot feeders, safeguarded by the National Feedlot Accreditation Scheme.
- This vision, as you will see today has seen industry armed and prepared to tackle the big picture issues affecting red meat production in Australia.

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Data driven R&D journey begins

- Armed with this vision and strategic direction of Australian Lot Feeders', MLA went to work.
- Initial focus on developing accurate measurement techniques to quantify and measure greenhouse gas emissions of feedlot cattle.
- This then progressed to greenhouse gas reduction strategies – such as feed additives
- Importantly - the Australian lot feeding industry, with matched monetary contributions from the federal government has helped build the capability and capacity of Australian scientists & scientific research organisations.
- This has created an environment, where, to this day, Australia is a global leader in research related to greenhouse gas emissions.
- From the feedlot perspective, this work all started in 2006 with a project titled: '**Greenhouse gas emissions from Australian beef cattle feedlots**'

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FLOT.331 - ‘Greenhouse gas emissions from Australian beef cattle feedlots’

- Research organisations:
  - University of Melbourne (project lead), University of Wollongong, CSIRO, Agriculture and Agri-Food Canada
- Objectives:
  - Provide measures of methane, nitrous oxide, carbon dioxide and ammonia from two feedlots.
  - develop enhanced Australian capability in quantification of greenhouse gas emissions from agricultural production systems.
- Key findings:
  - Methane Emissions (CH_4): Average 113 g/head/day, 40% lower than national inventory equation estimates.
  - Ammonia Emissions (NH_3): Averaged 176 g/head/day, 3x higher than IPCC estimates, suggesting greater volatilization
  - Nitrous Oxide Emissions (N_2O): 3.3 g/head/day, half of IPCC estimates. High NH_3 losses resulted in less N_2O formation.
  - Carbon Dioxide (CO_2): 12.9 kg/head/day, slightly higher than estimates but considered non-anthropogenic (recycled carbon).

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Application of precise measurement technology

Measurements of pen emissions

Effluent pond and manure compost

OP-Laser, open-path laser spectrometer,
OP-FTIR, open-path FTIR spectrometer

Industry then embarked on a series on manure management and nitrogen based greenhouse gas emissions projects

Project code	Project title	Key outcome
B.CCH.1020	Manure management to reduce greenhouse emissions from cattle feedlots	Using urease inhibitors (UI) to reduce ammonia (NH_3) and nitrous oxide (N_2O) emissions unlikely to be a cost-effective strategy
B.FLT.0148	Reducing feedlot nitrogen-based greenhouse gas emissions.	Addition of lignite to the feed pad is an effective strategy for mitigating ammonia emissions.
B.FLT.0356	Greenhouse Gas Emissions from intensive beef manure management.	Mean measured pen N_2O emissions were 0.496 µg m-2 s-1 and 0.00469 µg m-2 s-1 for the northern and southern feedlots. Standard inventory calculations estimate much larger emissions: 2.6 µg m-2 s-1 and 3.0 kg N_2O head-1 year-1 (IPCC, 2006).
B.FLT.0361	Feedlot Mass Balance and Greenhouse Gas Emissions – A Literature Review	The current state of the mass balance approach for manure prediction, and capability to estimate methane (CH4) and nitrous oxide (N2O) from feedlot manure.

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Revision of the national inventory – Nitrous Oxide

- In 2015, updates to both the methods and the activity data used by the national inventory resulted in substantial reductions in emissions from the feedlot industry.
- It was also identified that emission factor for nitrous oxide (N_2O) emissions from feed pads used in the inventory was overpredicting N_2O emissions
- Australian studies reported 73% lower emissions than the current IPCC inventory estimates.
- This was implemented in the national inventory in 2021 and resulted in a decrease in the total emissions of the Australian feedlot sector of 19%.

"People use these numbers to make judgements about the industry and we need to have knowledge to guide where research is directed, and practice change is undertaken."

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Continued focus on enteric methane quantification

- Project B.FLT.0396 – ‘Long-term total greenhouse gas emissions from beef feedlots’ was published in 2020 after a 2 year measurement period.
- Methodology:
  - Cutting-edge GHG measurement tools and models, captured long-term emissions data.
- Key Findings:
  - Methane (CH_4): Emissions were overestimated by 30% in national inventory; actual emissions are 20.5% (northern) and 41.4% (southern) lower.
  - Nitrous Oxide (N_2O): Lower emissions (up to 80%) than predicted by current inventory models.
  - Ammonia (NH_3): High continue to emissions pose a significant challenge

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Redefining how enteric methane is calculated

- Several projects have now provided growing evidence that methane emissions reported in the national inventory do not reflect actual observed methane measurements.
- A significant R&D program commenced in late 2021 - ‘Australian feedlot enteric methane inventory program’ –
- The work involved;
  1. a large respiration calorimeter experiment to measure the enteric methane emissions of Australian feedlot cattle fed diets containing different levels of dietary fat and roughage (NDF).
  2. Development of new and more accurate ways to predict enteric methane from Australian lot fed cattle.
- Results:
  - The Moe and Tyrrell (1979) equation currently utilized by the Australian National Inventory report had poor accuracy with mean bias overprediction of 115 g CH_4/d,
  - The Moe & Tyrell (1979) predicted CH_4 production (mean of 194.9 g CH_4/d) was 2.44 × observed CH_4 production (mean of 79.9 g CH_4/d),
  - There was significant linear bias and poor precision
  - Methane was overpredicted by 55.0 and 163 g/d at minimum, and maximum predicted values, respectively.

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Proposed revision to the national inventory – enteric methane

A new equation to predict enteric methane from Australian feedlot cattle was developed:

$$CH_4\ (g/d) = 5.11 \pm 1.58 \times DMI - 4.00 \pm 0.821 \times EE + 2.26 \pm 0.125 \times NDF$$

Where:
DMI = dry matter intake, kg/day;
EE = ether extract (dietary fat), % dietary DM; and
NDF = neutral detergent fibre, % dietary DM

- This equation, along with a dossier containing industry activity data to support a revision to the national inventory are in the process of being submitted to the national inventory team.
- The work recognises the truth that grain feeding is a methane ameliorant.
- If accepted, it will result in decrease in the size of the feedlot industry emissions of ~44%.

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New emissions baseline + enteric methane reduction technologies = powerful tools for industry moving forward

- The board and R&D committee have supported MLA to tackle new innovations to directly reduce enteric methane.
- Several innovations and products have been studied in an independent, robust manner, and many have proved very effective at significantly, if not entirely reducing enteric methane emissions from feedlot cattle.
- This has resulted in significant advancements in the knowledge of how methane suppressing feed additives work in different scenarios.
- However, further research and development is required to ensure that they are adopted safely, effectively and in a way that is economically viable.
- Future R&D work in this space will continue to hone-in and improve our understanding of the rumen microbiome and how it can be rewired to create products improve performance and reduce emissions simultaneously and unequivocally .

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