The carbon-foot print of Northern Ireland milk production systems

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What can the calculator be used for

1. Calculating the carbon-footprint of individual farms with a high degree of accuracy (relatively few assumptions)

2. Calculating the carbon-footprint of a greater number of farms using ‘survey’ data (involves a number of assumptions)

3. Calculating the carbon-footprint of experimental systems, and examining the effect of making changes within systems (involves a number of assumptions)

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1) Calculating the carbon-footprint of individual farms with a high degree of accuracy

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Carbon footprint of commercial dairy farms in Northern Ireland (RCF project)

- Data obtained from seven farms involved in an on-farm research project
- ‘High input – high output’ farms
- Calculations based almost entirely on actual farm data
- Data collected by AFBI staff, checked, and inputted to the calculator

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Background information on 7 commercial dairy farms (RCF project)

		Average	Minimum	Maximum
No. of dairy cows		184	117	373
Milk sold	*l/cow/yr*	8,497	7,388	10,294
Total milk sold	*kg/yr*	1,660,753	926,634	3,914,401
Land area	*ha*	119	71	239
Stocking rate	*ce/ha/yr*	2.6	1.9	3.5
Concentrate use	*kg/cow/yr*	2,564	2,002	2,976
Concentrate use	*kg/kg milk*	0.29	0.25	0.31
Fertiliser use	*kg N/ha/yr*	185	152	228

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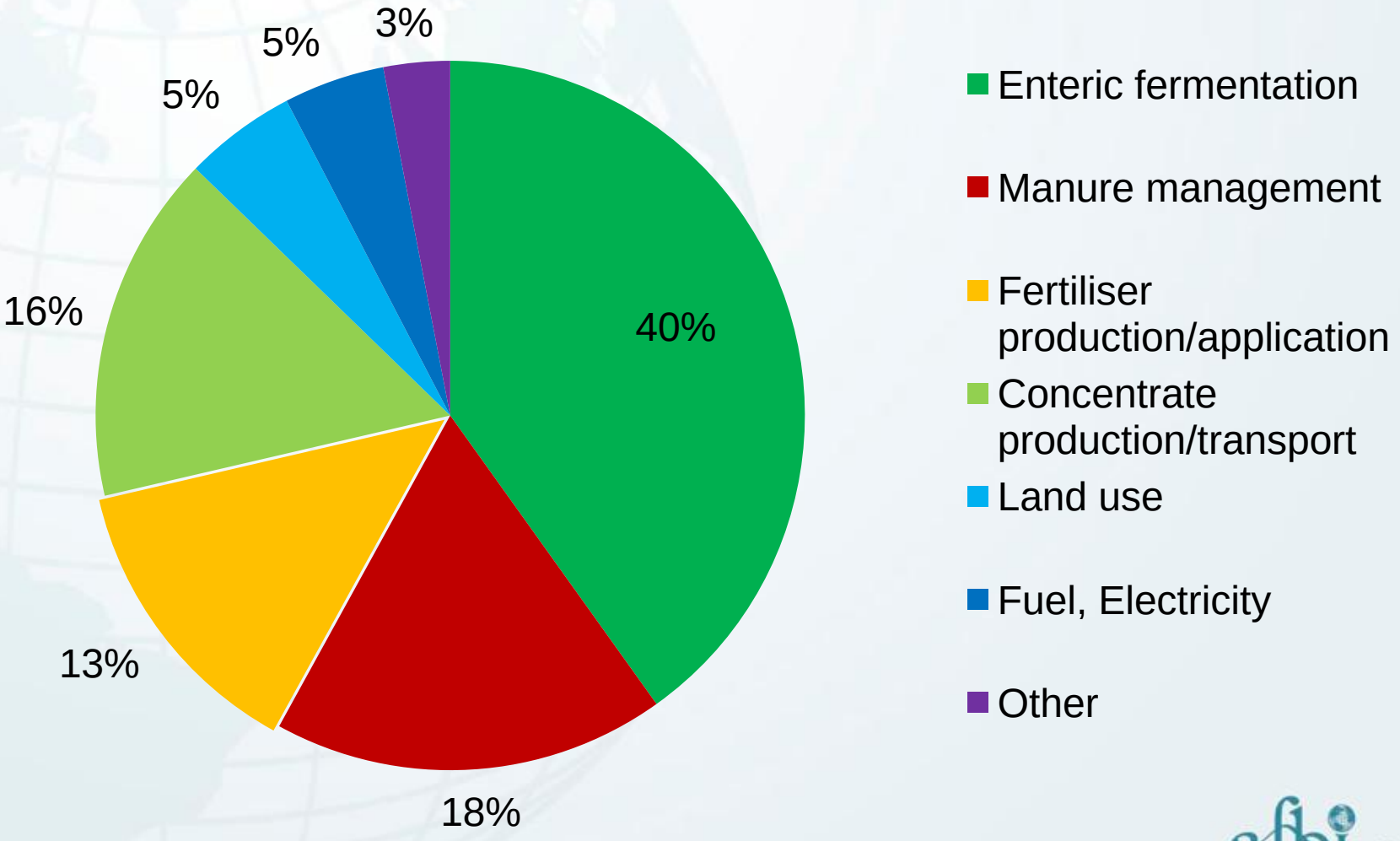
Greenhouse gas emissions from 7 commercial dairy farms (CO2 e)

