

Livestock production and the abatement of agricultural GHG Emissions

Observations and Overview from work at
University College Dublin

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Who am I and
who do I represent?



Nicholas M. Holden

- * Associate Professor of Biosystems Engineering
- * My research is at the interface of soil science, agrometeorology and agriculture systems, leaning towards applied research to answer questions about the environmental impacts of (mainly) grassland agricultural production systems
- * Have worked in Ireland with Agmet since 1995; CAgM rapporteur; Contributing author to CAgM GAMP; CAgM expert team member; CAgM expert team leader; COST networks on agrometeorology
- * Worked on climate change impacts on agriculture; adaptation to climate change (dairying); LCA of dairy and beef systems; dairy system modeling
- * Current work on *Sustainable Nutrient Management Decision Support System* (SNM-DSS); Soil Quality; spectroscopy; Carbon security (starting soon); microarrays for water quality assessment
- * Active proposals under review with DAFM-RSF (3); Agri-ICT (DAFM); SFI; FP7



Others at UCD / Disclaimer

- * Animal production (contributed materials):
 - * Dr. Tommy Boland
 - * Dr. Karina Pierce
 - * + research teams
- * Most of this work was conducted in collaboration with other research institutions in Ireland and abroad

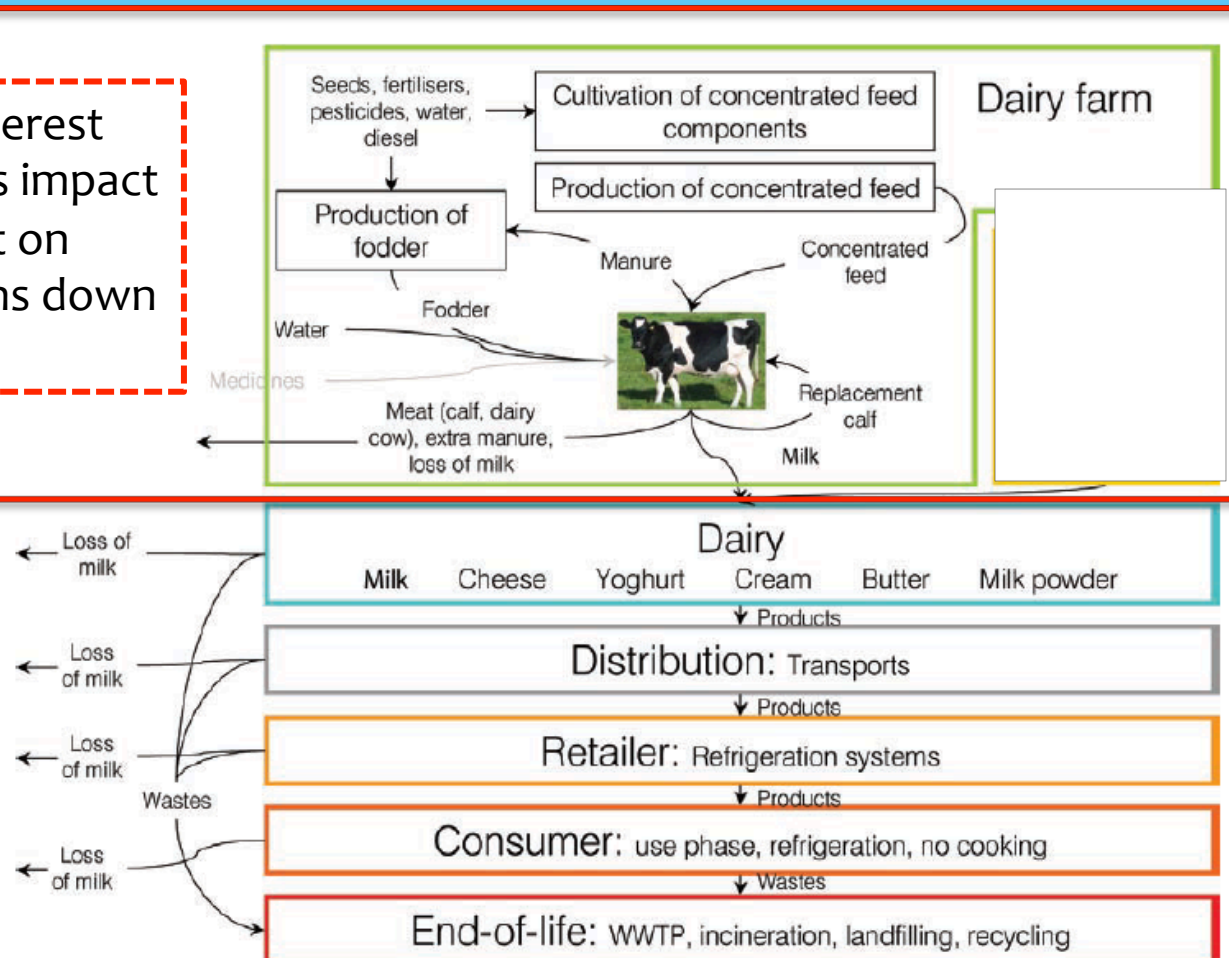


Agriculture vs. the agri-food chain



The dairy system is complex...

The bit of interest today, but its impact is dependent on what happens down the line



Where are the emissions?

- * For milk (at the consumer), the farm stage accounts for:
 - * 80% GHG emissions
 - * 40% energy consumption
- (IDF, 2009)



Where are the emissions?

- * For milk produced in Ireland, emissions outside of Ireland account for about
 - * 15% of GHG emissions (Yan et al, 2012)
 - * 27% of GHG emissions (Casey and Holden, 2005)
- * Associated with concentrate feed, fertilizer and energy consumption



→ Focus on Agriculture and activity in Ireland...

Based on the work of the research teams of
Dr Tommy Boland and Dr Karina Pierce

Animals



Pigs

Feeding regime:

