

Key factors influencing the carbon footprints of Northern Ireland dairy farms

Aurélie Aubry, Steven Morrison, Tianhai Yan, Paul Caskie,
Paul Keatley, Conrad Ferris

Introduction

- Need to accurately estimate GHG emissions for the development and evaluation of mitigation strategies
- AFBI developed the BovIS GHG calculator
 - ❖ Using a life cycle assessment
 - ❖ Based on recent research findings, using Tier II and III emission factors (country specific)

See EAAP Poster 239 in Session 19

- ❖ User friendly
- ❖ Available to producers through DAERA online service
- ❖ Meets international standards (PAS 2050)



Objectives of the present study

1. Obtain a source of data representative of the dairy industry in Northern Ireland
2. Estimate the carbon footprints of commercial dairy farms
3. Identify farm characteristics that account for variability



Input data

Land/Crops

Livestock

Grazing/Forage

Fertiliser/Manure

Fuel/Electric

Land Use

Land Controlled Details (only include land attributable to the dairy enterprise)

Land Owned (ha):

Land Leased In (ha):

Land Let Out (ha):

Forage Offered During Grazing Period - Produced on Farm

Crop Name	Area (ha)	Yield (tonnes DM/ha)	Total Quantity Offered (kg DM)					
			Cows	Bulls	Heifers >2y	Heifers 1-2y	Heifers 6-12m	
Area of Grassland	61	8.0	0	0	0	0	0	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="button" value="Add Crop"/>

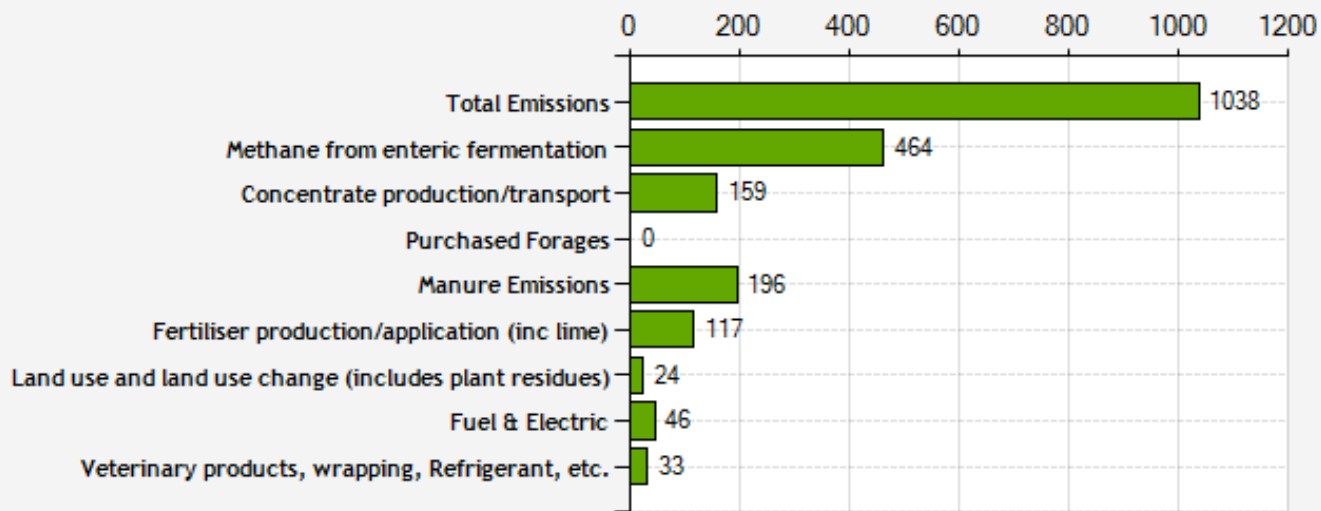
Summary output

emissions By Source (Excluding Sequestration)

Carbon Emissions per kg of Milk Produced: 1038 g CO₂e per kg of milk

Carbon Emissions per kg of Meat Produced: 16.14 kg CO₂e per kg of meat (14.00% of total CO₂e emissions)

Grams of Carbon Equivalent (CO₂e Per kg of Milk Produced)



Summary

Livestock

Dairy Cows:	122.0
Heifers:	123.0
Breeding Bulls:	0.0
Milk Sold (corrected):	1082676 kg
Yield per Cow:	8874 kg
Replacement Rate (excludes mortality):	30%
Average Concentrate Feed Rate:	0.26 kg conc/kg milk
Average Concentrate Feed Rate (inc heifers/breeding bulls):	0.30 kg conc/kg milk

