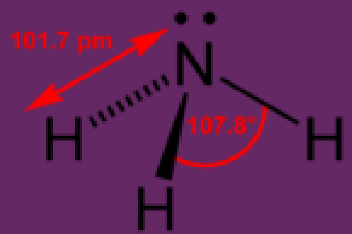
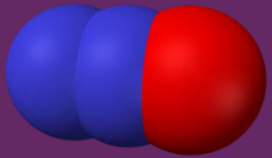
How Low Can We Go?
Long Term Implications of Feeding Lower Protein Diets





University of Reading,
Aberystwyth University, SRUC,
Rothamsted Research North Wyke

The Nitrogen Cycle

25%

H3

N fixation

N fertiliser

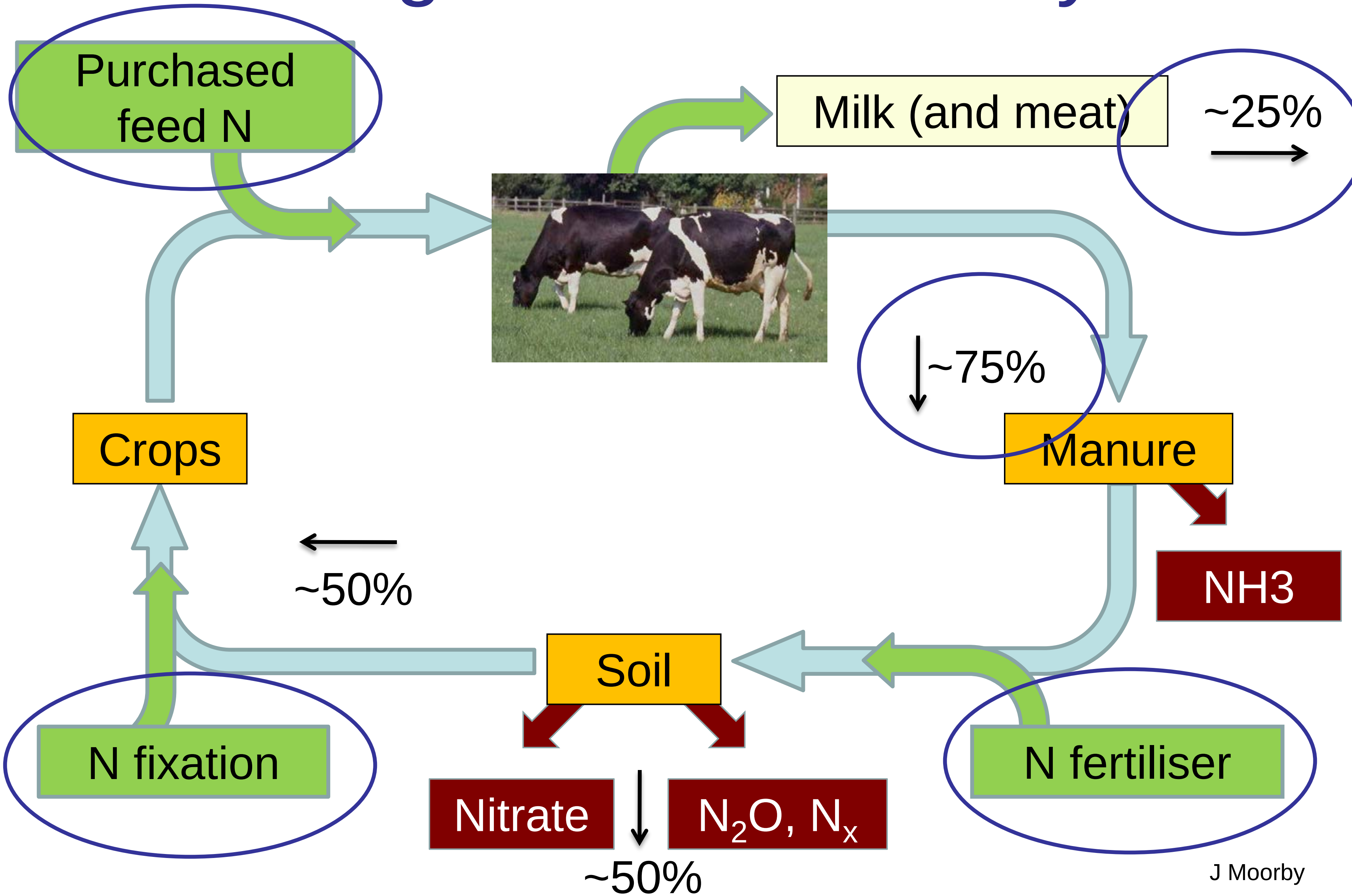
Nitrate

N_2O,

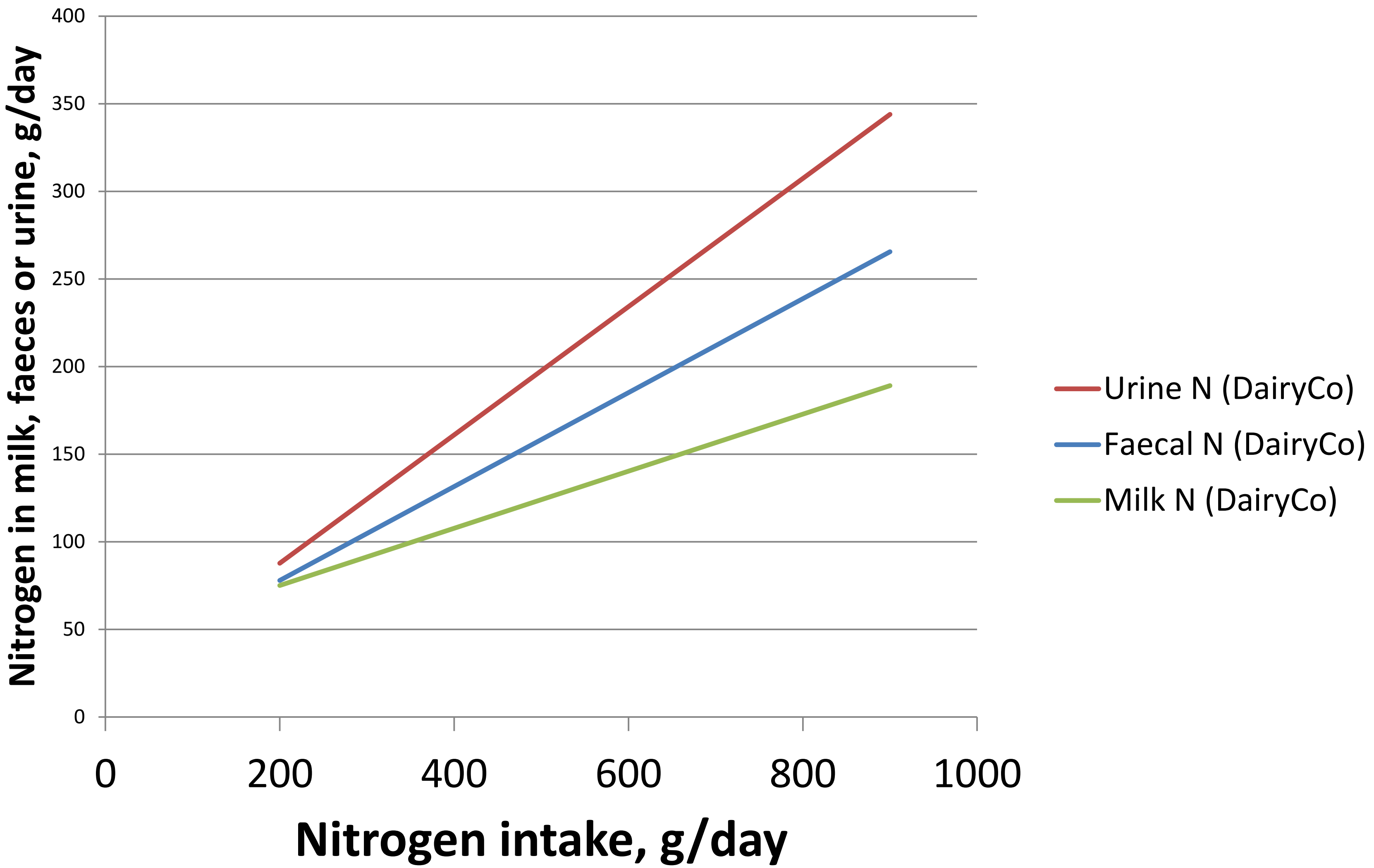