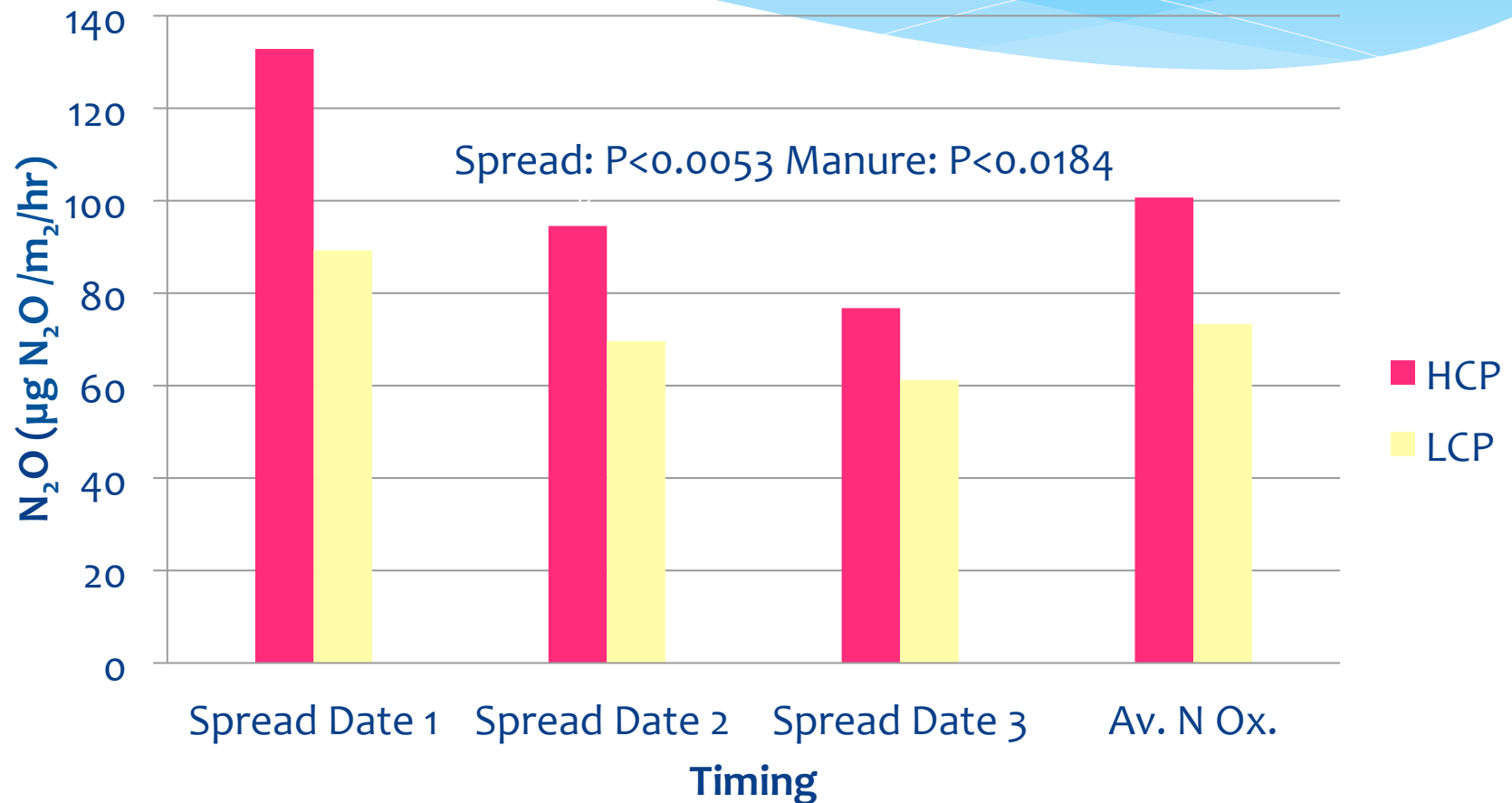
- * Low protein diet – meeting protein requirement with added synthetic A.A to prevent deficiency (1%) (LCP Diet = 83% wheat, 12% soya & 1.3% soya oil & mins/vits)
- * High protein diet – supplying excess protein (HCP Diet = 65% wheat, 31% soya , 1.3% soya oil & mins/vits)

Spreading date:

