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Feed efficiency and methane emissions in dairy cattle: animal, herd and population considerations

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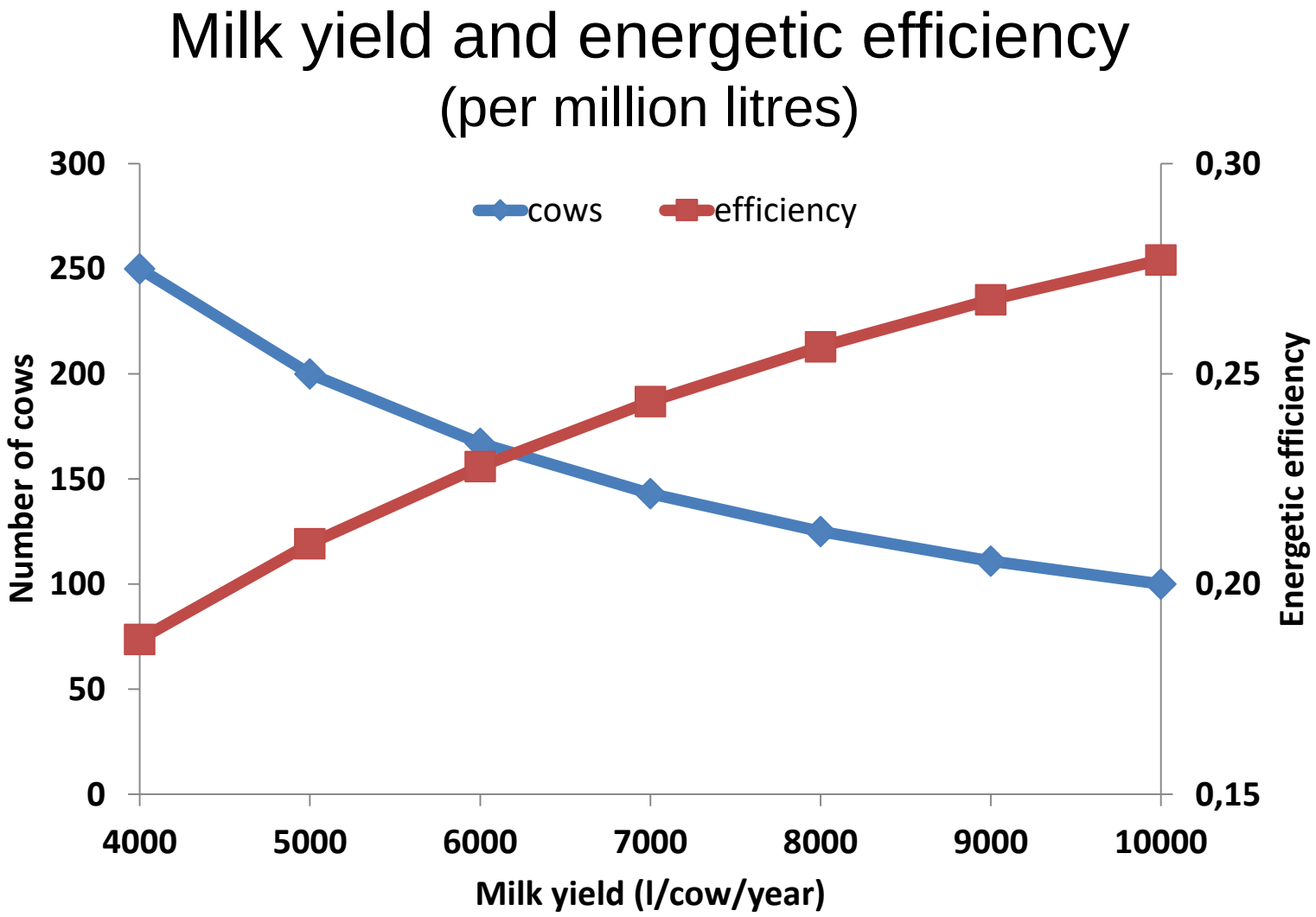
70th Annual Meeting of the
European Federation of Animal Science
Ghent, Belgium, 29 August 2019