~50%

J. Moorby, 2008

Nitrogen Use Efficiency

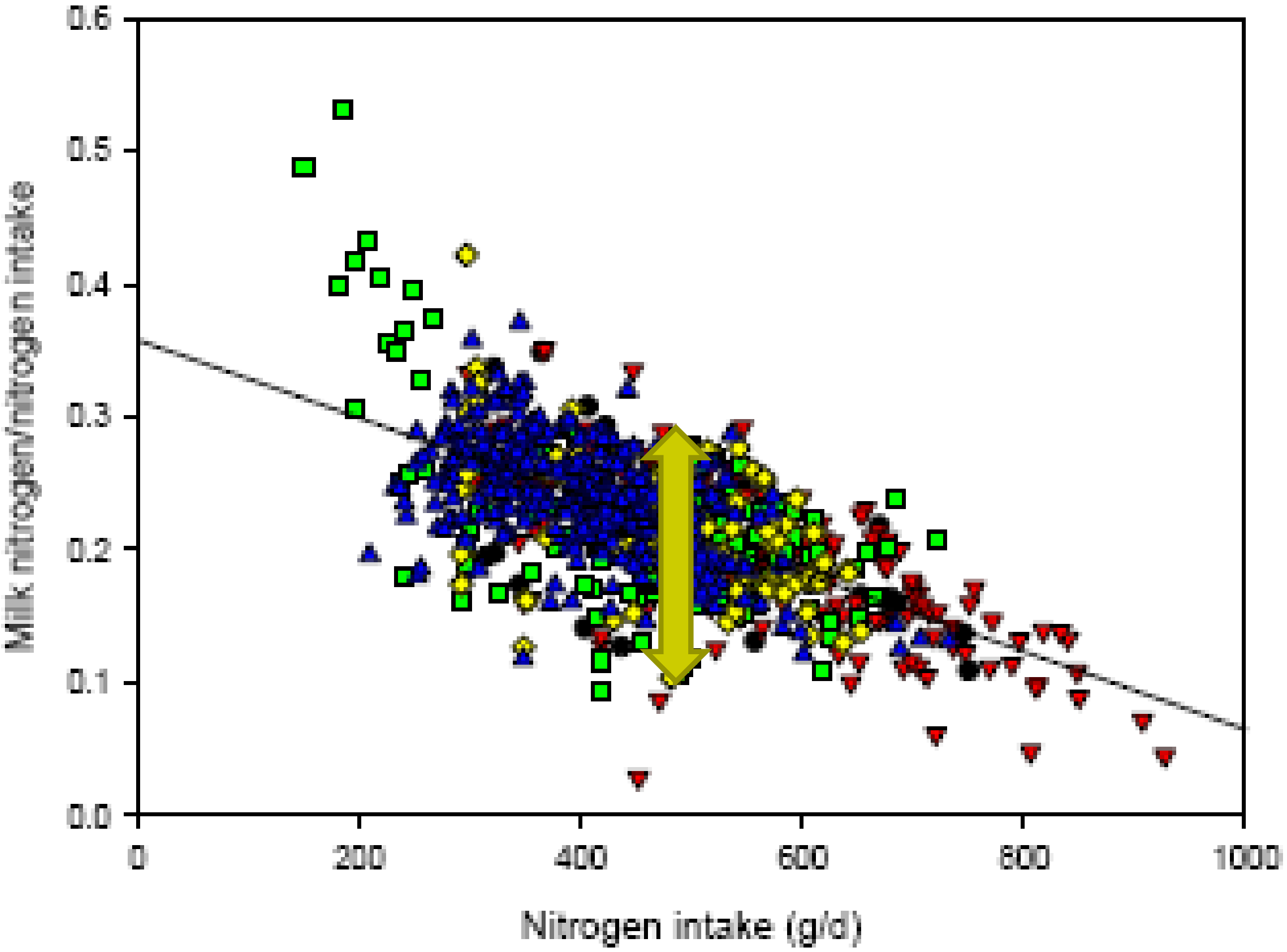


Meta Analysis of N Balance Trials

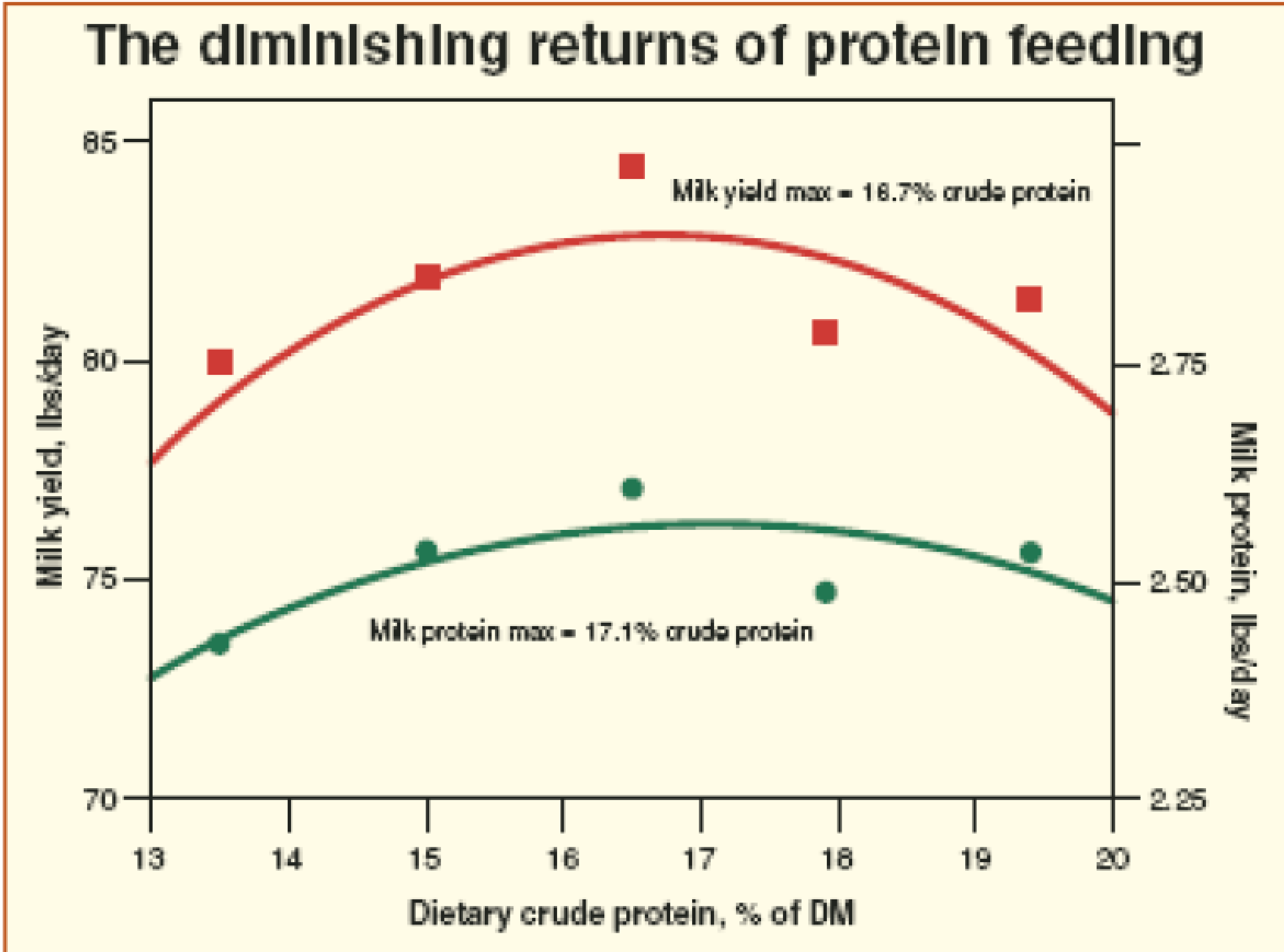


Mills et al. (2009)

