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Feed Efficiency and Methane Emissions

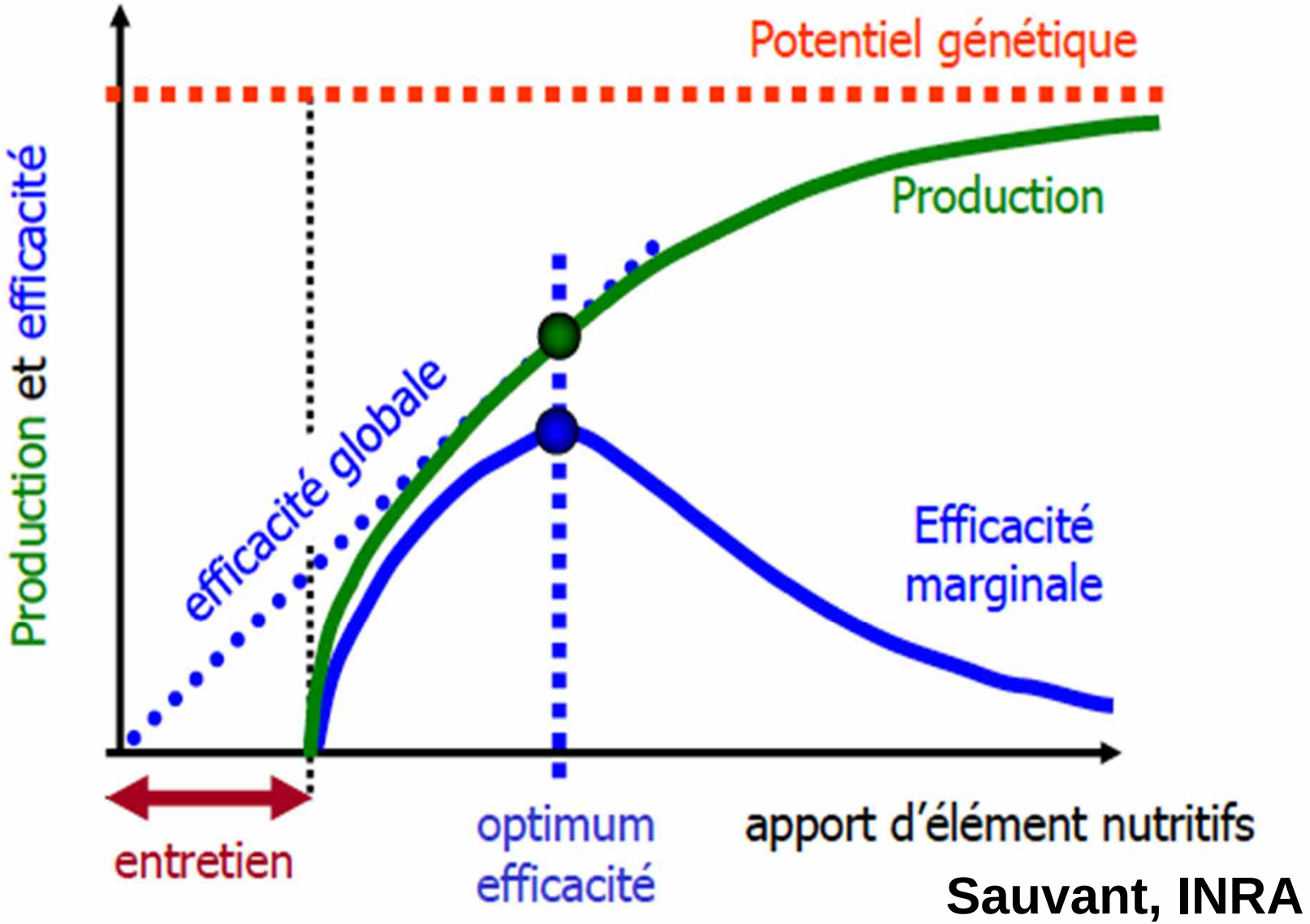
Phil Garnsworthy
University of Nottingham

Feed Efficiency

- Two alternative ratios:
  - Feed conversion ratio (FCR) – how much feed does it take to produce a kg of milk?
  - **Feed conversion efficiency (FCE) – how much milk (or milk constituent) is produced per kg of feed?**

Per cow. Per herd. Per day. Per year.

Optimal Efficiency



Sauvant, INRA

Dairy System Targets (Australia)

Feeding System	Target
	kg milk/kg feed DM
Pasture + silage + low conc.	**1.0**
Pasture + silage + med conc.	**1.2**
Pasture + partial mixed ration	**1.3**
Hybrid system	**1.4**
Total mixed ration (no grazing)	**1.6**

Take action if FCE is >0.1 lower

Little, GRAINS2MILK (2014)

Achieving Increased Feed Efficiency

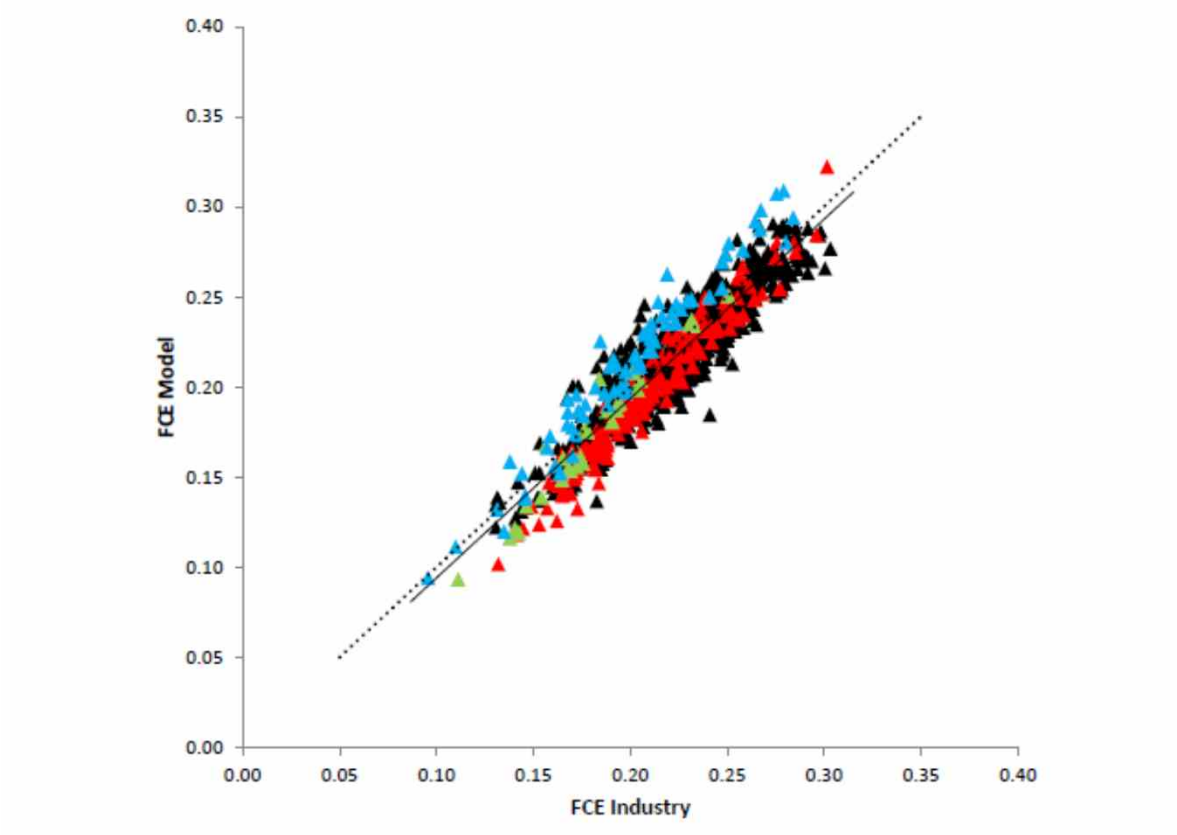
- Better genetics - genomics
- Increase accuracy of diet formulation
- Increase accuracy of assessing feed intake
- Improve digestion and/or absorption of nutrients *
- Reduce feed wastage (e.g. mouldy silage)
- Improve animal health
- Improve diet presentation
- Reduce energy losses (e.g. less methane) *
- Reduce milk fat – minimum 3.5%
- Develop strategies for economic body weight changes