Other

Milk from Forage:	3621 kg
Fertiliser Use:	45.3 tonnes
	12.2 tonnes N
	152.1 kg N/ha
Efficiency of Grass Utilisation:	8.921 tDM/ha
Liveweight exported:	26425 kg

Summary output



Farm survey data

- Data from 100 Specialist dairy farms for period 2011/2012 obtained from DARD Farm Business Survey (FBS)/ Farm Accountancy data network (FADN)
- Farms selected at random and cover a range of dairy systems with a good geographical spread across Northern Ireland
- Calculations based on actual data combined with a number of assumptions, including:
 - ❖ Allocation between dairy and other enterprises (using cow equivalents)
 - ❖ Number of months grazing
 - ❖ Forage yields and nutritive values
 - ❖ Manure handling systems

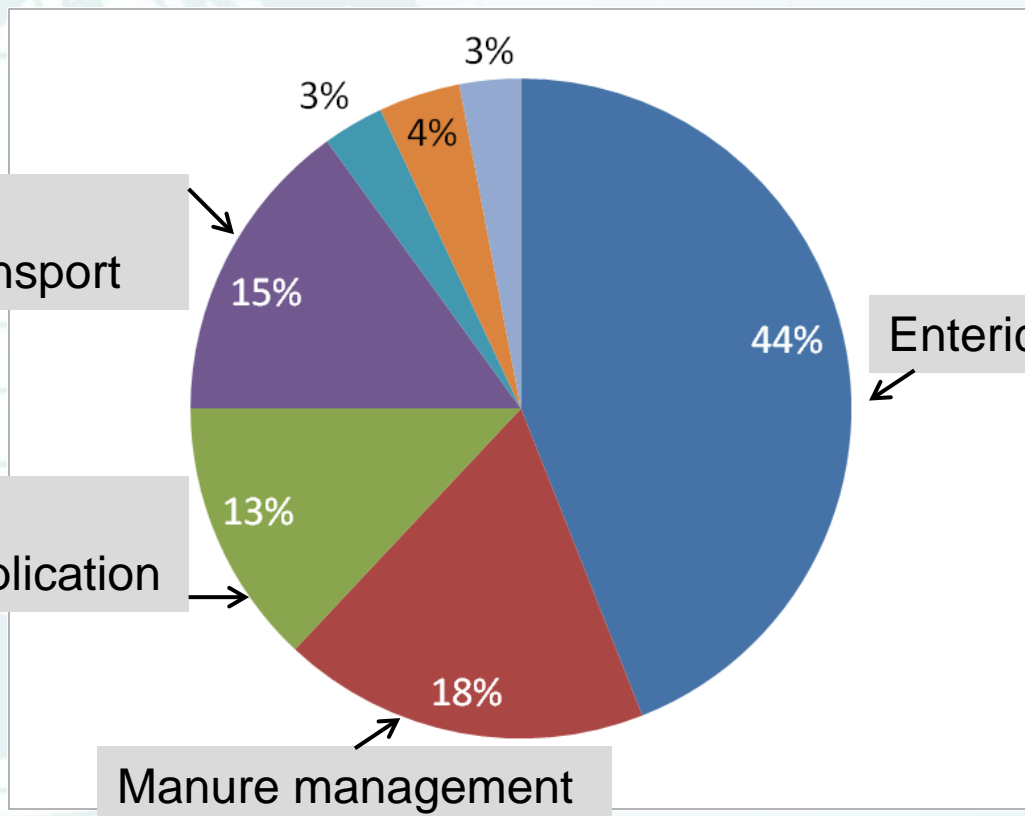


Characteristics of the 100 commercial dairy farms

		Average	Minimum	-	Maximum
No. of dairy cows		94	15	-	362
No. of heifers		59	3	-	278
Milk sold	<i>l/cow/yr</i>	6,349	4,539	-	9,618
Land area	<i>ha</i>	68	19	-	222
Stocking rate	<i>ce/ha/yr</i>	2.0	0.8	-	3.2
Concentrate use	<i>kg/cow/yr</i>	1,982	676	-	3,528
Concentrate use	<i>kg/kg milk</i>	0.30	0.12	-	0.45
Fertiliser use	<i>kg N/ha/yr</i>	134	0	-	261



Source of GHG emissions (%) for the 100 dairy farms



Concentrate production/transport

Enteric fermentation

Fertiliser production/application

Manure management



GHG emissions from 100 dairy farms

	Average	Minimum	Maximum
Excluding sequestration			
Emissions/cow (t)	7.9	4.3 -	10.6
Emissions/ha (t)	10.8	3.5 -	21.1
Emissions/kg of milk produced (kg/kg)	1.22	0.89 -	1.69
Including sequestration			
Emissions/kg milk produced (kg/kg):	1.02	0.67 -	1.41