- * Slurry applied at 3 timings: Mid tillering – GS 25; Stem extension – GS 31-32; Flag Leaf – GS 37-39



Change in NOx emissions



COWS

Work at UCD:

- * The potential to reduce CH₄/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



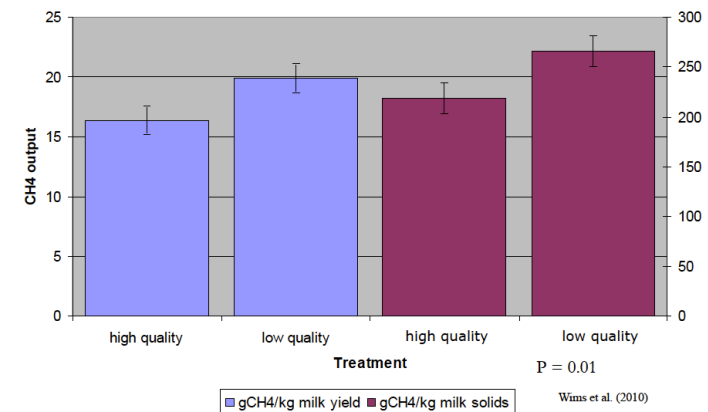
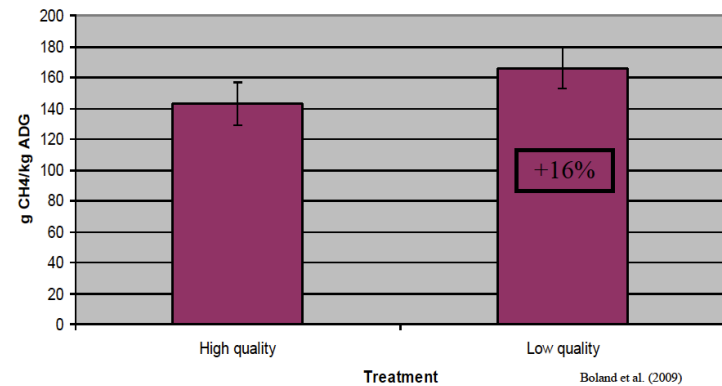
Cows – the animal