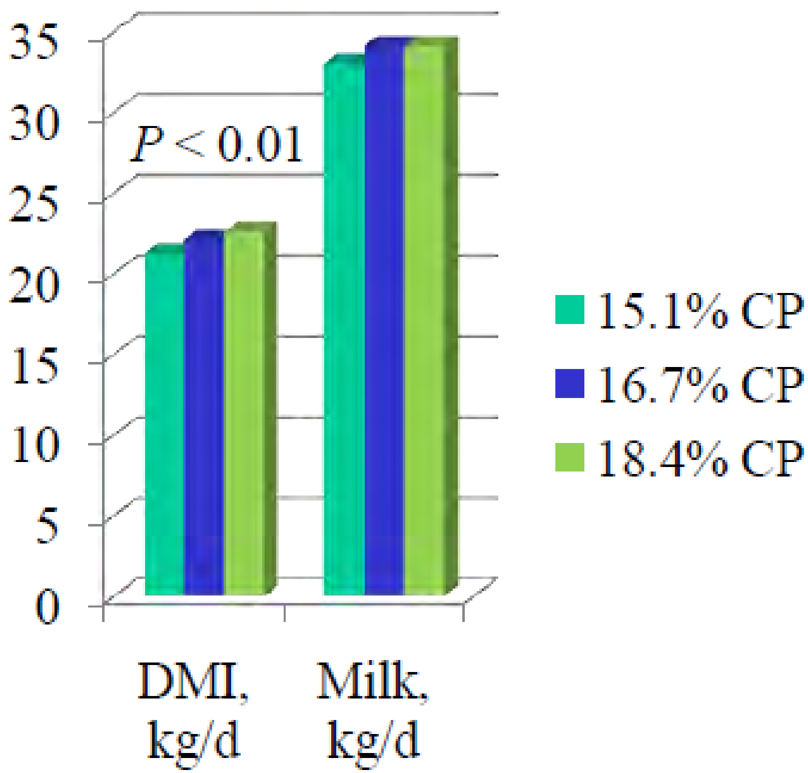
Milk N/Intake N vs. N Intake

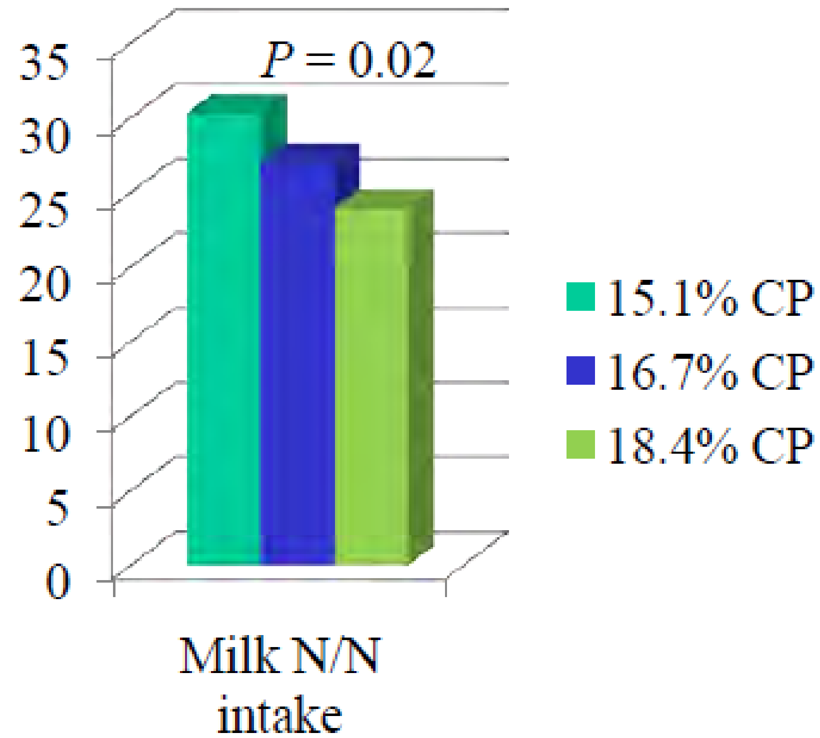


Mills et al. (2009)


The diminishing returns of protein feeding
Milk yield max = 16.7% crude protein
Milk protein max = 17.1% crude protein
85
80
75
70
2.75
2.50
2.25
13
14
15
16
17
18
19
20
Milk yield, lbs/day
Milk protein, lbs/day
Dietary crude protein, % of DM