Individual cows

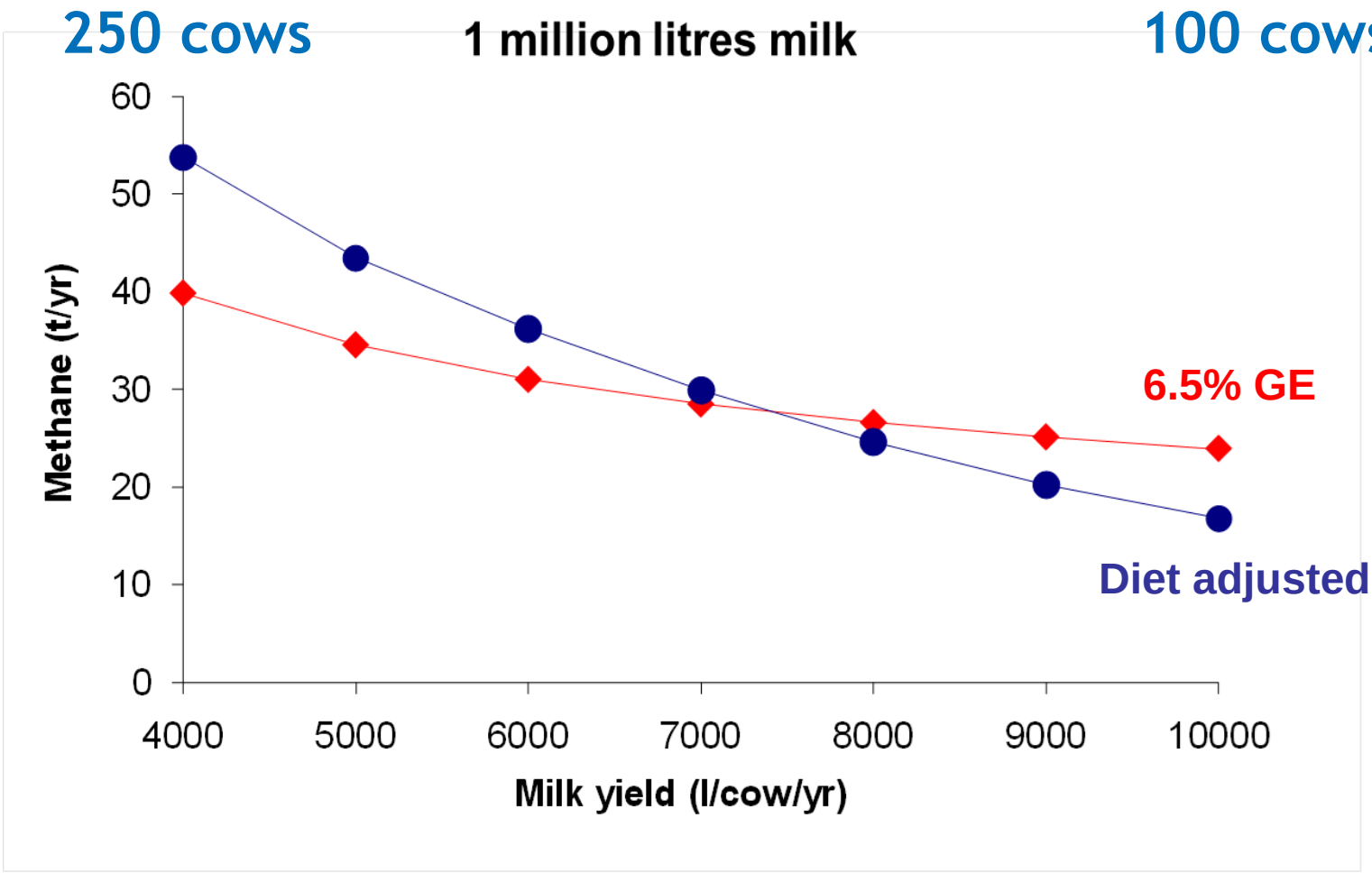
Live weight kg	650	650
Milk Yield kg/d	30	40
ME MJ/d	228	285
M/D MJ/kg DM	11.5	11.5
DMI kg/d	19.8	24.8
Feed Efficiency	1.51	1.61
CH_4 g/d	441	551
CH_4 g/kg DMI	22.3	22.3
CH_4 g/kg milk	14.7	13.8

1. Higher milk yield = higher DM intake = more CH_4 per day
2. Maintenance is lower proportion = higher feed efficiency = less CH_4 per kg milk
3. Higher diet energy = lower DMI = less CH_4 per day, per kg DMI & per kg milk and higher feed efficiency

Milk yield and efficiency of herds



Methane and Milk Yield



Garnsworthy, 2004. Anim Feed Sci Technol, 112, 211-223

Higher milk yield reduces methane by diluting maintenance and needing fewer replacements