Some Gaps in Knowledge

Many farmers do not know how much feed their cows are eating

- TMR mixer wagon records
- Concentrate and straights use / purchase
- Rate of eating into silage clamp
- Grazing herbage allowance per day
- Feed given to youngstock
- Changes are as important as accurate amounts, so record data and use the records

Modelling FCE (Milk solids / DMI)



Positive

Milk yield

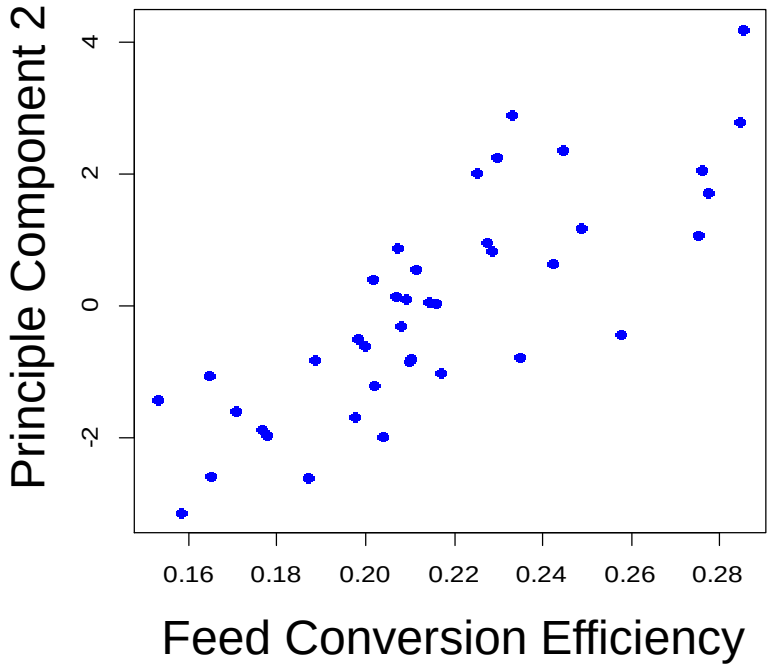
Milk fat %

Fat yield

Live-weight gain

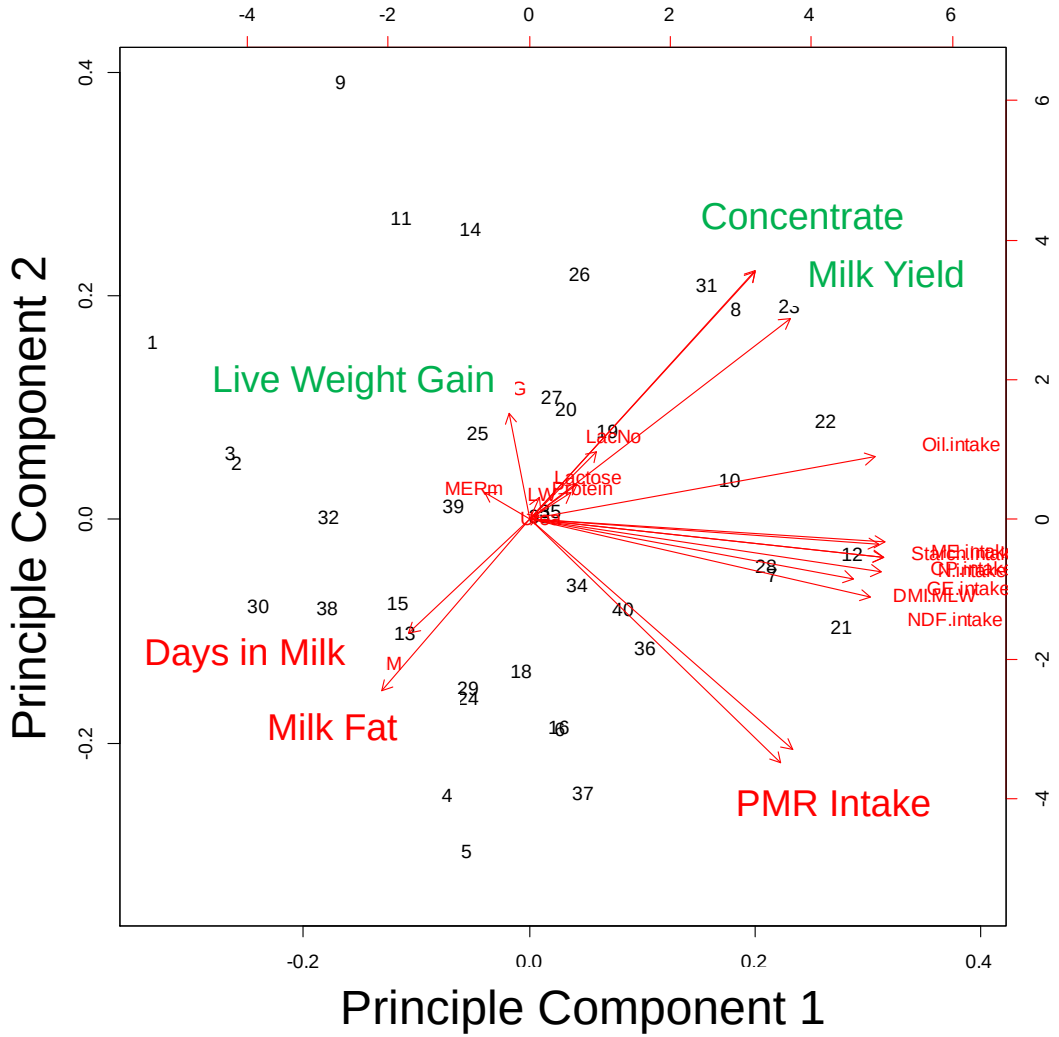
Negative

Concentrate DMI	0.008
PMR DMI	0.010