- * 12% difference in intake between efficient and inefficient cattle
 - * No differences in daily CH₄ emissions detected to date in Ireland
- Reduces feed requirements and GHG emissions associated with feed production

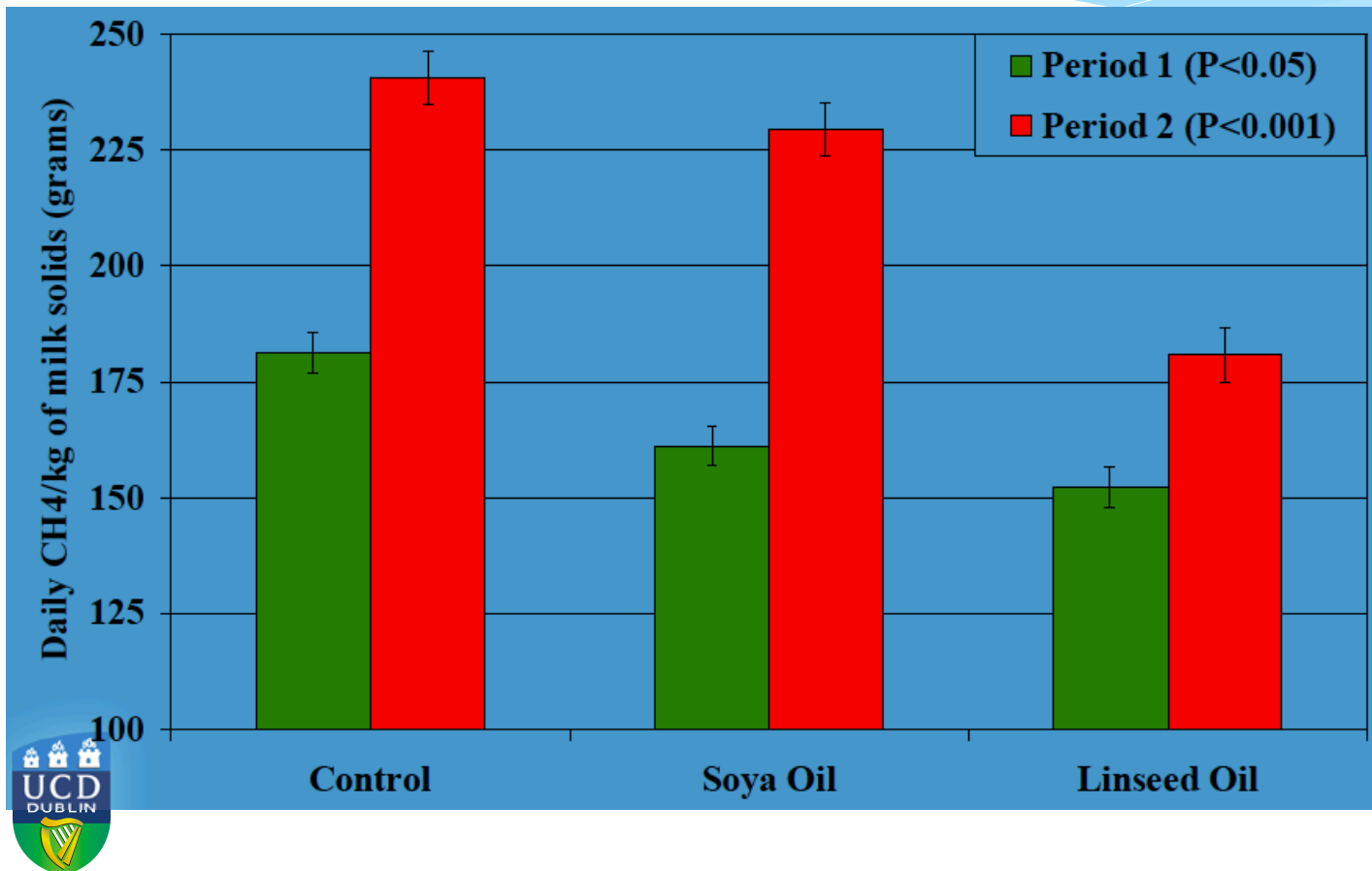


Cows – the diet

- * Need to modify grass quality as this is the predominant input
- * Maize silage quality can have a similar effect
