REDUCING ENTERIC METHANE FROM RUMINANT LIVESTOCK - A SNAPSHOT OF RESEARCH BEING DONE BY DIFFERENT ORGANISATIONS AROUND THE WORLD

CHRIS GRAINGER - 25 JUNE 2010

In collaboration with:

- Teagasc-Moorepark - Matthew Deighton
- Teagsac-Grange - Padraig O'Kiely
- AFBI Hillsborough - Tianhai Yan
- UCD - Tommy Boland
- AgResearch NZ - Simone Hoskin
- DPI Ellinbank Victoria - Peter Moate

Reducing enteric methane emissions from ruminant livestock

Matthew Deighton

Teagasc, Moorepark Dairy Production Research Centre, Fermoy, Co. Cork

Current research programme Moorepark

Methane emission measurements in large scale studies comparing:

- different dairy cattle breeds
- different ryegrass cultivars
- different supplementation strategies

Current research programme Moorepark

Variation in methane emission measurements from large scale studies related to changes in rumen microbial population

LCA modeling to assess total GHG emissions from pastoral systems

Current research programme Moorepark

Preliminary results show methane reduced by:

- 10% by maintaining low herbage mass and high leaf:stem ratio
- 11% by cows grazing grass compared with TMR diet

Ongoing research programme

Teagasc, Grange Beef Research Centre, Dunsany, Co. Meath

Padraig O'Kiely

Evaluate (*in vitro*) methane production for major forages

- grasses – species, varieties, management systems, season of year
- legumes – species, varieties, season of year
- grass silages differing in fermentation characteristics
- maize silages differing in maturity at harvest
- whole-crop cereals differing in grain:straw(+chaff)
- contrasting ratios of grass silage to maize (or whole-crop cereal) silage
- cereal grains conserved by a range of technologies
- energy/protein-rich feeds

UNDERTAKE THE ABOVE USING TOTAL GAS PRODUCTION AND RUSITEC SYSTEMS

Evaluate (*in vitro*) impacts of feed additives on methane production

- **biological and chemical agents, and combinations of these.**

UNDERTAKE THE ABOVE USING TOTAL GAS PRODUCTION AND RUSITEC SYSTEMS

Beef production studies (using SF_6 as marker)

-Methane production from maize silages by cattle

-Maize silages differing in maturity at harvest versus ad libitum concentrates

-Methane production from whole-crop cereal silages by cattle

- Whole-crop wheat silages (differing in grain:straw), grass silage and ad libitum concentrates

Model impacts on national beef herd

Using data from the preceding animal production studies, model the impacts of changing the animals diet on enteric methane production, beef production and profits (per animal, per kg carcass gain and per hectare)

Reducing Animal Derived Greenhouse and Transboundary Gas Emissions

Tommy Boland, Karina Pierce and Bridget Lynch

School of Agriculture, Food Science and Veterinary Medicine

What are we doing?

- The potential to reduce CH_4/GHG emissions through manipulation of
  - Forage type and quality
  - Dietary additives
  - Animal genetics
  - Production system
- Better understand the relationship between diet and rumen microbial population
- Model impacts of changes in production systems on GHG emissions





How are we doing it?

- In vitro screening of concentrate ingredients, dietary additives and novel compounds
- In vivo testing of forage type and quality, plant oils, organic acids, fish oil and protected aa
- Impact of ‘Residual Feed Intake’ on methane emissions
- Microbial population analysis
- Metagenomic analysis of the rumen microbiome
- LCA and economic modelling

Facilities

SF_6 indoor and outdoor

Fistulated animals and metabolism house

Gas exchange chambers

Artificial rumen system

Infield measurement following land spreading

What have we achieved?

- Increasing sward quality reduces CH_4 output per kg LWG
- Alternative forages reduce enteric CH_4 emissions compared to grass silage
- Increasing sward quality reduces CH_4 output per kg milk and milk solids
- Coconut oil, soya oil, linseed oil and fish oil reduce enteric CH_4 emissions
- Soya oil reduces methanogen activity in the rumen and rumen ammonia concentration
- Dietary manipulation reduces ammonia emissions from pig slurry

Where to now?