Effects on DMI

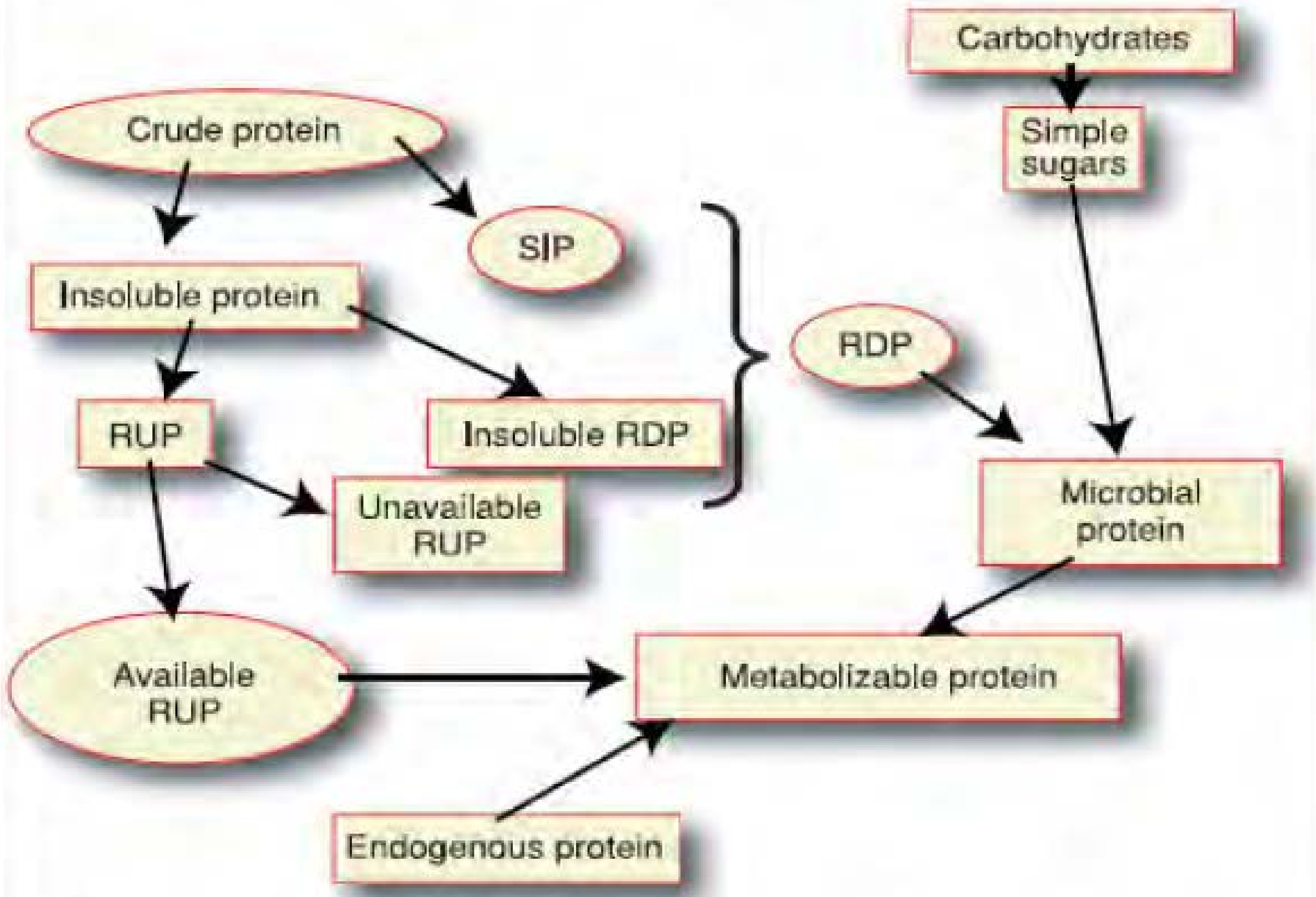




Dietary Protein and Dairy Production

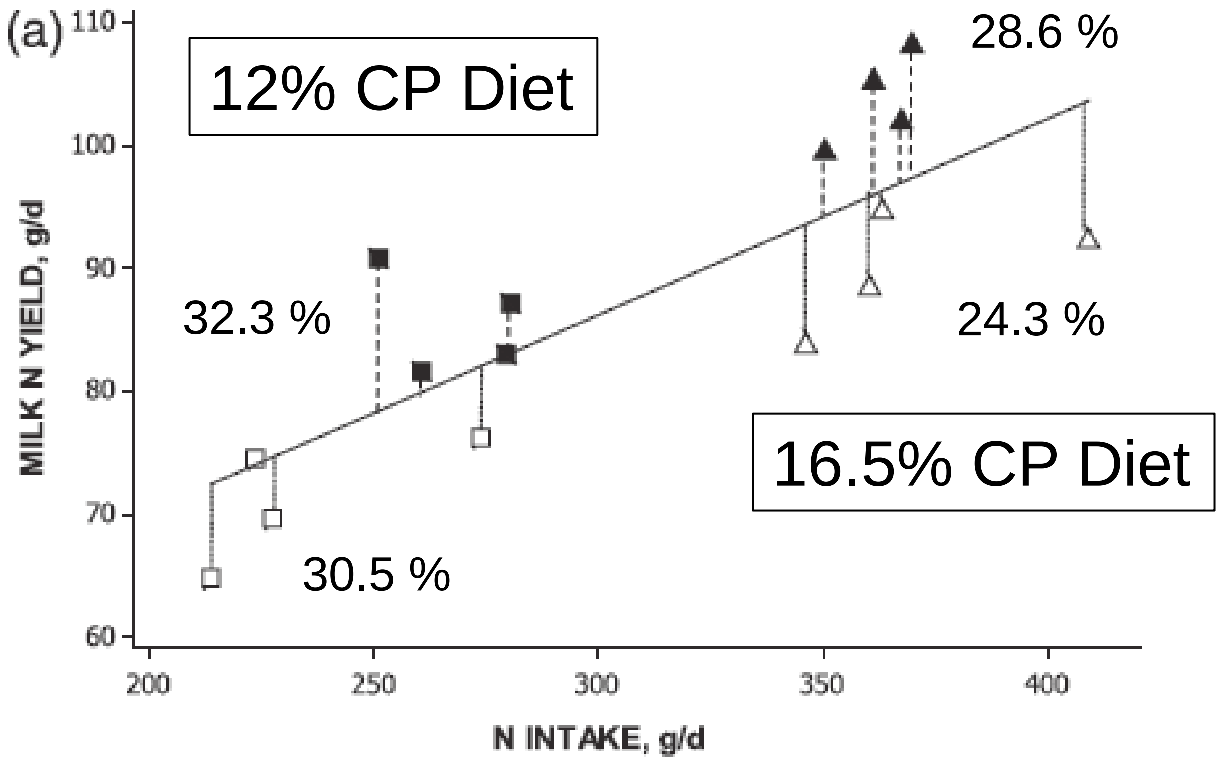
- Numerous (!) studies examining the effect of dietary protein concentration on animal performance
  - Concerns over environmental impacts – lower protein levels
  - With and without changes to dietary energy supply
  - Fermentable energy and metabolizable energy both important
- Short-term, cross over designs, periods of weeks
  - Dietary adaptation – changes to labile protein pool
  - Differential response to dietary protein content
    - Low to high different from high to low
- Recent interest in lower protein diets with rumen-protected essential amino acids
  - Lysine and methionine (also histidine) considered first limiting
  - Metabolic versus digestive effects of protein supply