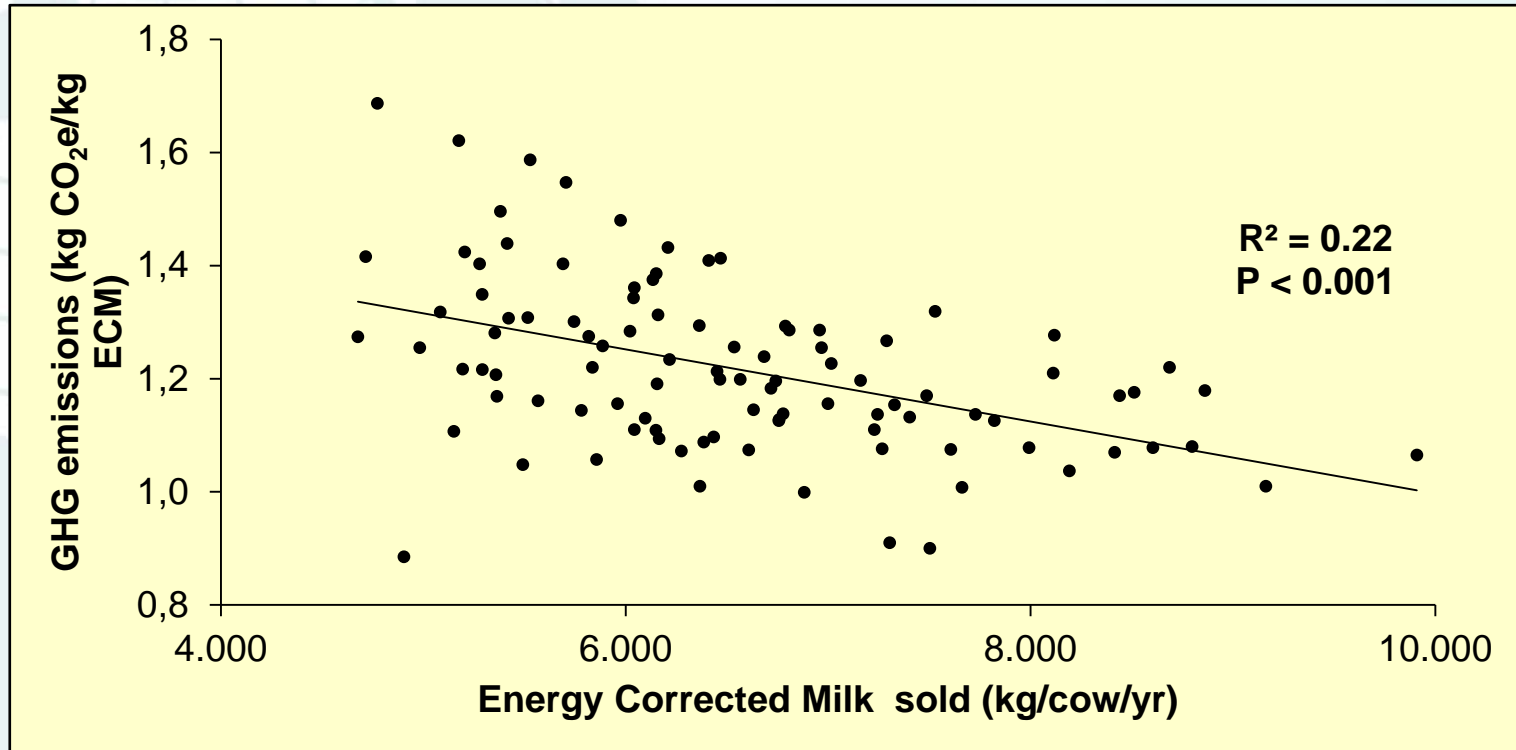
GHG emissions from 100 dairy farms

	Average	Minimum	Maximum
Excluding sequestration			
Emissions/cow (t)	7.9	4.3 -	10.6
Emissions/ha (t)	10.8	3.5 -	21.1
Emissions/kg of milk produced (kg/kg)	1.22	0.89 -	1.69
Including sequestration			
Emissions/kg milk produced (kg/kg):	1.02	0.67 -	1.41