Seven principle components explain >90% of variation within the data

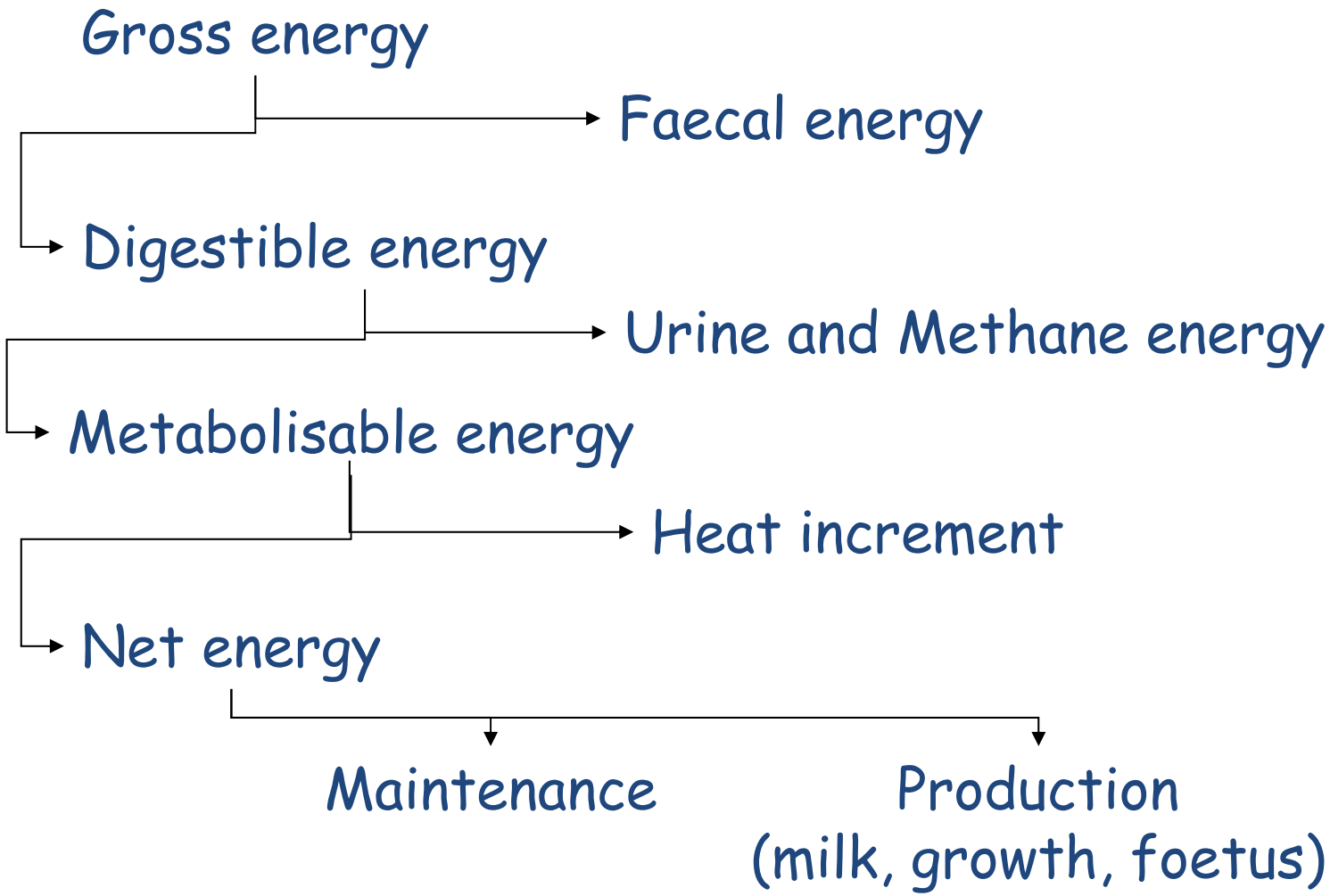
Of those, only PC2 is correlated with FCE



Positive effects of concentrate intake, milk yield and live weight gain

Negative effects of PMR intake, days in milk and milk fat

Energy Partition



Energy types
Gross, Digestible, Metabolisable

Digestibility, methane and efficiency

- Methane varies from 2% to 12% of Gross Energy intake (IPCC value 6.5%)
- Average cow (33 kg milk/d) consumes
  - GE 370 ; DE 275 ; ME 230 MJ/d
- 12% CH_4 →2% CH_4