		Average	Minimum	Maximum
Excluding sequestration				
Total emissions	*tonnes*	1,822	1,049	4,230
Allocation factor for milk production	*% of total*	*86*	*77*	*90*
Emissions per cow	*t/cow*	9.6	8.9	11.3
Emissions per ha	*t/ha*	15.0	12.0	19.0
Emissions per kg of milk produced	*kg/kg milk*	1.11	1.02	1.19
Including sequestration				
Emissions per kg of milk produced	*kg/kg milk*	0.97	0.89	1.07

Sources of Greenhouse Gas Emissions from the 7 farms



2) Using survey data to examine drivers of GHG emissions

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Farm Business Survey data

- Data from 117 Specialist dairy farms for period 11/12 obtained from DARD (Farm business survey data)
- Farms selected to cover a spectrum of dairy systems – good geographical spread across NI
- Sub-set of data from 100 farms used in GHG modelling exercise
  - >75% dairy cattle (relative to total number of cattle)
- Calculation of GHG emissions based on actual data collected from Farm Business Survey, combined with a number of assumptions:
  - Dairy heifer numbers
  - Allocation between dairy and other enterprises
  - Number of months grazing
  - Forage yields and nutritive values
  - Manure handling systems
  - Land use change

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Background information on 100 farms (Farm Business Survey, DARD)

		Average	Minimum	Maximum
No. of dairy cows		94	15	362
No. of heifers		59	3	278
Milk sold	*l/cow/yr*	6349	4540	9618
Stocking rate	*ce/ha/yr*†	2	0.8	3.2
Concentrate use	*kg/cow/yr*	1982	676	3528
Concentrate use	*kg/kg milk*	0.3	0.12	0.45
Fertiliser use	*kg N/ha/yr*	134	0	261
Diesel use	l/100 kg ECM	1.6	0.7	4.1
Electricity use	kWh/100 kg ECM	3.6	1.3	10.3

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Source of GHG emissions (%) from 100 dairy farms (Farm Business Survey, DARD)

	Average	Minimum	Maximum
Source of emissions (%)			
- Enteric fermentation	44	36	51
- Manure	18	14	21
- Fertiliser	13	0	22
- Concentrate	15	6	23
- Land use	3	1	7
- Fuel, electricity	4	2	10
- Other sources	3	2	4

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Calculated GHG emissions from 100 dairy farms (Farm Business Survey Data, DARD)