- * Can supplement diet with oils



Cows – the diet



Cows – the diet

Oils are expensive and their carbon footprint can be large

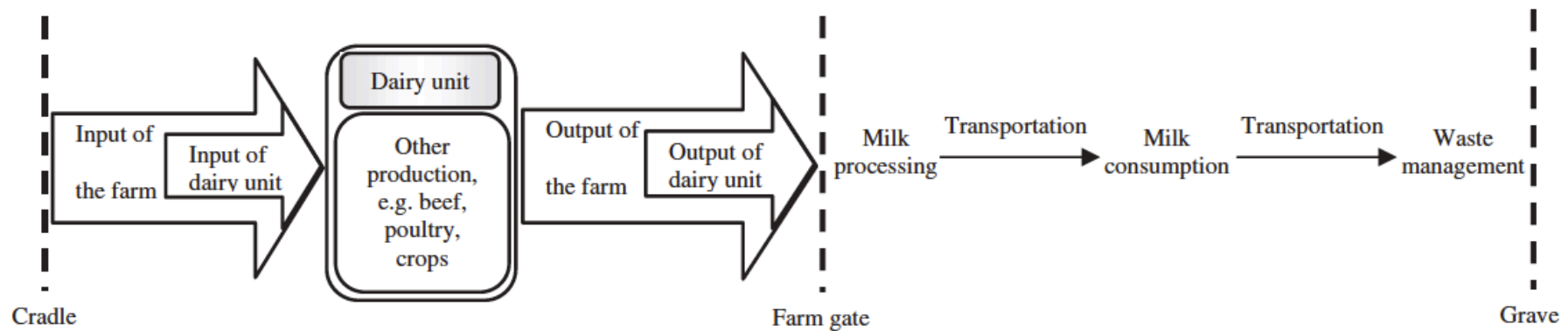
- The same fatty acids present in soya and linseed oil are found in grass
- Can we select for grass varieties with elevated fatty acid levels to reduce methane emissions?

→ Yes – differences exist in the fatty acid content of grass; therefore we can select