  = +37 MJ GE = +23 MJ ME = +4.5 kg milk
- OR

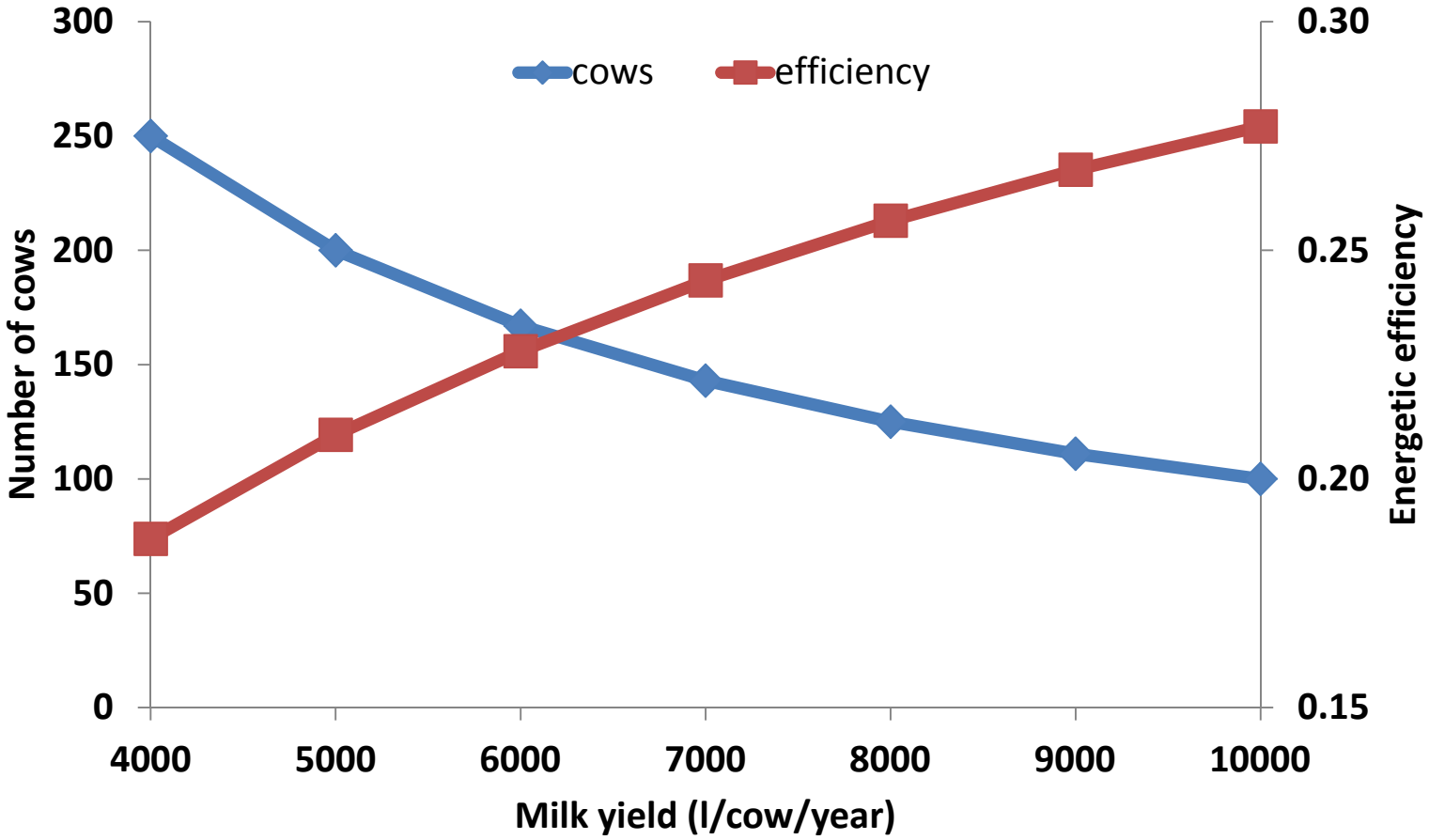
  = -0.13 digestibility = -0.5 kg milk

Whole Herd Efficiency

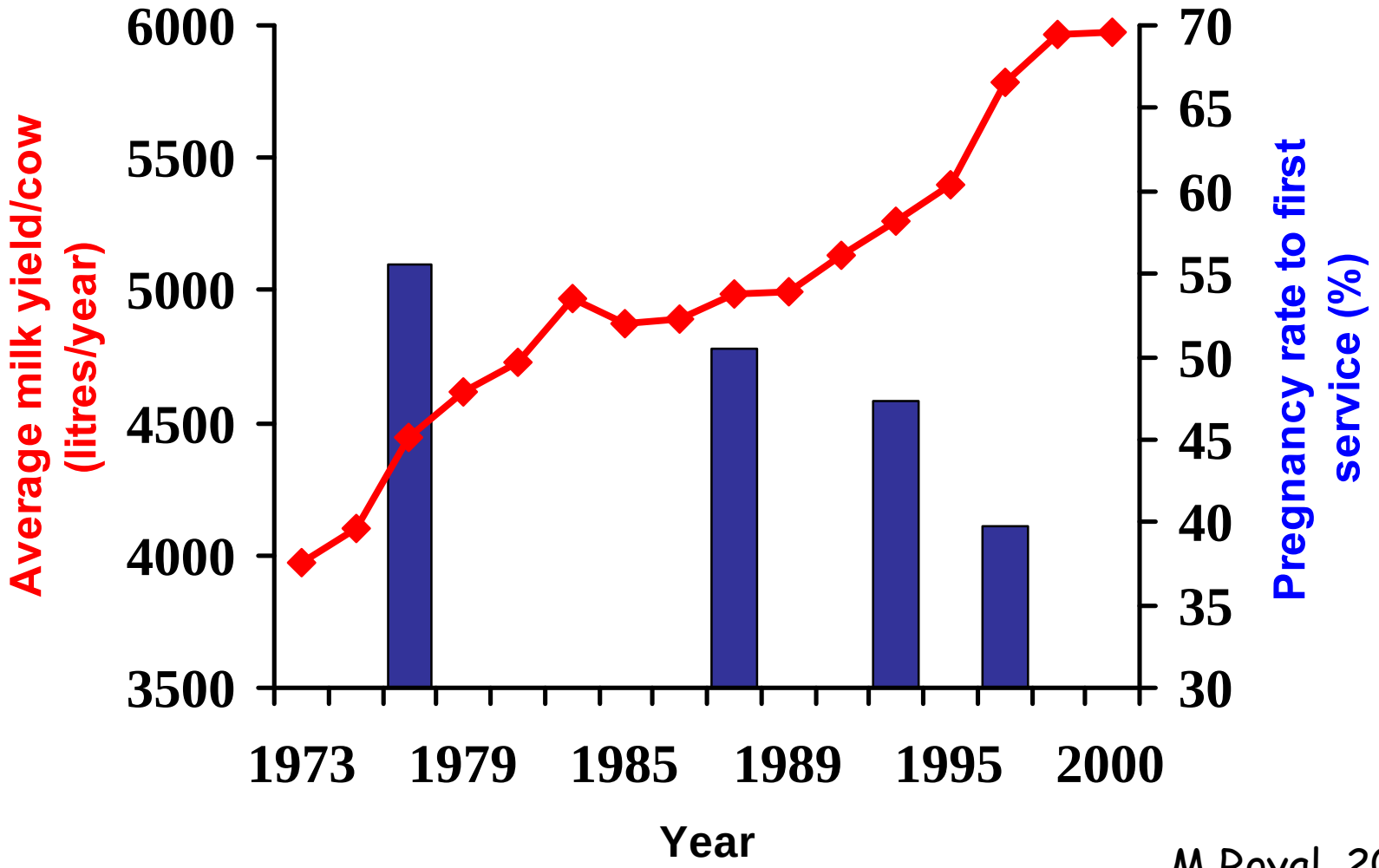
- Herd milk yield / [Feed for cows plus heifers]

- Milk yield
- Fertility
- Replacement Rate
- Number and age of heifers

Production Efficiency (of herd)
Milk yield and energetic efficiency
(per million litres)