- Focus on rumen fermentation and microbial population
- Combine enteric CH_4 mitigation with AD
- Control development of rumen microbial population

AFBI Hillsborough
Methane data – Tianhai Yan

• From 1992, over 900 dairy cows, 130 beef cattle and 50 sheep have been used in calorimeter measurements to examine effects on methane emission from

- Animal factors
  - Cattle breed (e.g., dairy cow: Holstein vs. Jersey vs. Norwegian)
  - Genetic merit of cows (high vs. medium vs. low yielding)
  - Stage of lactation (early vs. mid vs. late)
  - Parity (first vs. second or over)

- Dietary factors
  - Concentrate proportion (high vs. medium vs. low)
  - Grass type (fresh grass vs. grass silage vs. dry grass)
  - Forage type (grass silage vs. maize silage vs. whole crop wheat silage)
  - Diet quality (high vs. low protein level; high vs. low ME content)
  - Dietary additives (oil, fumaric acid, yeasts, etc.)

•All results have been published in a range of refereed scientific journals, scientific conferences and farming press

Mitigation Strategies Conclusions

- Methane emissions from cattle can be predicted using factors of animal (productivity and live weight) and diets (intake and chemical composition)

- Methane energy output as a proportion of GE intake can be reduced by
  - — increasing milk yield
  - — increasing feed intake (DMI, GEI, DEI and feeding level)
  - — increasing energy utilisation efficiency
  - — decreasing dietary fibre content (NDF, ADF and forage proportion)
  - — increasing dietary quality (ME, CP and lipid content)

- Dietary manipulation and animal management are effective approaches to reduce methane emissions from dairy cows

Current Research Projects

- **Stimulus Funding from the Department of Agriculture and Food (ROI)**

  — A four year project with research teams from Teagasc and University College of Dublin

  — Aims: to examine effects of different dairy production systems on methane emissions

- **Statistical modelling of GHG and ammonia emissions from different dairy, beef and sheep production systems in Northern Ireland and UK**

  – To develop relationships between inputs and outputs of GHG and ammonia for different dairy, beef and sheep production systems

  — To develop national GHG inventory in NI and UK

- **Validation of novel technique for measurements of enteric methane emissions with SAC: (1). Methane gun; (2) electronic methane sensors**

Coming projects from DEFRA

1. Ruminant Genetic Improvement Network (IF0169): selection of low CH4 emission cattle and sheep

2. Agricultural GHG Inventory Research Consortia - AC0114 - Improvements to the National Inventory: Inventory Delivery: Data Mining

3. Agricultural GHG Inventory Research Consortia – AC0115 - Improvements to the National Inventory: Methane

Ruminant Nutrition & Greenhouse Gas Mitigation Team

Methane emissions research

Simone Hoskin: ***Team Leader***
Cesar Pinares: ***Senior Scientist***
Stefan Muetzel: ***Senior Scientist***
David Pacheco: ***Senior Scientist***
Sunny Sun, Cibele Longo, Natasha Swainson: ***Postdocs***
Kirsty Hammond: ***PhD's***
German Molano: ***Research Associate***

IINVENTORY CH_4 RESEARCH

Current focus on confirming previous findings with SF6 technique using gold-standard calorimetry (sheep 24, cattle 4)

- Effect of physiological state on Ym: sheep
- Relationship between Ym & DMI, independently of physiological state
  - Contrasting pasture quality & DMI & Ym
- Effect of age on Ym: sheep, cattle

Regional differences in dairy production: modelling of regional production levels & DMI for use in National model for DMI & Ym

CH_4 MITIGATION

(Calorimetry, SF_6 & In-vitro (batch & continuous culture))