But, higher milk yield may reduce fertility, leading to more replacements

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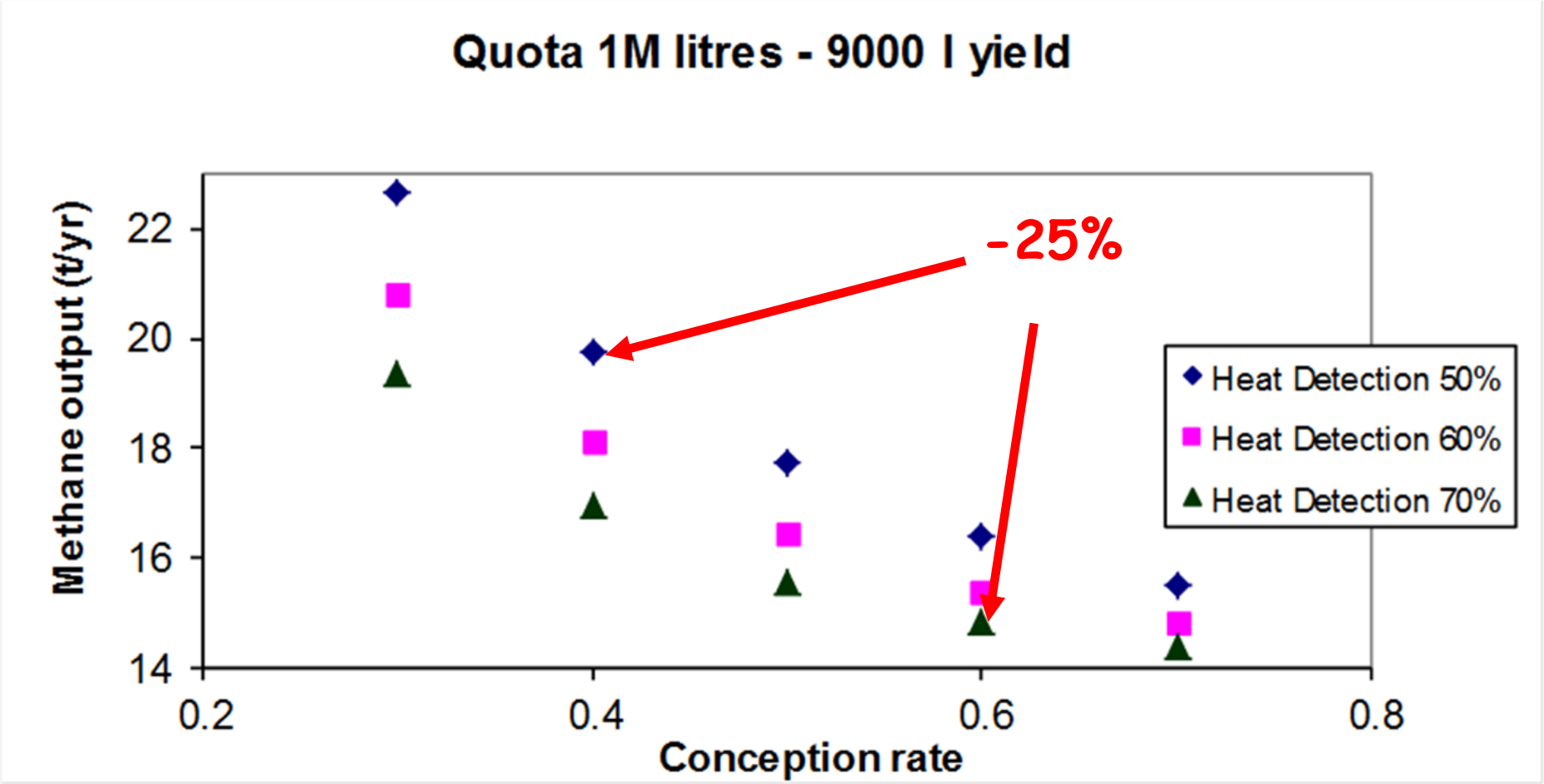
Fertility affects methane per herd