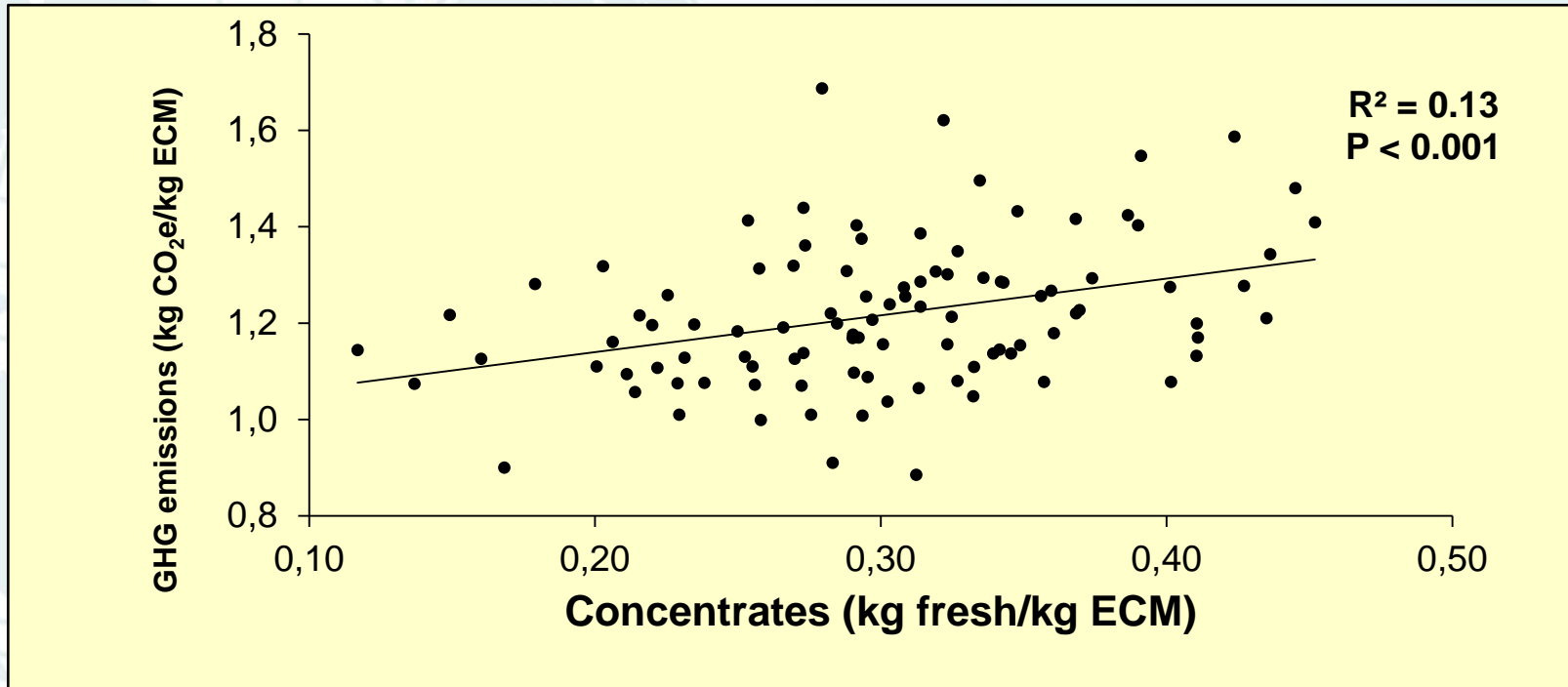
↓ 16 %



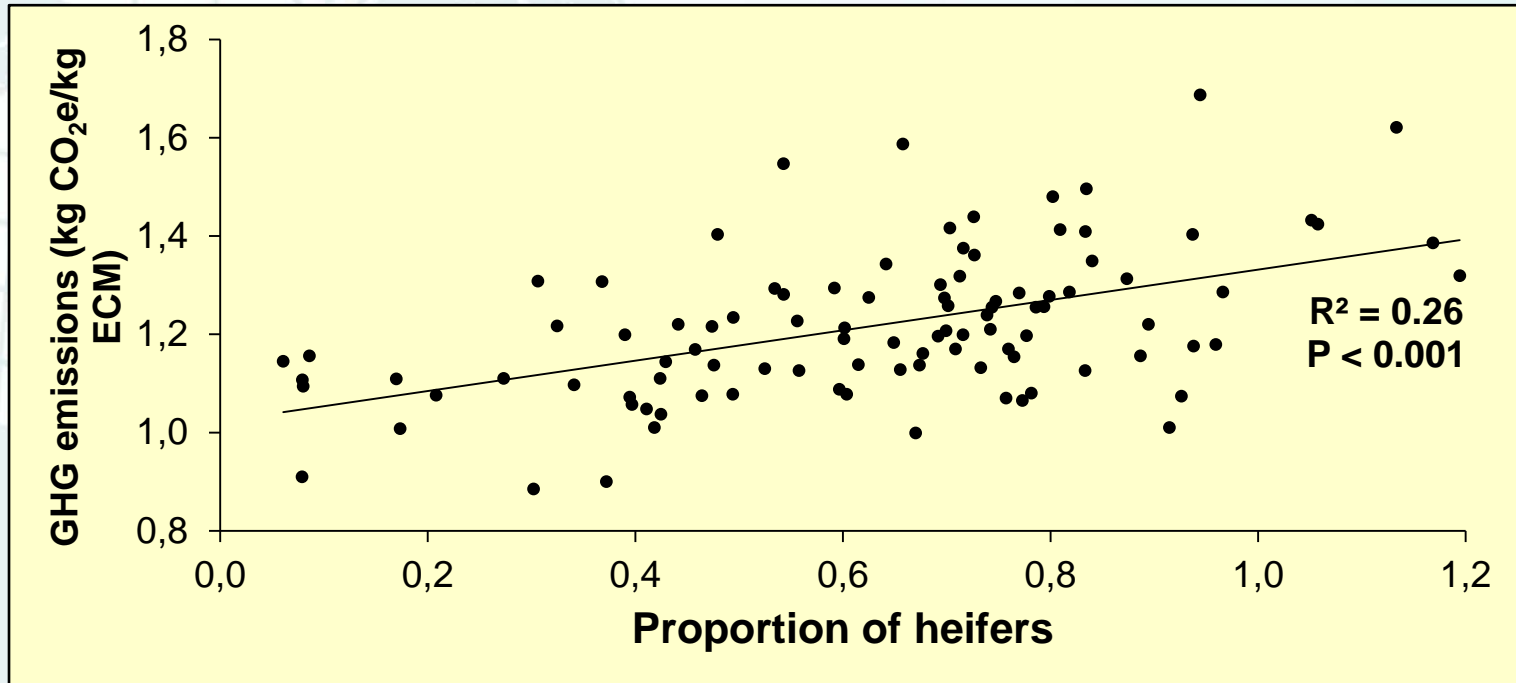
Relationship between milk produced and carbon footprint



Relationship between concentrate feed rate and carbon footprint



Relationship between the proportion of heifers on a farm and its carbon footprint



Combination of factors

- Stepwise linear regressions indicated that CF is best explained using:

$$\text{Carbon footprint} = 1.28 - 0.0815 M + 0.32 PH + 0.66 C + 0.486 N$$

(R²= 0.64)

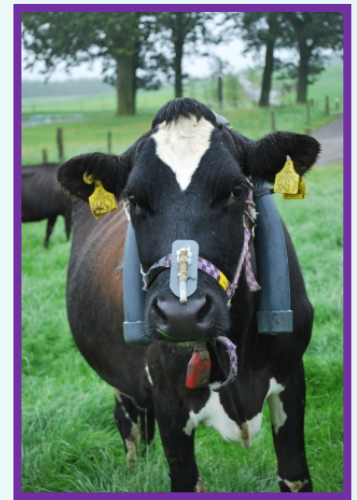
Where M is ECM sold (kg ECM/cow/yr) $\times 10^{-3}$
 PH is the proportion of heifers
 C is concentrate used per kg of ECM (fresh kg/kg ECM)
 N is the inorganic fertiliser N applied (kg N/ha/yr) $\times 10^{-3}$

- Overall, it indicates that CF decreases with
 - ❖ Increased milk production per cow
 - ❖ Reduced concentrate feed levels
 - ❖ Reduced fertiliser use
 - ❖ Reduced replacement rates



Other uses of the calculator

- Explore relationships between carbon footprints and financial indicators
- Determine the carbon footprints of a number of farms each year to assess trend (this was done for the period 1990-2013)
- Use the calculator to explore the effects of mitigation strategies using experimental data



Conclusions

- Improving production efficiency reduces dairy carbon footprints (as long as there are no negative effects on health and fertility)
- CF also found to decrease with reduced replacement rate (often overlooked in empirical studies)
- Successful application of a user friendly calculator that can be used by farmers, advisors, scientists, policy makers, on a range of systems
- Farm Business Survey: good source of data to calculate average emission levels, with a process that can be repeated every year



Acknowledgments

This work was funded by DAERA
and AgriSearch