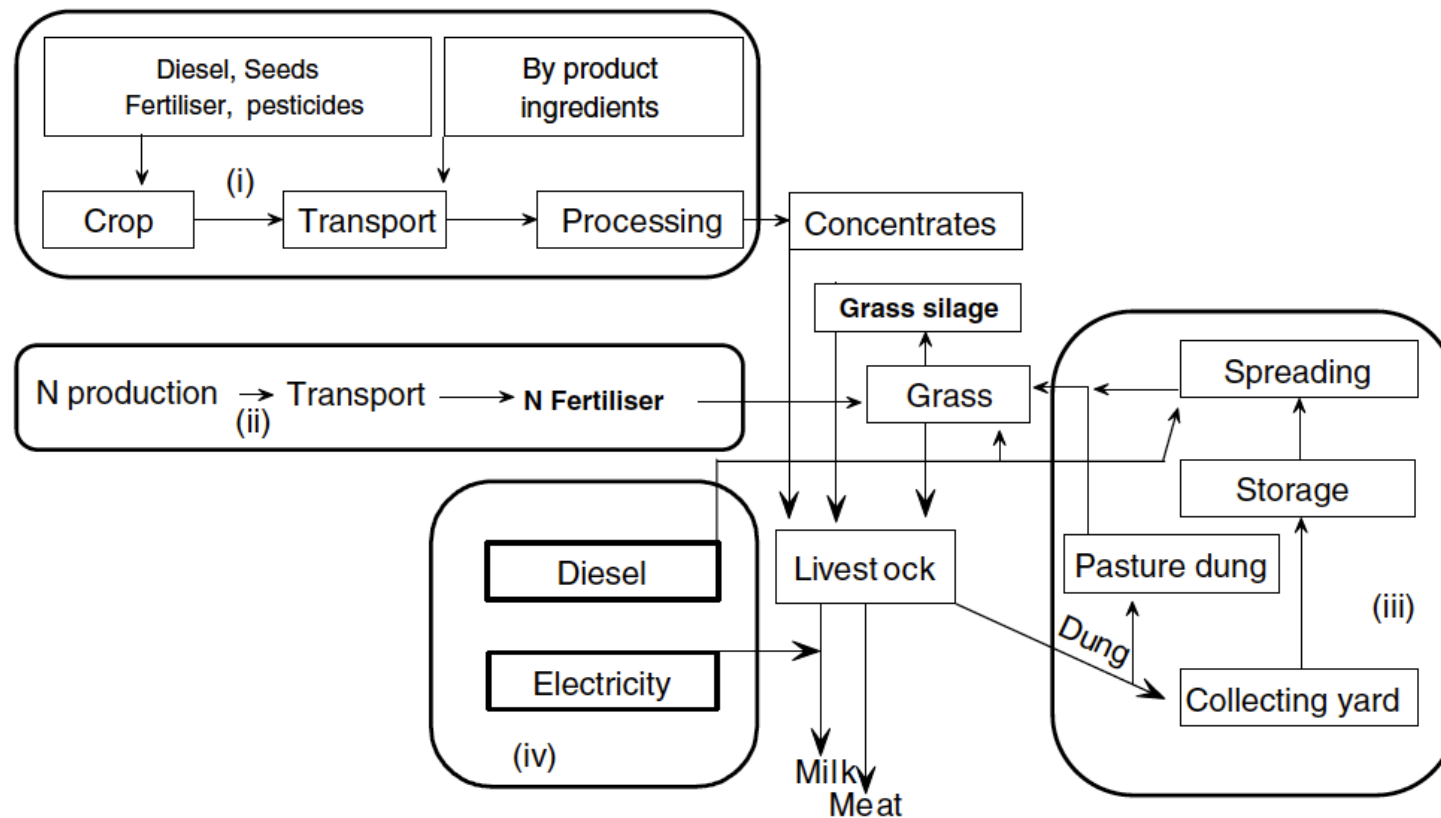
Systems



The system is complex with multi-functional farms



Dairy LCA system diagram



Emissions basket?

- * Agricultural production is a “system”... change one part and the rest is changed (c.f. definition of a system)

A system is an assembly of parts where:

1. The parts or components are connected together in an organised way
2. The parts or components are affected by being in the system (and are changed by leaving it)
3. The assembly does something
4. The assembly has been identified by a person as being of special interest