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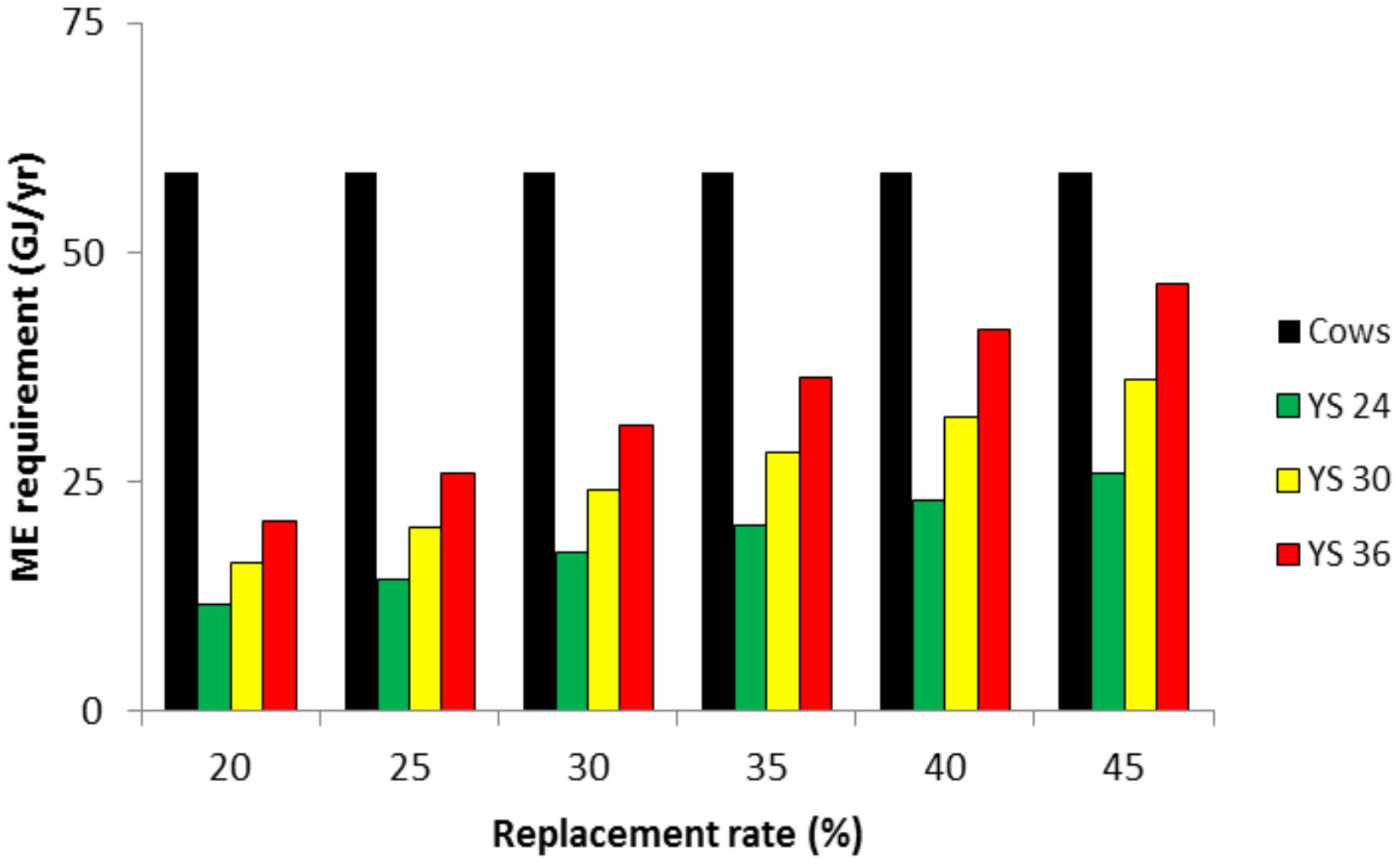