Exploiting animal to animal variation: sheep & dairy cattle

Methane markers, genes, heritability

Pasture & forage chemical composition

Alternative forage species: herbs, brassicas, legumes

Supplements to forage: palm kernel/ maize silage for dairy

Digestive processes, digesta kinetics

Microalgae, monensin, coconut oil/copra

Methane knockdown modelling, CH_4 vs H_2, microbiology

Ruminant species differences: sheep/cattle/deer

CH_4 MITIGATION

- SF_6 (various equipment/ method development) vs calorimetry
- Rumen microbiology (large, various programmes)
  - Methanogen ID, culture, activity, interaction with other microbes (Graeme Attwood, Peter Janssen)
  - Gene targets for inhibition (Ron Ronimus)
  - Vaccine development (Bryce Buddle)
- Farm systems modelling (includes all GHG, carbon)
  - Dairy, sheep & beef, deer (many scientists from all over AgResearch contributing, Greg Lambert)

Recent and Future Enteric Methane Abatement Research

DPI Ellinbank, Victoria, Australia

Dr Peter Moate and Mr. Richard Williams

Victoria
The Place To Be

DEPARTMENT OF PRIMARY INDUSTRIES | future farming systems research

Background

Research at Ellinbank, funded by the Australian Federal Government and Victorian State Government, aims to identify practical nutritional and management strategies for reducing enteric methane emissions from dairy cows consistent with maintaining profitable and viable dairy production

Strategy

Use *in vitro* technique to screen and evaluate potential feedstuffs

- Tannins: pasture species containing tannin and grape mark,
- Fodder crops: turnips, chicory, rape
- High-fat by-products: hominy, cold pressed canola, brewers grains, cottonseed meal, almond hulls,
- Omega-3 fatty acids: DHA and EPA

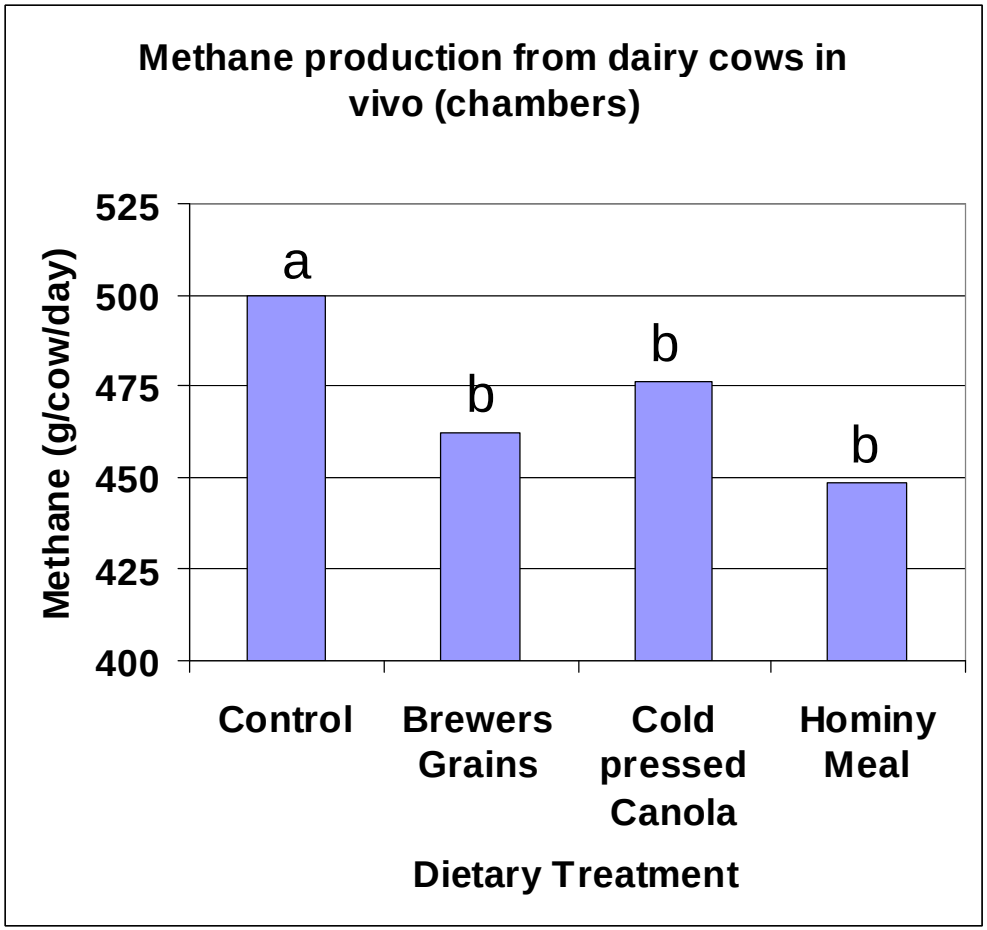
Evaluate promising feedstuffs *in vivo* either by SF_6 or chamber technique