Declining Fertility in UK dairy cows



M Royal, 2000
DEFRA statistics

Reproductive rate and health

- Average cow leaves herd after only 3 lactations
- 50% of culls for infertility, 50% for health
- If improve from 3 to 4 lactations
  - Increases lifetime milk yield 27%
  - Increases lifetime feed input by 12%
  - Reduces methane and N emissions by 20%
- Tools developed at Nottingham
  - Fertility Index (managed by DairyCo and SRUC)
  - Nutritional Strategies to improve insulin and fertility

defra
Department for Environment Food and Rural Affairs

LINK
COLLABORATIVE RESEARCH

Oestrous Detection

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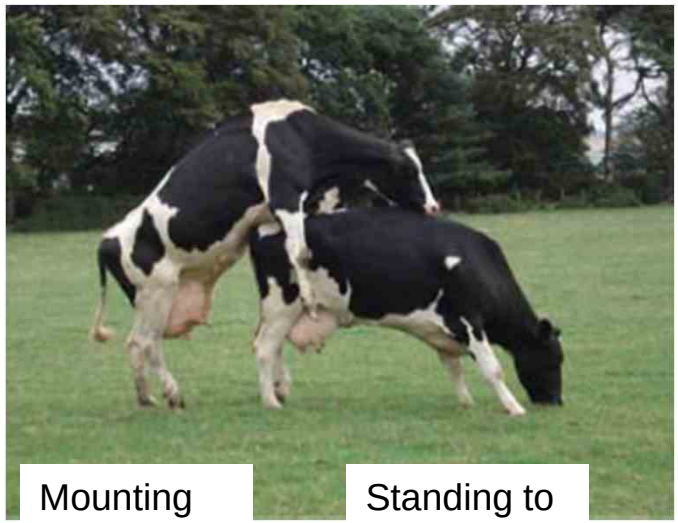
- Cow must be in oestrus to get pregnant when mated
- Observation is accurate
- Larger herds, fewer staff = less time for observation

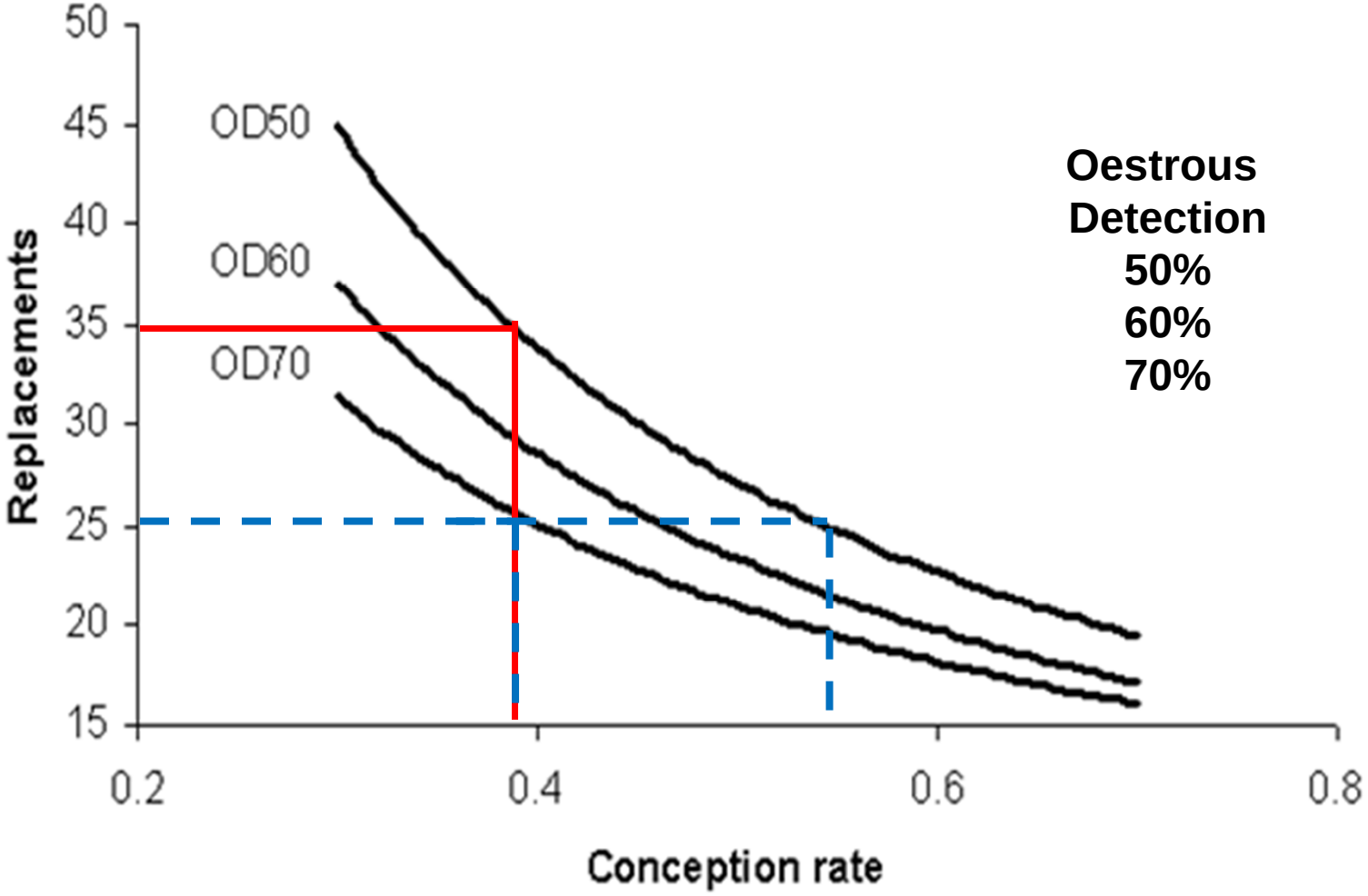


Mounting cow

Standing to be mounted

- Oestrous detection rate now only 50%
- Coupled with 40% conception rate:-
- Only 20% of ovulations result in pregnancy