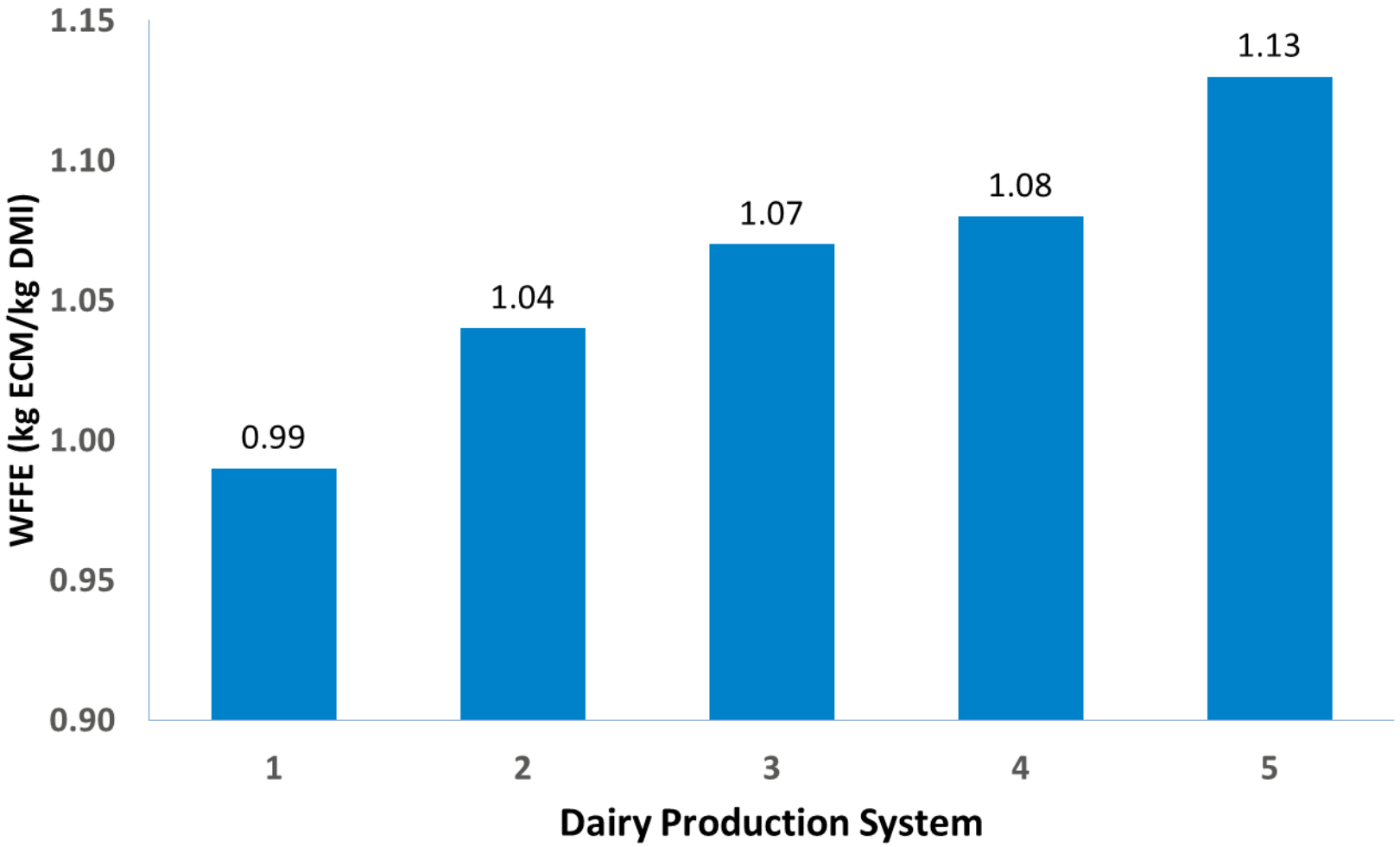
Replacement rate, age at first calving and energy requirements