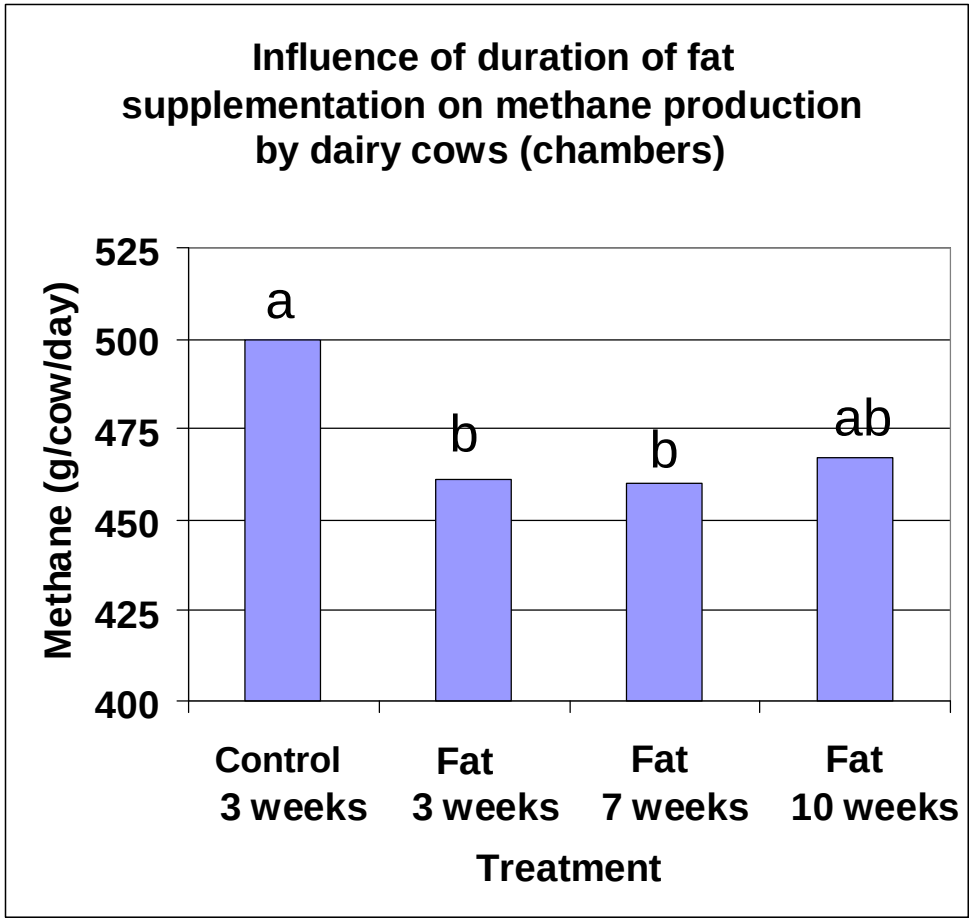
- **Feeds evaluated: cottonseed meal, hominy, cold pressed canola, brewers grains, tannin, algae meal (DHA-Gold)**

Future research:

- **Evaluate combination of fat and tannin**
- **Investigate high and low methane producing cows**
- **Measure methane production in high and low feeding efficiency cows**