How cows make metabolizable protein



SIP = Soluble intake protein; RUP = rumen-undegradable protein;
RDP = rumen-degradable protein.

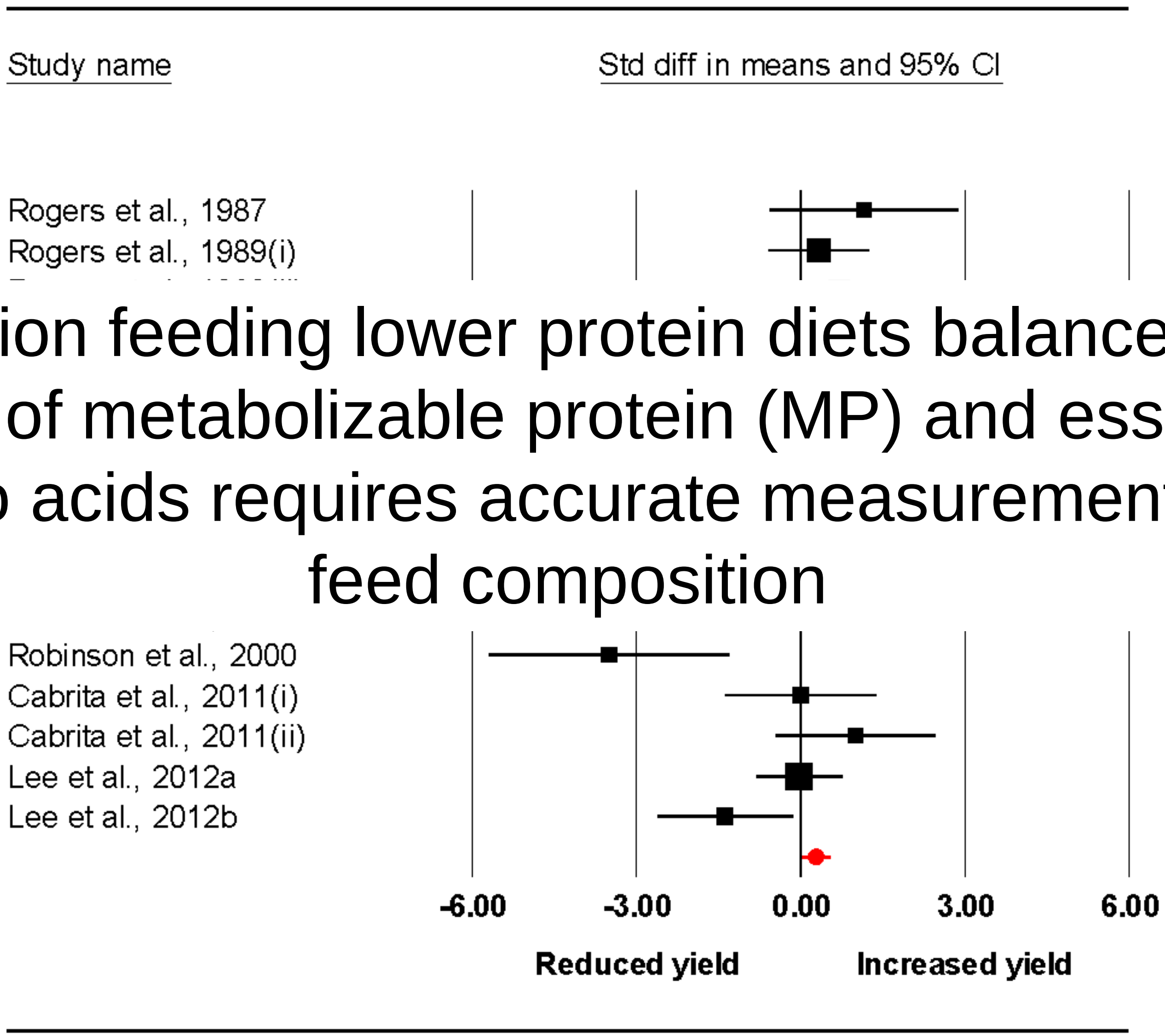
Effect of Higher Starch Diets on N Utilization