Cow fertility affects replacement rate

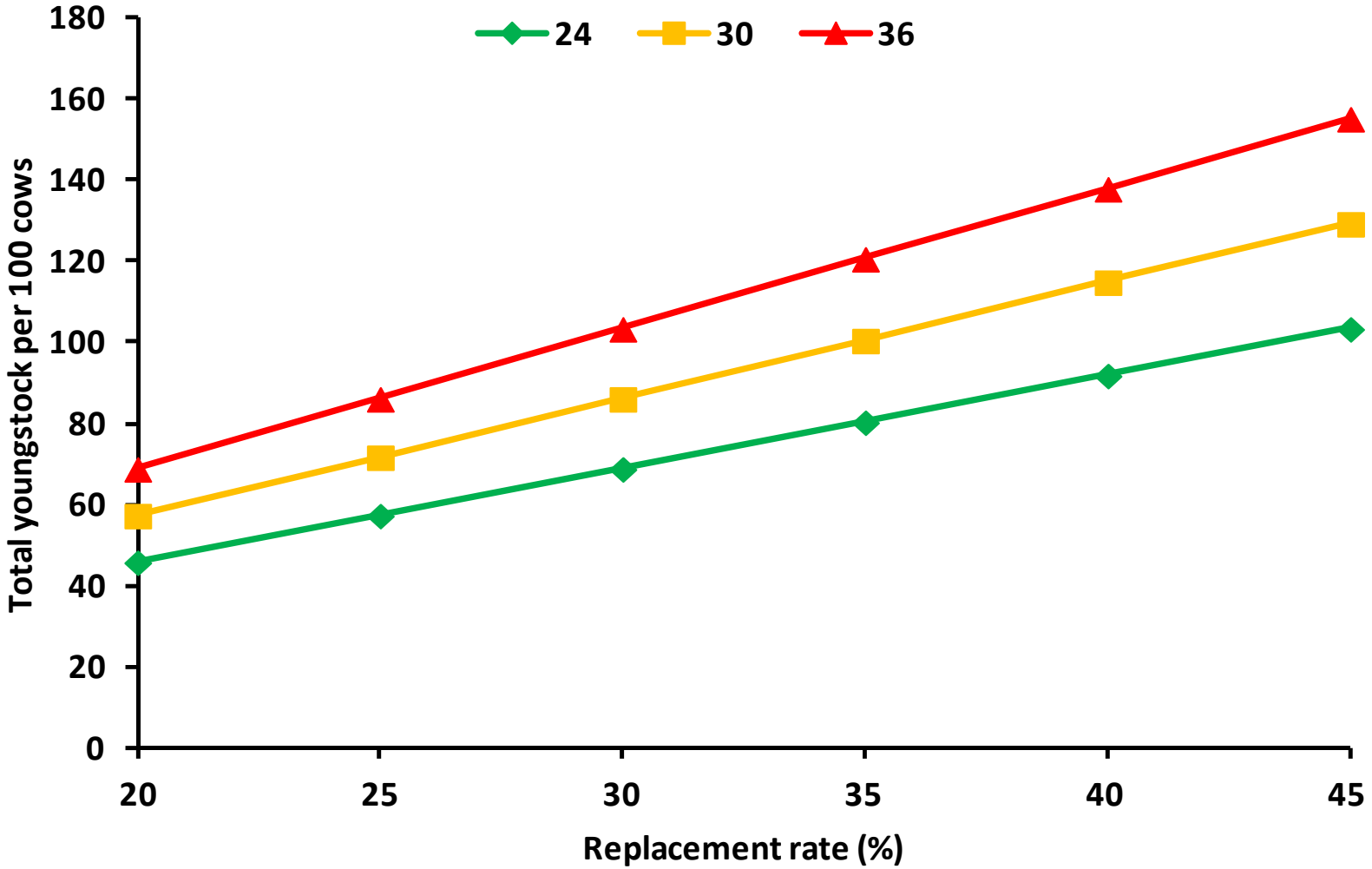


Garnsworthy, 2004. Anim Feed Sci Technol, 112, 211-223

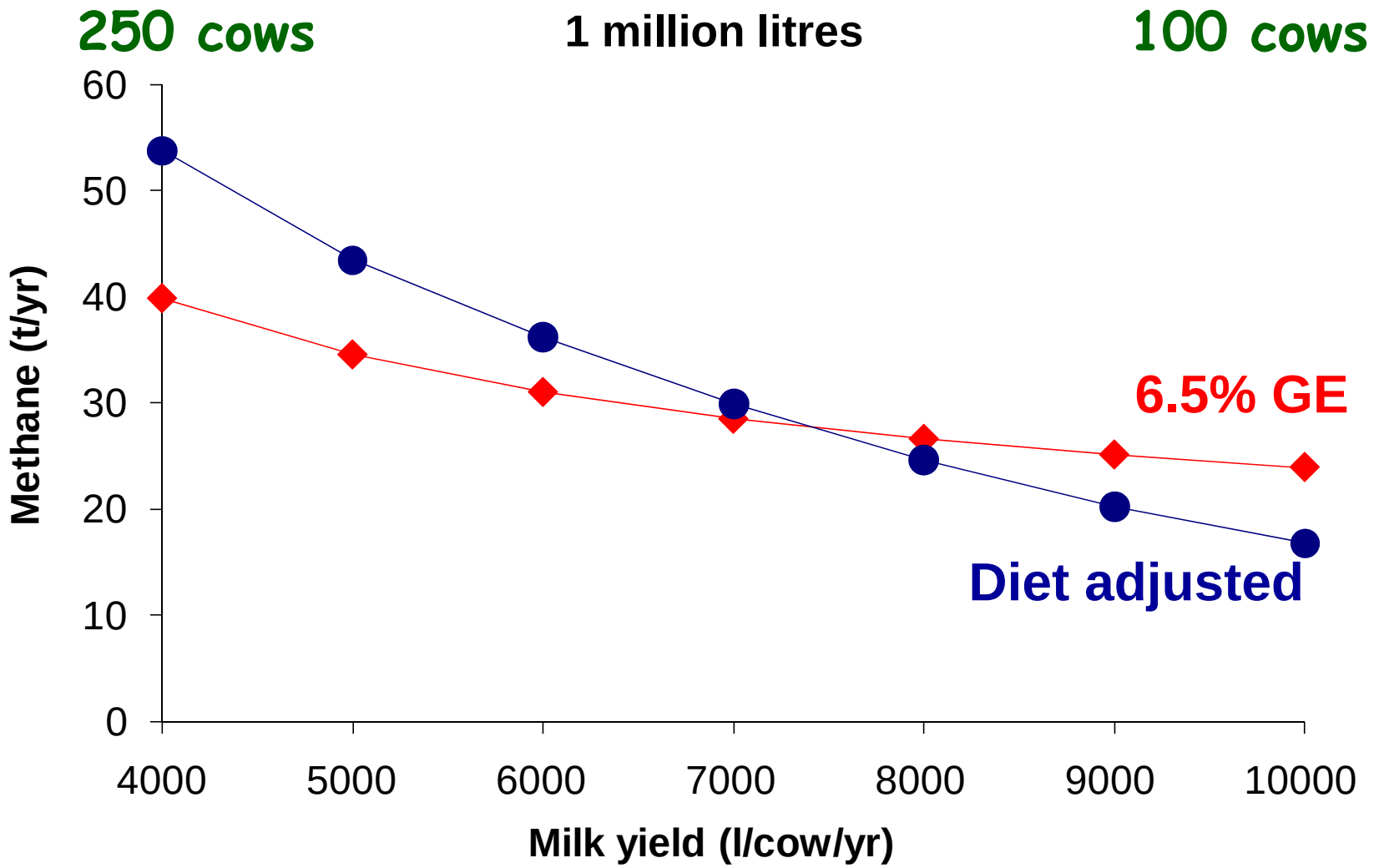
Summary so far

- Poor fertility, poor oestrous detection and high disease incidence
  - Increase replacement rate
  - Increase number of youngstock on farm
  - Increase environmental impact
  - Reduce herd production efficiency
- What about heifer rearing?
  - Age at first calving, heifer losses