	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

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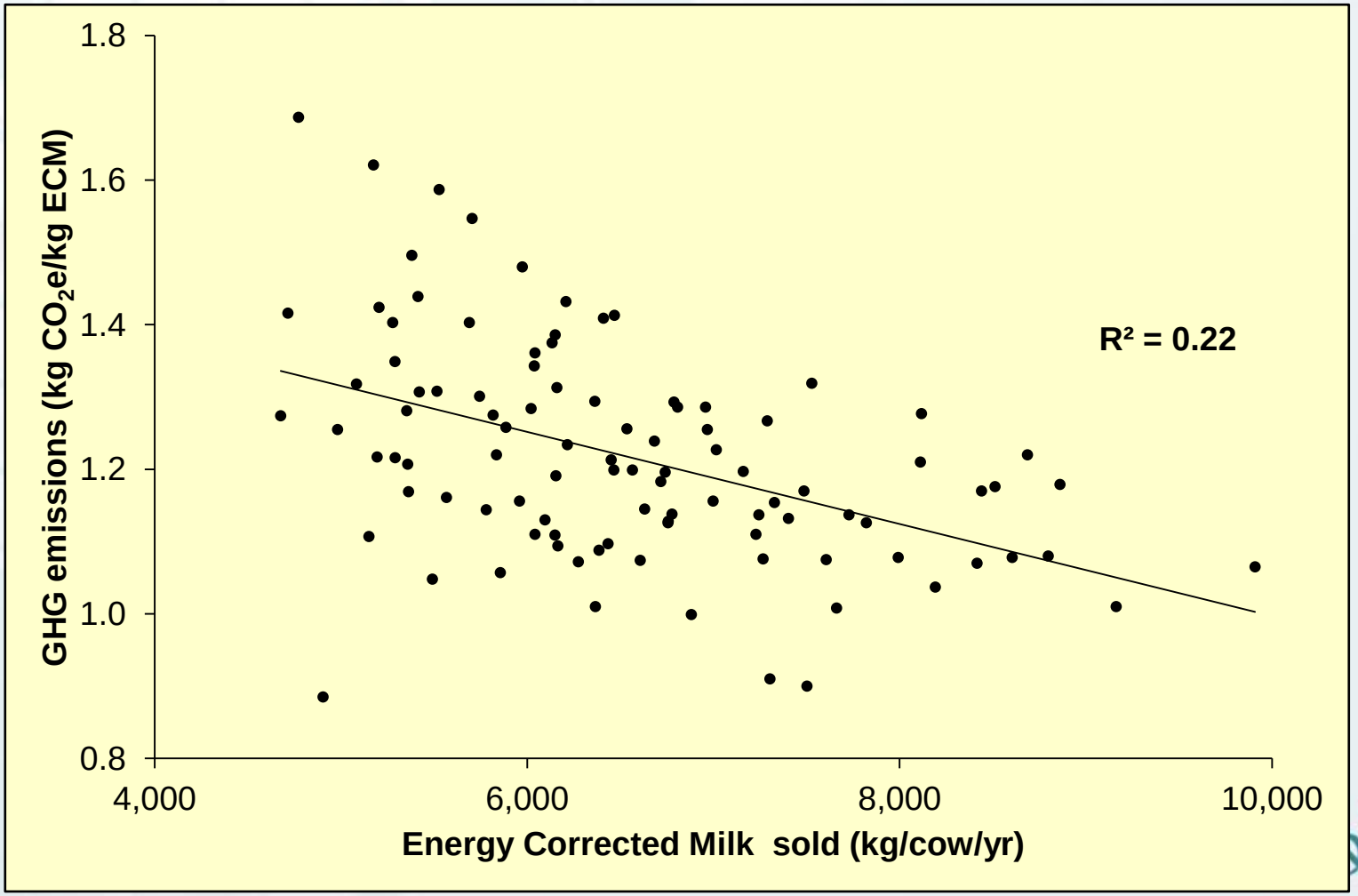
Relationship between GHG emissions/kg of ECM milk and yield of Energy corrected milk (100 farms)