Feed energy required for heifers ranges from 16 to 44% of total feed energy for herd

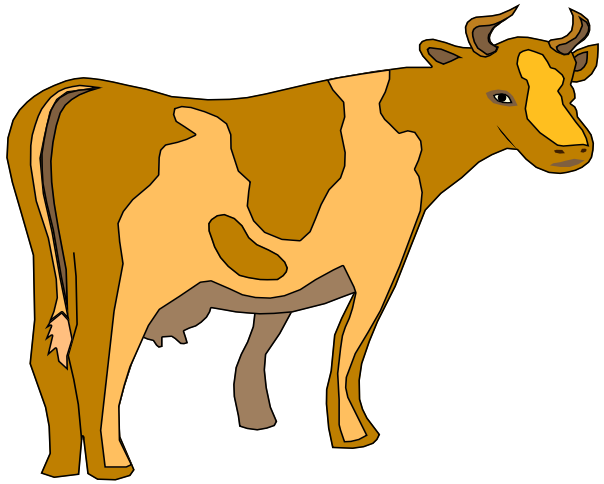
Feed energy ≡
Diet CFP
Methane
N excretion
P excretion
Profit

Whole farm feed efficiency



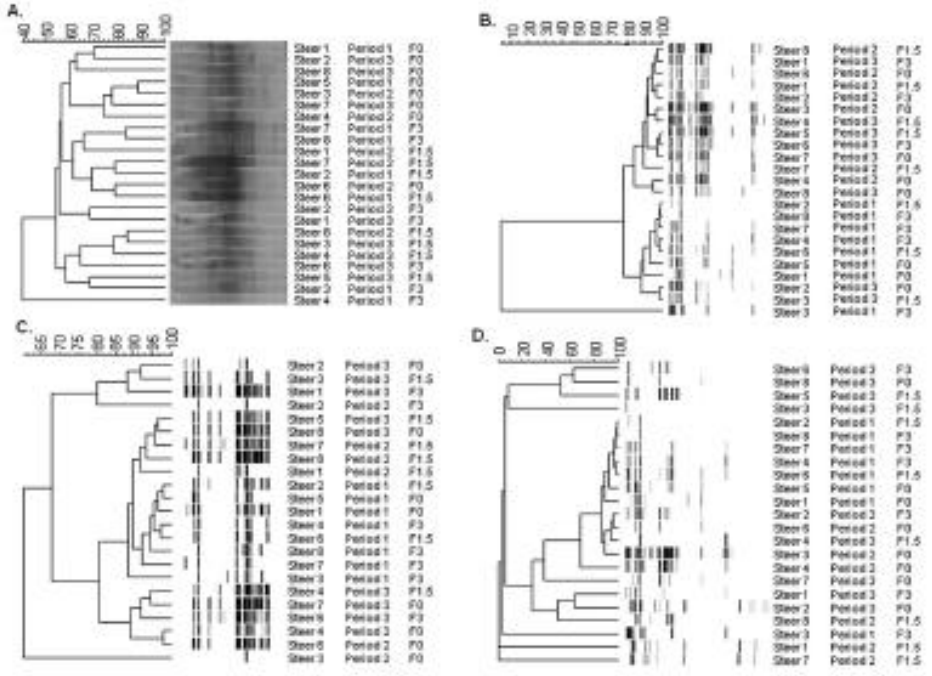
Grazing months	>9	6-9	3-6	<3	0

RuminOmics (EU-FP7 project)



Linking the cow genome to the rumen microbiome, feed efficiency and impact

Measured CH_4 and sampled 1,000 cows



Wallace, R.J., *et al.* (2019) *Science Advances* 5, EAAV8391.