Age at calving, replacement rate and number of heifers on farm

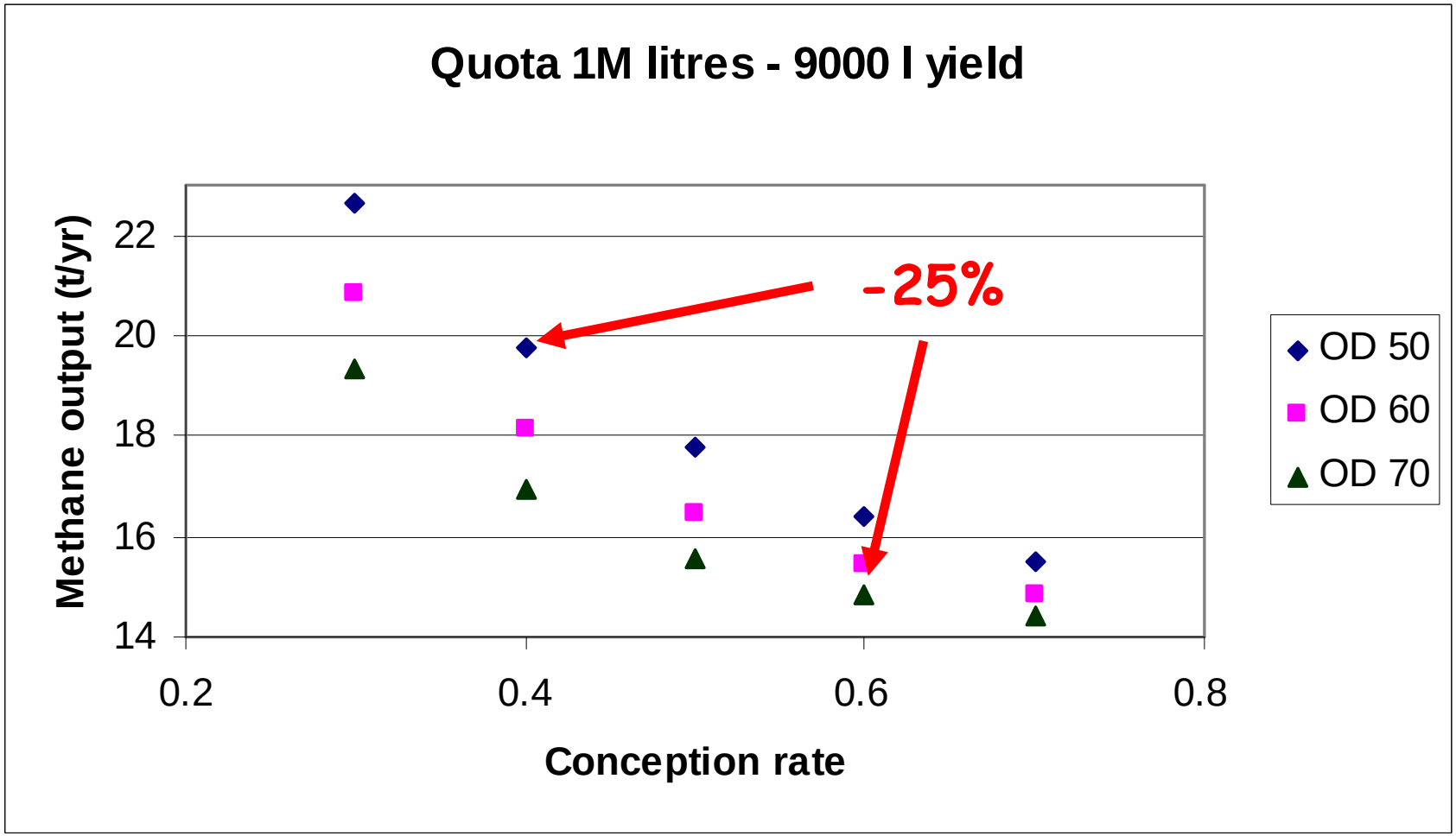


Methane and Milk Yield



Garnsworthy (2004)

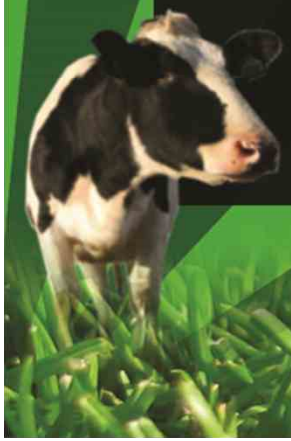
Fertility and methane in a high-yielding herd



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

Whole Farm FCE

- Takes feed requirements of youngstock into account
- Improving fertility will reduce the number of heifers needed on farm
- Reducing age at first calving will reduce individual heifer's feed requirements