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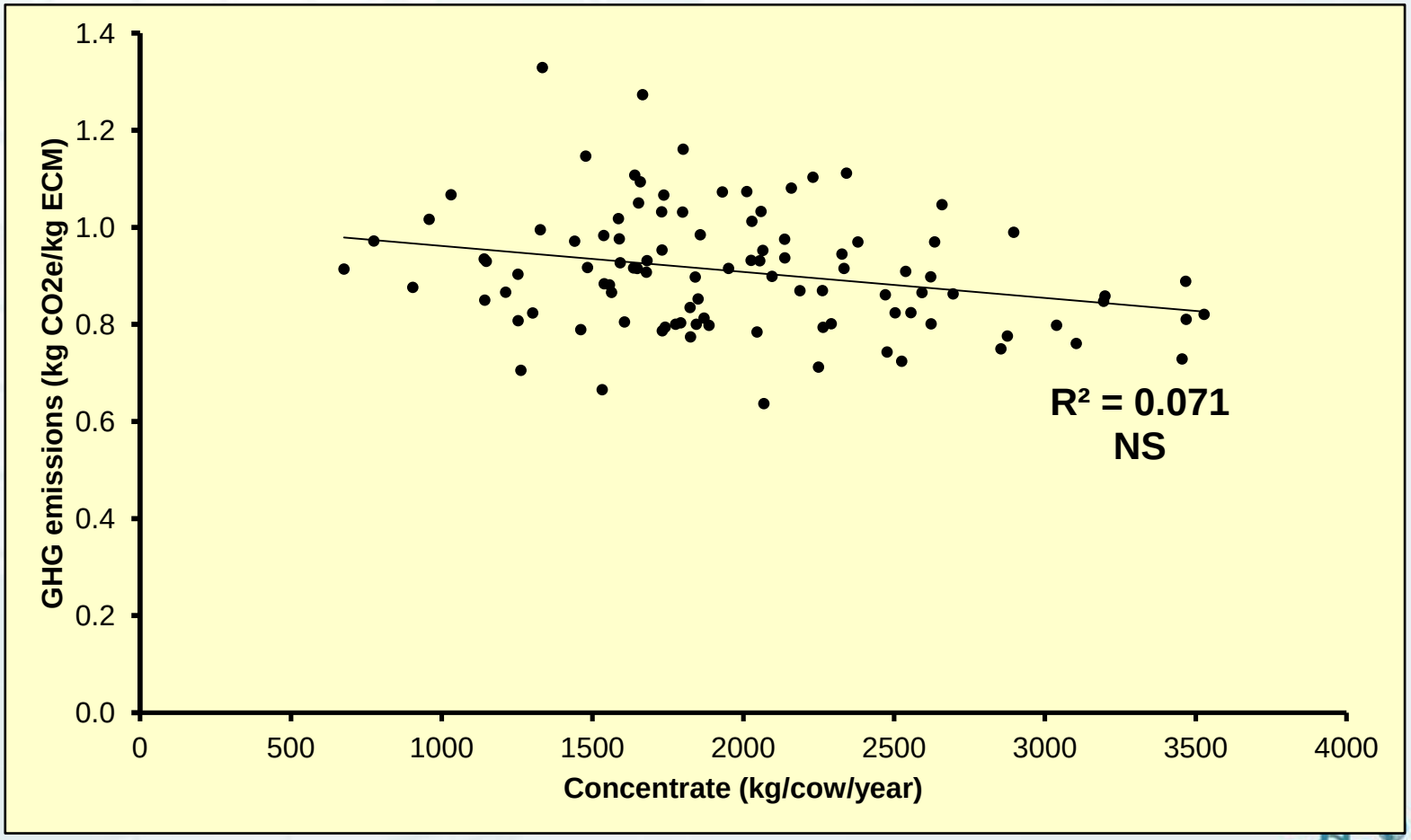
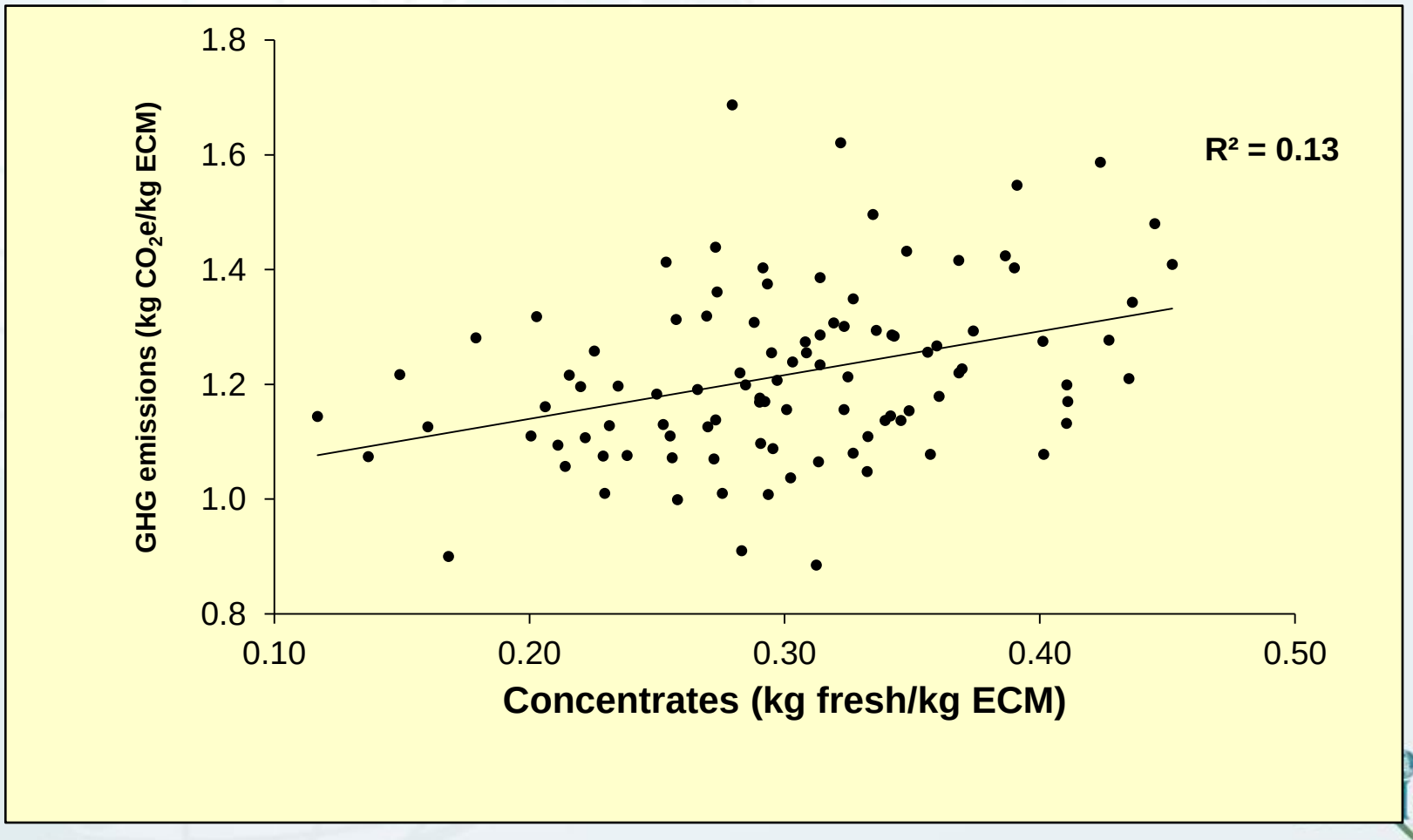
Relationship between GHG emissions/kg of ECM and annual concentrate input (100 farms)