Scale and efficiency



Scale 1: Farmlet

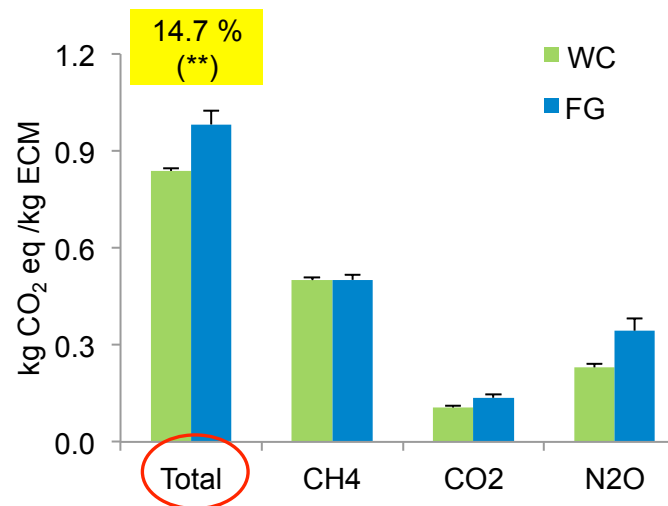
Example:

Farmlet scale research on using White Clover in place of Fertilizer Nitrogen:

A clear signal is seen

Farms scale?

National scale?

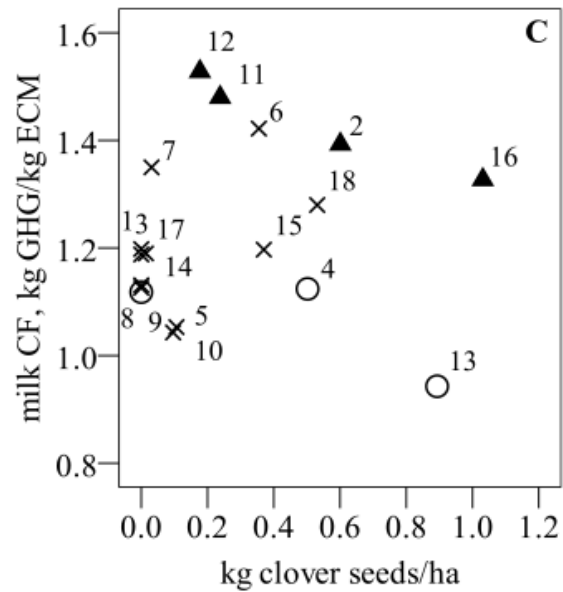


Farmlet → Farm

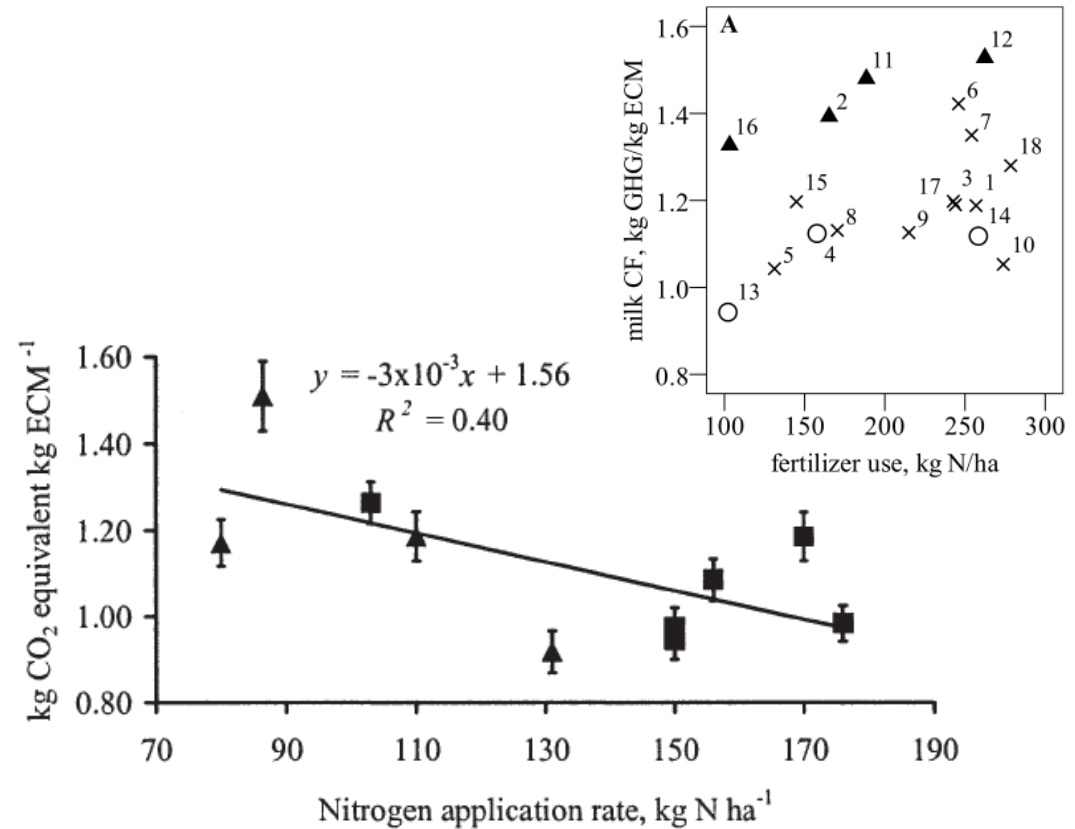
- * Using white clover as a source of nitrogen instead of mineral fertilizer could reduce the CF of milk by 12 to 24%
- * Sensitivity analysis indicated the result was robust
- * There is much uncertainty about how to upscale to demonstrate a national benefit
 - Animal efficiency
 - Grass and feed quality
 - Management efficiency