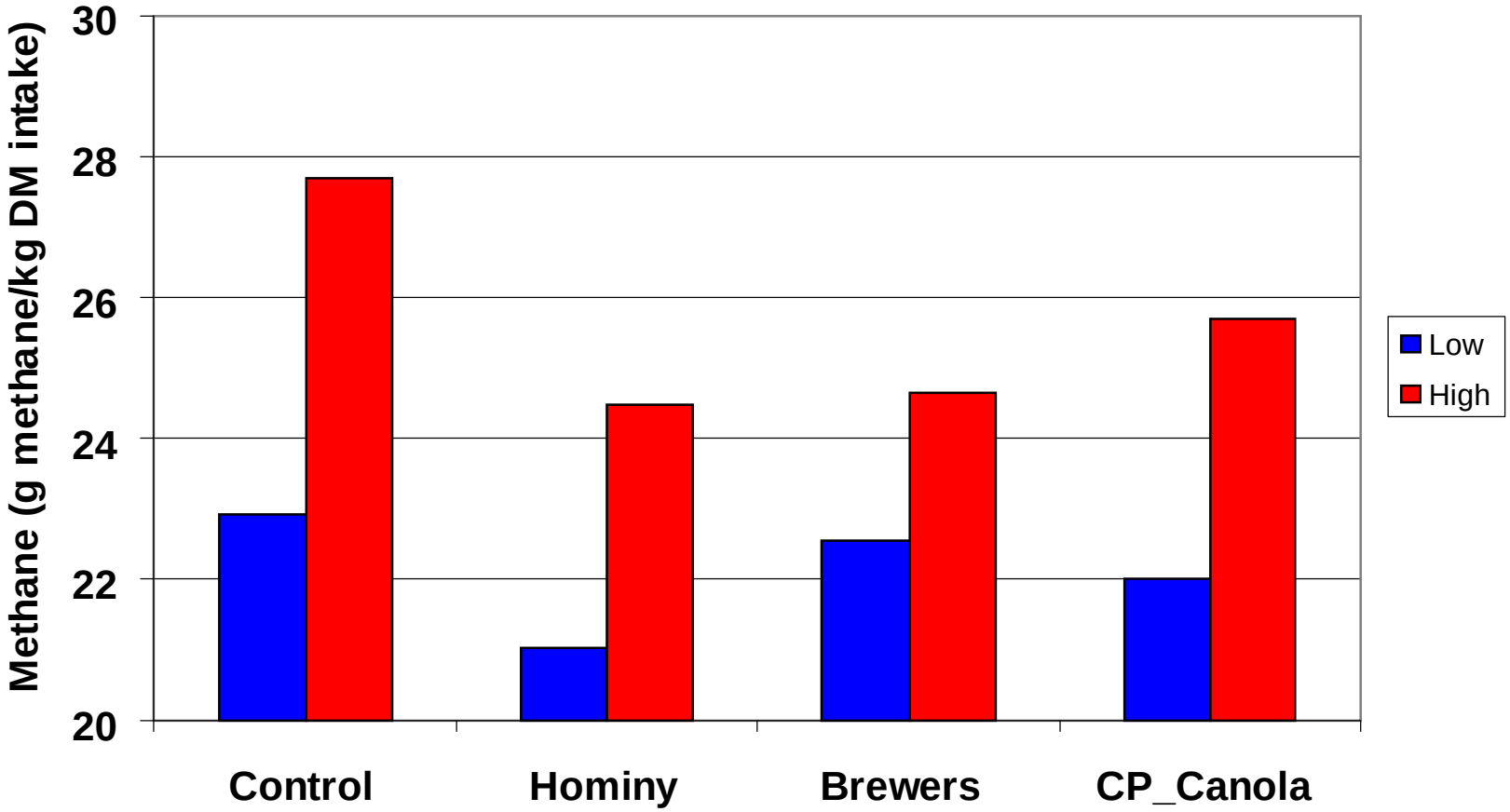
Results from Recent Ellinbank Research





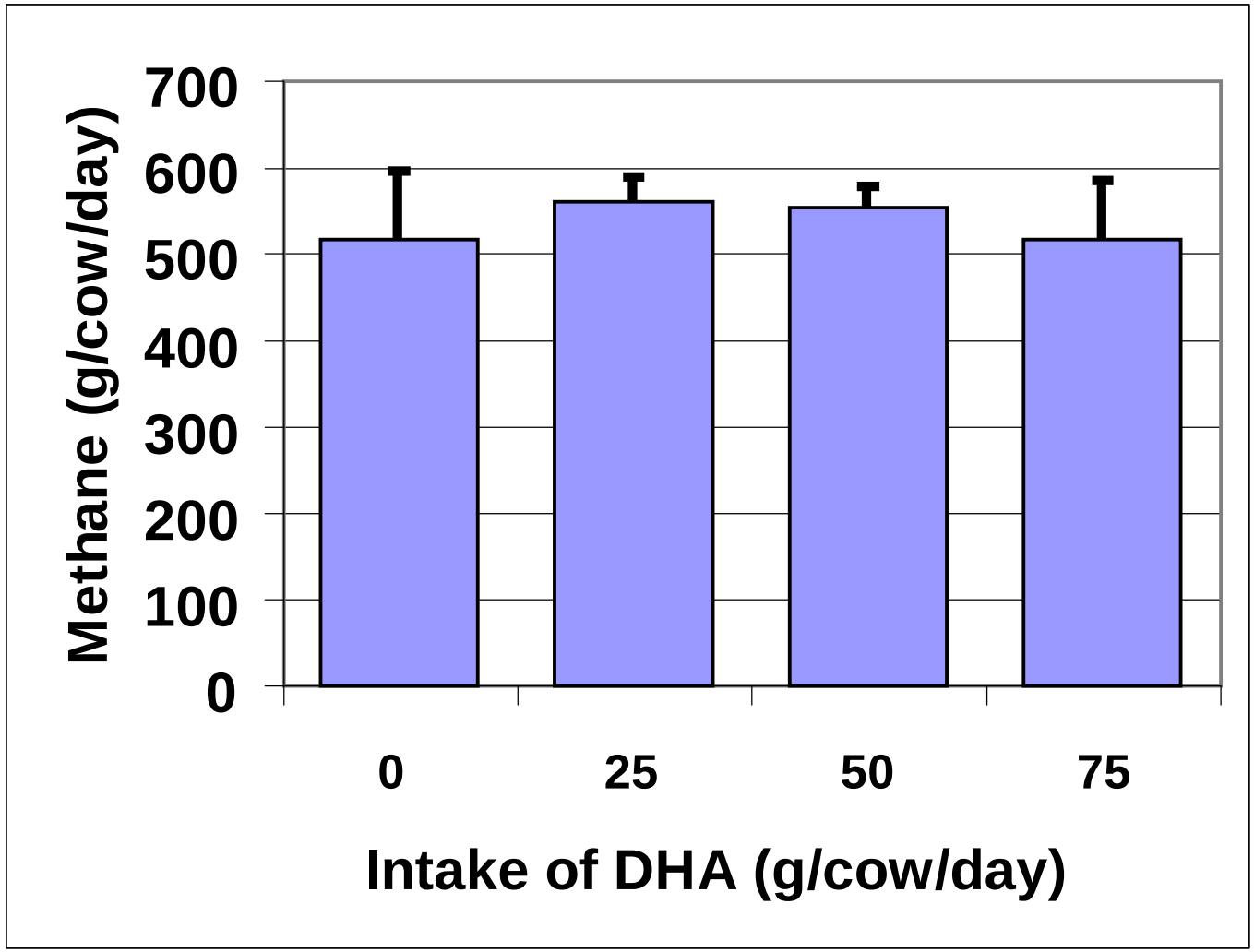
Moate and Williams 2009

High and Low Methane producing Cows



Moate *et al.* 2009

Influence of supplementation with DHA on emissions of methane by dairy cows in respiration chambers



Moate and Williams 2010

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