Relationship between GHG emissions/kg of ECM milk and concentrate feed rate (100 farms)



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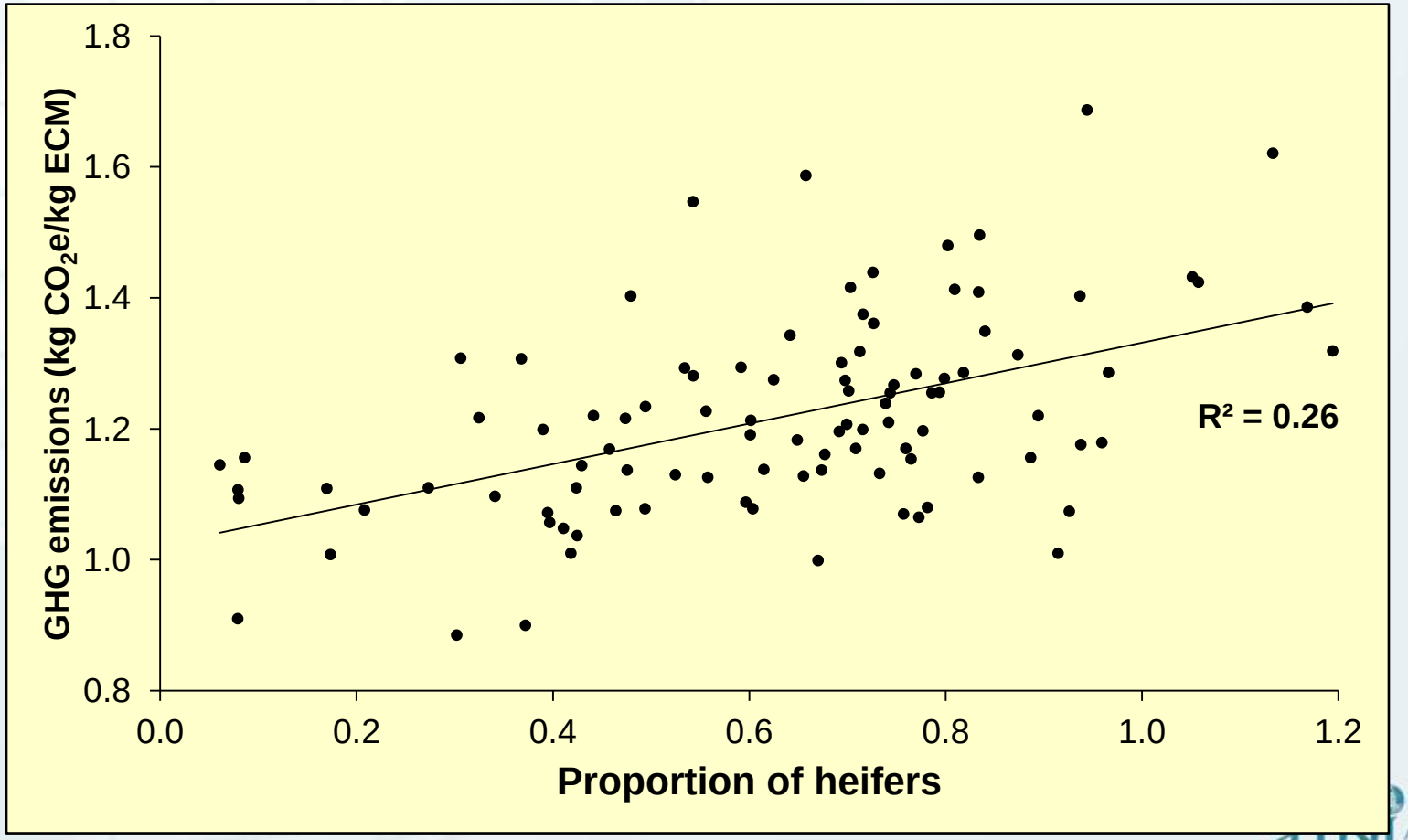
Relationship between GHG emissions/kg of ECM milk and the proportion of heifers on a farm (100 farms)