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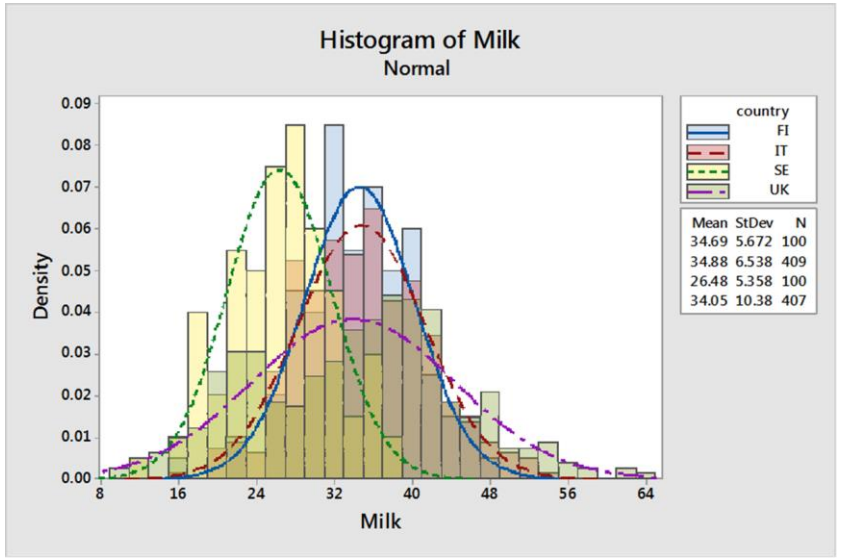
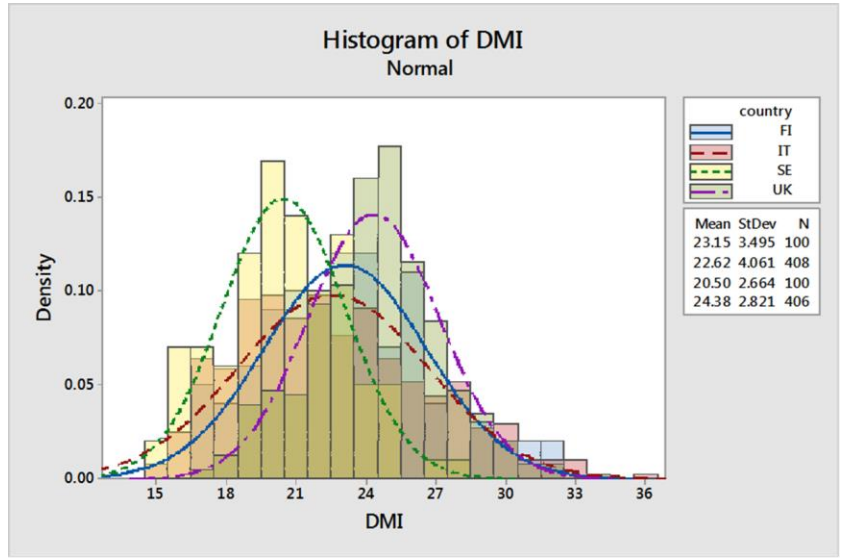
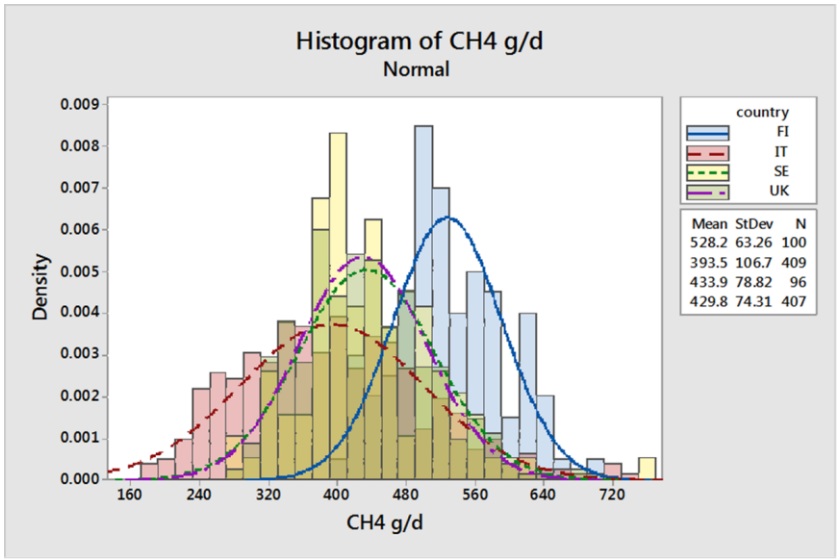
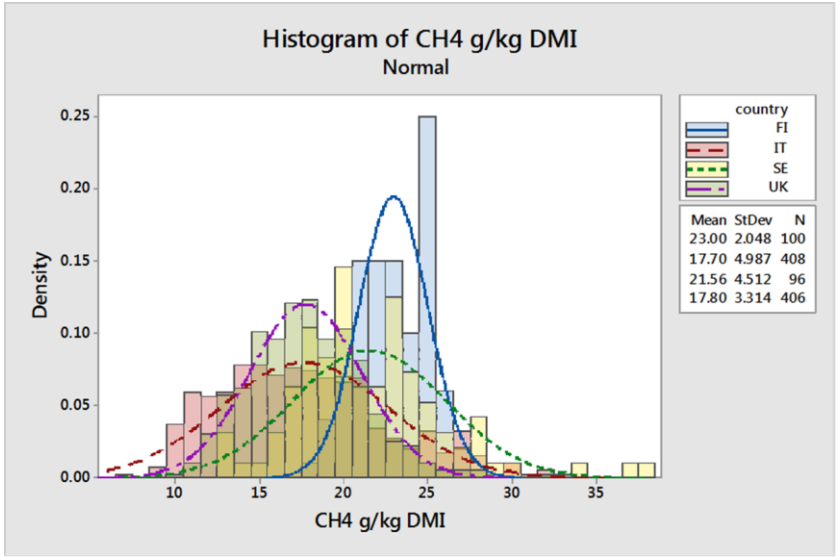
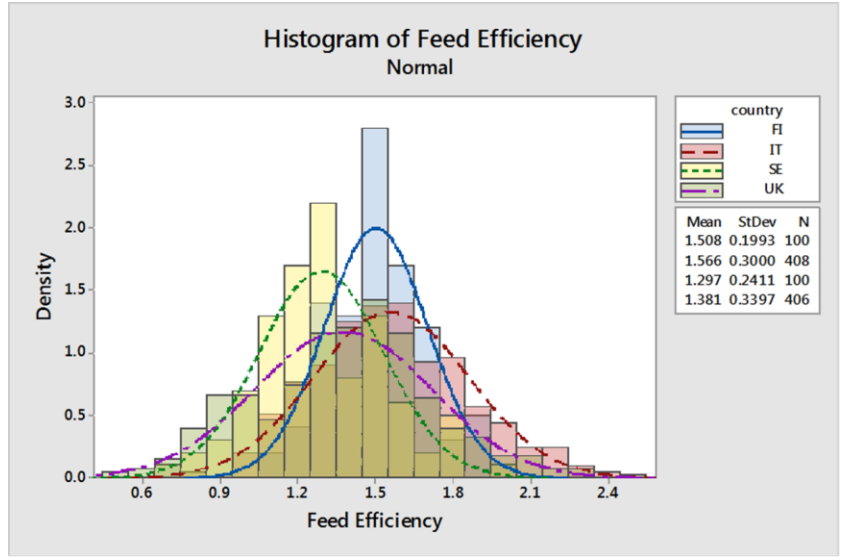
Cows are variable