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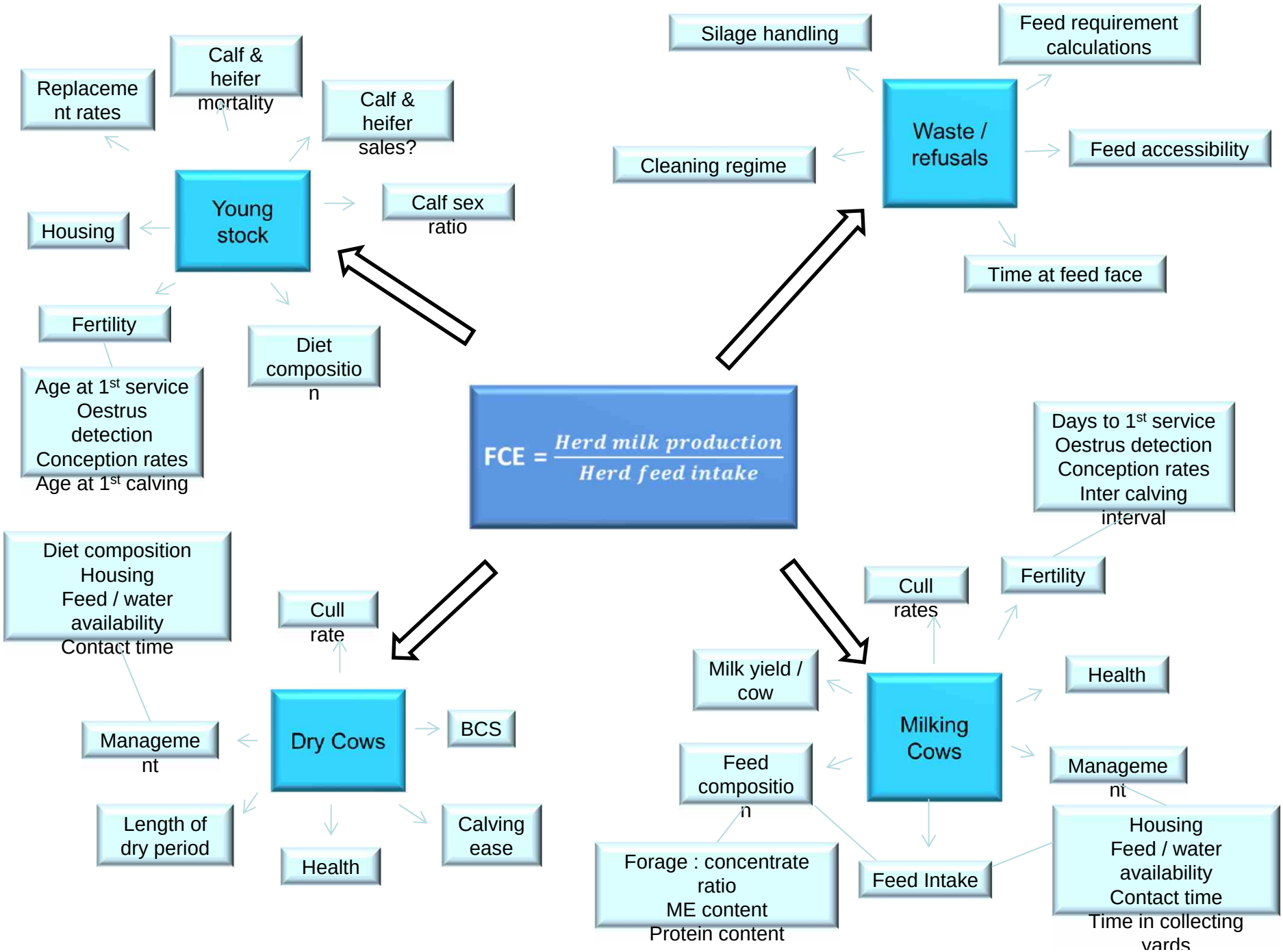
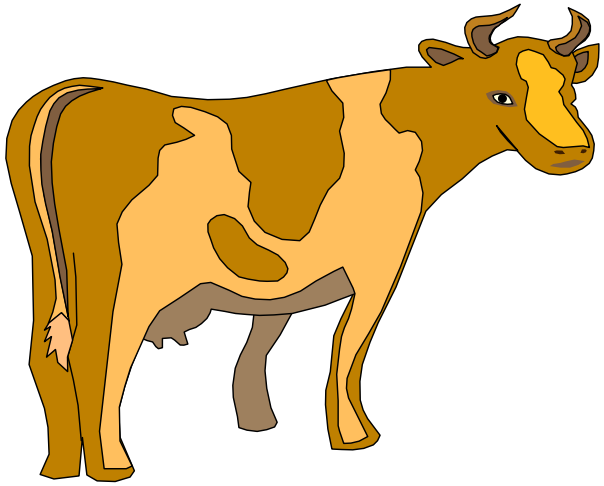
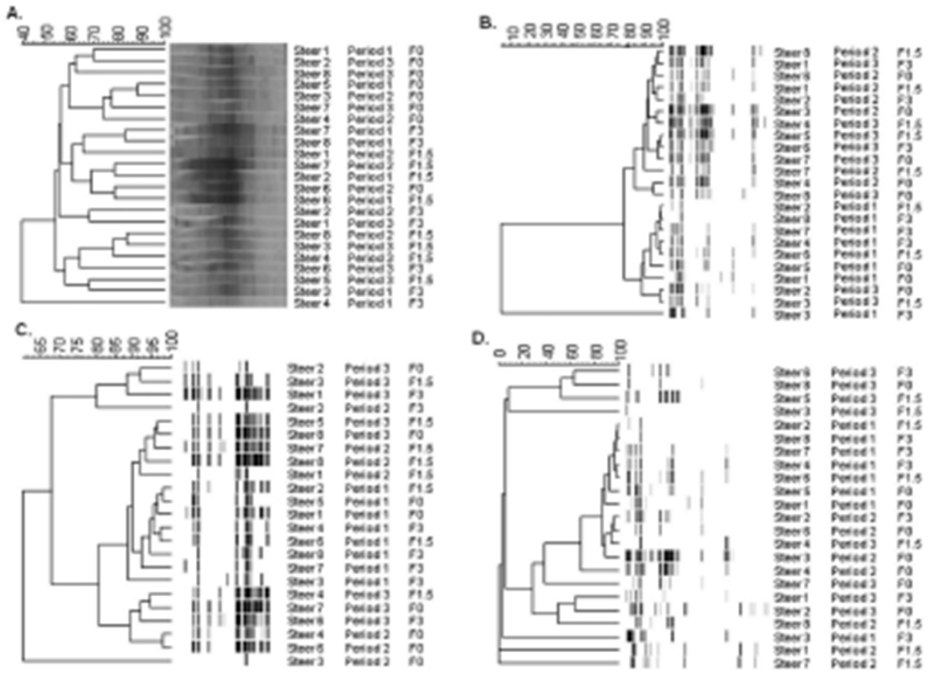

FCE = Herd milk production / Herd feed intake
Young stock
Replacement rates
Calf & heifer mortality
Calf & heifer sales?
Housing
Calf sex ratio
Fertility
Age at 1st service
Oestrus detection
Conception rates
Age at 1st calving
Diet composition
Waste / refusals
Silage handling
Feed requirement calculations
Cleaning regime
Feed accessibility
Time at feed face
Dry Cows
Diet composition
Housing
Feed / water availability
Contact time
Cull rate
Management
BCS
Length of dry period
Health
Calving ease
Milking Cows
Days to 1st service
Oestrus detection
Conception rates
Inter calving interval
Fertility
Cull rates
Milk yield / cow
Health
Management
Feed composition
Forage : concentrate ratio
ME content
Protein content
Feed Intake
Housing
Feed / water availability
Contact time
Time in collecting yards

RuminOmics (EU-FP7 project)



Measuring CH_4 and sampling 1,000 cows



Linking the cow genome to the rumen microbiome and feed efficiency

RUMINOMICS

Conclusions

- Production efficiency is the main driver of profit and environmental impact
- To optimize production efficiency
  - Use genetic potential of animals

    Feed for efficiency and low impact
  - Reduce wastage of animals from poor fertility and disease
  - Aim for first calving at <24 months and minimise rearing losses
- Breeding for low methane will not be as effective as breeding for efficiency, fertility and health