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3) Calculating the GHG footprint of experimental systems

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Cow performance within three spring calving milk production systems

- 3 Spring calving systems examined over 3 years
- 26 cows/system
- Systems differed in concentrate inputs

	Low concentrate	**Medium concentrate**	**High concentrate**
Concentrate intake (t/year)	0.56	1.14	1.85
Milk yield (kg/year)	5650	6289	6571
Fat (g/kg)	44.7	45.8	44.8
Protein (g/kg)	34.2	34.6	34.7
Stocking rate (cows/ha)	2.3	2.6	2.9

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Breakdown of GHG emissions from three milk production systems (for a 100 cow herd)

- Assumed values adopted for heifer rearing, fuel and electricity use

	Low conc.	Medium conc.	High conc.
Total farm emissions (t/year)	669	724	760
Source of emissions (%)			
- Enteric fermentation	45	45	43
- Manure	19	19	19
- Fertiliser	22	18	16
- Concentrate	6	10	16
- Land use	3	3	3
- Fuel, electricity	2	2	2
- Other sources	3	3	3

Calculated GHG emissions from three spring calving milk production systems

	Low conc.	Medium conc.	High conc.
Excluding sequestration			
Emissions/cow (t)	6.7	7.2	7.6
Emissions/ha (t)	12.1	14.7	17.1
Emissions/kg of milk produced (kg/kg)	1.09	1.03	1.05
Including sequestration			
Emissions/kg milk produced (kg/kg):	0.90	0.88	0.92
Effect of including sequestration (% reduction)	-17.5%	-14.5%	-12.3%

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Confinement vs grazing

- 2 systems examined over a full lactations (Confinement and low input grazing)
- 2 genotypes on each system (Crossbreds and Holstein)
- 20 cows/system

	System			
	Confinement		Grazing	
	HF	J × HF	HF	J × HF
Annual concentrate intake (t/cow)	3.4	3.3	0.94	0.88
Annual milk production (kg/cow)	9,053	7,438	6,274	5,964
Milk fat (%)	4.34	4.83	4.35	4.68
Milk protein (%)	3.40	3.68	3.36	3.60
Live weight (kg)	590	578	591	528
No. of days housed / year	365	365	154	154
Stocking rate (cows/ha)	3.1	3.1	2.6	2.6

Calculated GHG emissions from a Confinement and grazing system involving two cow genotypes

	System				
	Confinement			Grazing	
	HF	J x HF		HF	J x HF
Excluding sequestration					
Emissions/cow (t)	9.7	8.9		6.9	6.8
Emissions/ha (t)	21.6	22.0		14.0	14.4
Emissions/kg of milk produced (kg/kg)	1.02	1.05		1.05	1.02
Including sequestration					
Emissions/kg milk produced (kg/kg):	0.91	0.95		0.89	0.87
Effect of including sequestration (% reduction)	-11%	-10%		-15 %	-15%

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Conclusions

- The AFBI dairy GHG calculator allows the C-Footprint of milk production systems to be calculated with a high degree of precision due to the incorporation of the current scientific data

- Flexibility in 'source' of data (including the use of default values) allow the calculator to have a number of roles:
  - Footprint of individual farms
  - Trends in survey data
  - Modelling emissions from experimental systems

- Large range in calculated footprints of individual farms reflect a wide range of efficiencies

- Very different milk production systems can have similar carbon footprints

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