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Can we breed for low methane?

- Heritability of methane emissions is 0.1 to 0.4
- There is a lot of genetic and phenotypic variation (CV 10-30%)
- Methane ranges from 2 to 12% of Gross Energy Intake
- Reducing methane should save energy for use in milk synthesis
- Breeding could be a win-win solution

J. Dairy Sci. 102:7277–7281
https://doi.org/10.3168/jds.2018-15909

Short communication: Heritability of methane production and genetic correlations with milk yield and body weight in Holstein-Friesian dairy cows

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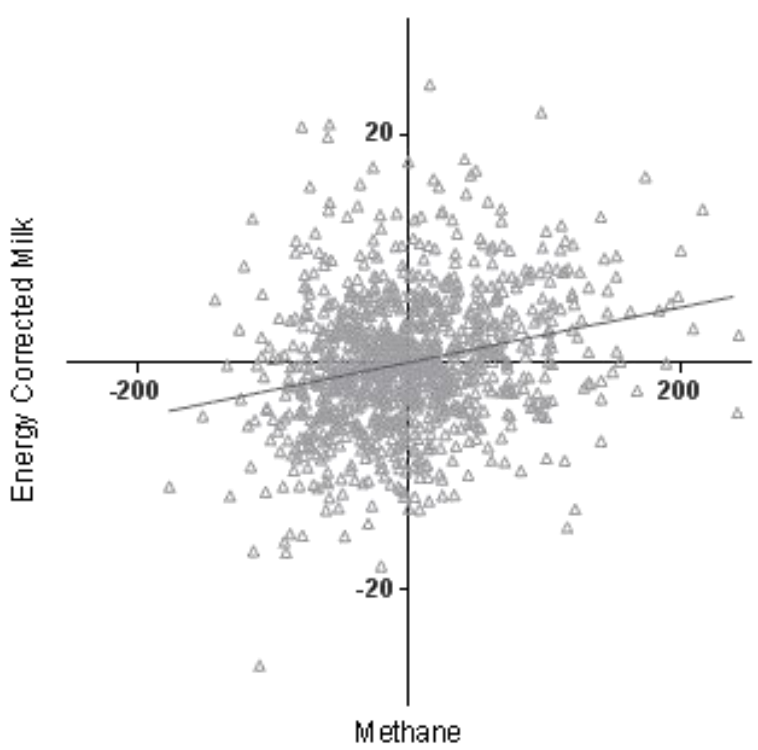
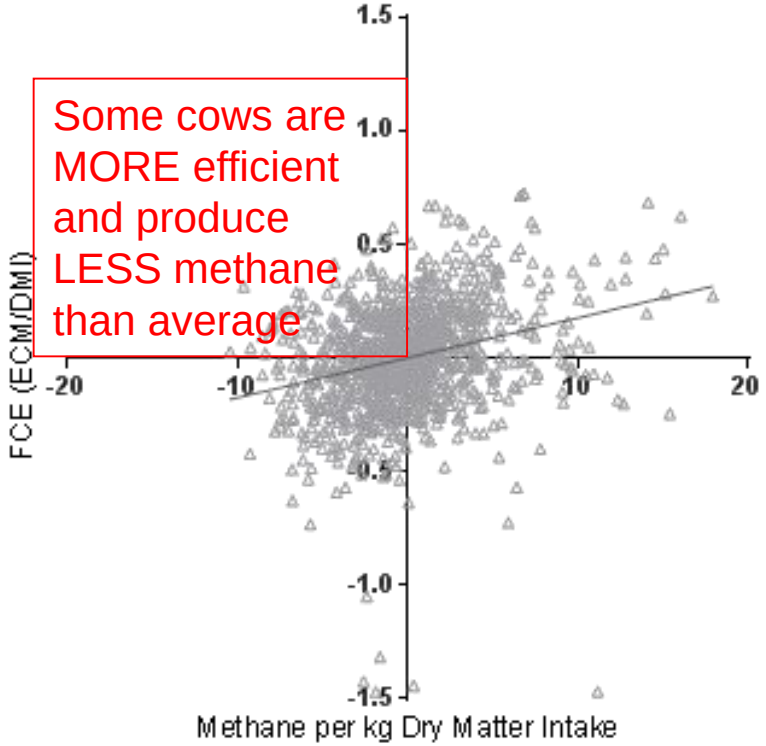
Should we breed for low methane?

Methane is related to milk yield and feed efficiency





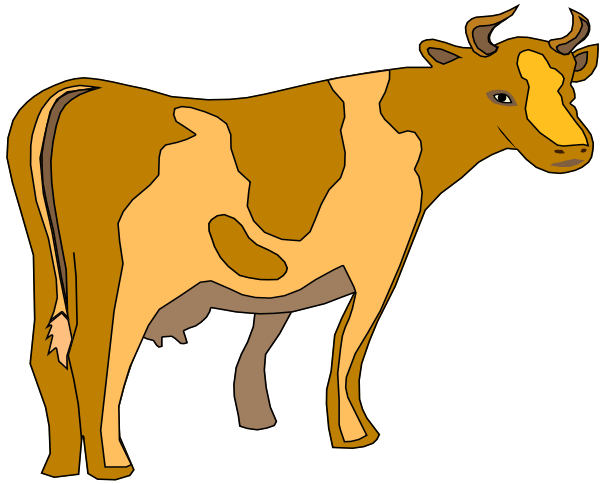
Some cows are MORE efficient and produce LESS methane than average

Reducing methane does NOT increase milk yield

High emitters generally digest forage more efficiently

Lower methane should not be the only breeding goal

RuminOmics (EU-FP7 project)



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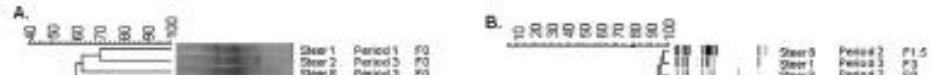
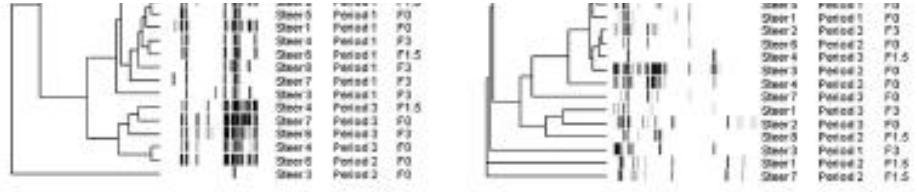


A core microbiome is heritable and is related to methane emissions and feed efficiency.

The cow controls her own rumen microbes – or the microbes control the cow.



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Wallace, R.J., *et al.* (2019) A heritable subset of the core rumen microbiome dictates dairy cow productivity and emissions. *Science Advances* 5, EAAV8391.

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Summary

- Feed efficiency and methane emissions have interactions
- Generally, higher milk yield = more efficient cow & lower methane yield
- But, not when higher milk yield = greater digestion of forage by a cow
- Or, when higher milk yield = lower fertility & more replacements
- Generally, more digestible diet = more efficient herd & lower methane yield
- But, in the population we see that greater efficiency = higher methane yield
- Getting the balance right is important for mitigation
- Aim for greater efficiency and lower emissions

Thank you for your attention