Scale 2: Farm



No clear signal
from commercial
farms



Farm → Nation

- * Large variation was found in farm attributes and management tactics
 - * a 1.5 fold difference in fertilizer N input was used to support the same stocking density
 - * a 2.5 fold difference in concentrate fed for similar milk output per cow.
- * CV for milk CF was 13%
- * CF of the milk production from the 18 dairy farms was 1.23 ± 0.16 kg CO₂ eq/kg Energy Corrected Milk (ECM)
- Farm survey data do not contain necessary information to properly capture the importance of efficiency and quality in the system



The messages



Where are the emissions?

Question

- * Do we care about global GHG reduction or are we really only concerned about changing the numbers for Ireland?

Message...

- * To see the benefit of decisions in Ireland, the impact must be in Ireland
 - * To make a real impact (rather than a political impact) we need to be good global citizens
- think global, act local



What drives agricultural emissions?

Question

- * Do we want to look at the mitigation of GHG emissions from the producer or the consumer perspective?

Message

- * Inventory reporting ignores the “consumer → product → emissions” scenario
- * If we want to be a “low carbon” society we must guard against “carbon leakage”
- * There is no point in policy that merely shifts the burden elsewhere in the world, it must be eliminated through efficiency



At the animal scale...

Question

- * Is there scope at the animal scale to reduce the impacts in Ireland?

Message

- * YES
 - * Increasing grass quality
 - * Increasing quality of winter forage
 - * Select animals for efficiency
 - * Increase fatty acid content of diet either through
 - * Plant oils
 - * Grass breeding



At the farmlet scale...

Questions

- * Under research conditions (farmlets) are further benefits seen by altering production tactics (such as using white clover)?

Message

- * YES
 - * N fertilizer demand reduced (emissions beyond Ireland)
 - * Lower losses from soil (empirical observations weaker than the modeled signal!)



At the farm scale...

Question

- * Under commercial conditions (farms) are the benefits of animal tactical choices discernable?

Message

- * NO
 - * Only a weak signal detected (note: were farmers “trying”?)
- * YES
 - * There are some key indicators such as output per cow that are important
 - * Integrated dairy/beef systems also very promising
 - * Need to capture management data reflecting quality of inputs, efficiency and tactical decision (part of current proposal under Agri-IT scheme with EU partners)



At the national scale...

Question

- * Can emission factors and empirical observations from research farmlets be used to calculate national scale impacts?

Message

- * The results from research farmlet experiments must be treated with caution – they do not necessarily transfer to commercial farms
- * Need verification under commercial conditions
- * We need to start collecting better data that will reflect the types of calculations that will be required





Questions?