11% improvement in N milk / N intake with high starch diets

Using Jersey cows *Cantalapiedra-Hijar et al., 2013.*

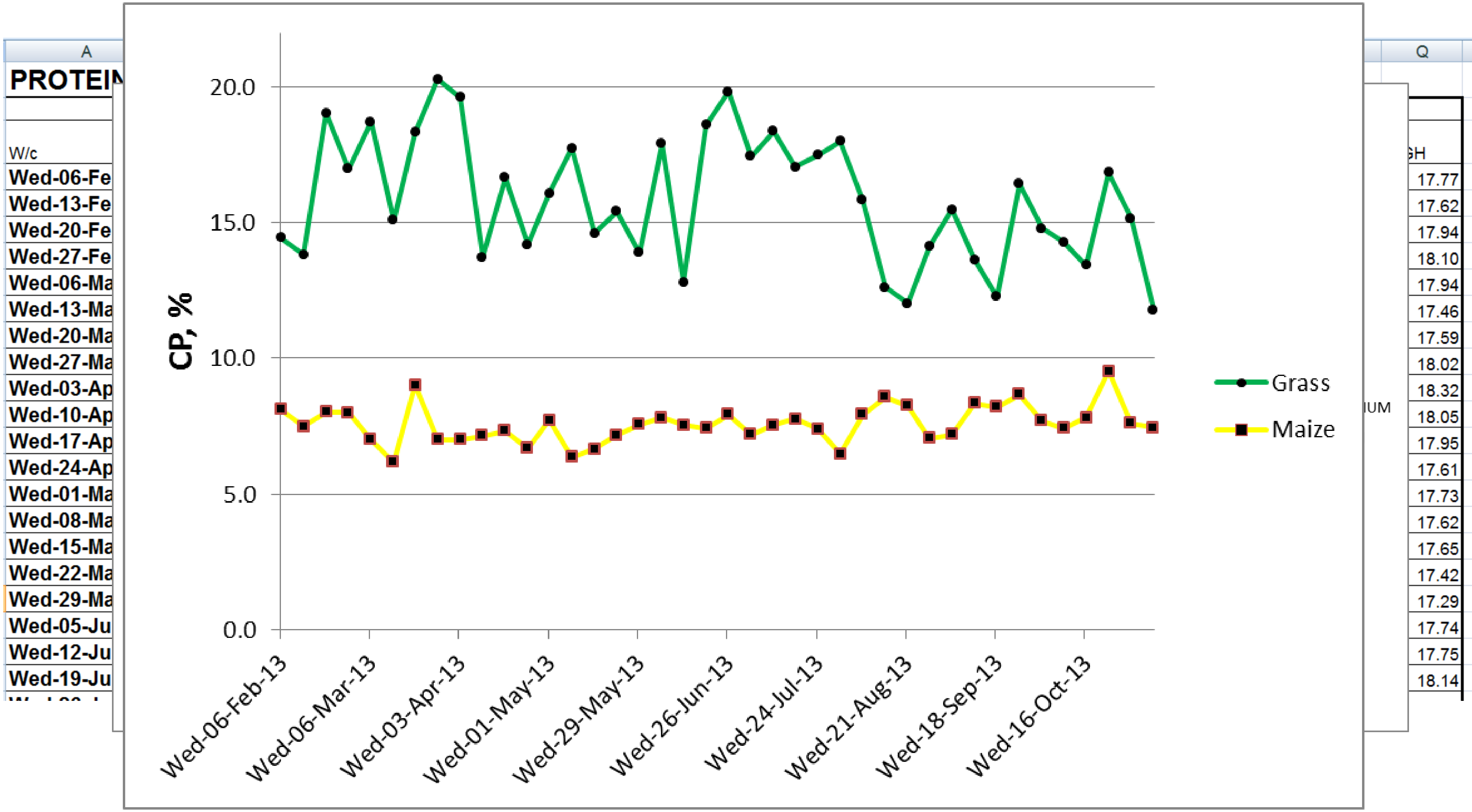
Effect of Rumen Protected Met and Lys on Milk Protein Yield for Diets With Less Than 15% Crude Protein



Precision feeding lower protein diets balanced for supply of metabolizable protein (MP) and essential amino acids requires accurate measurements of feed composition

Sinclair et al in press

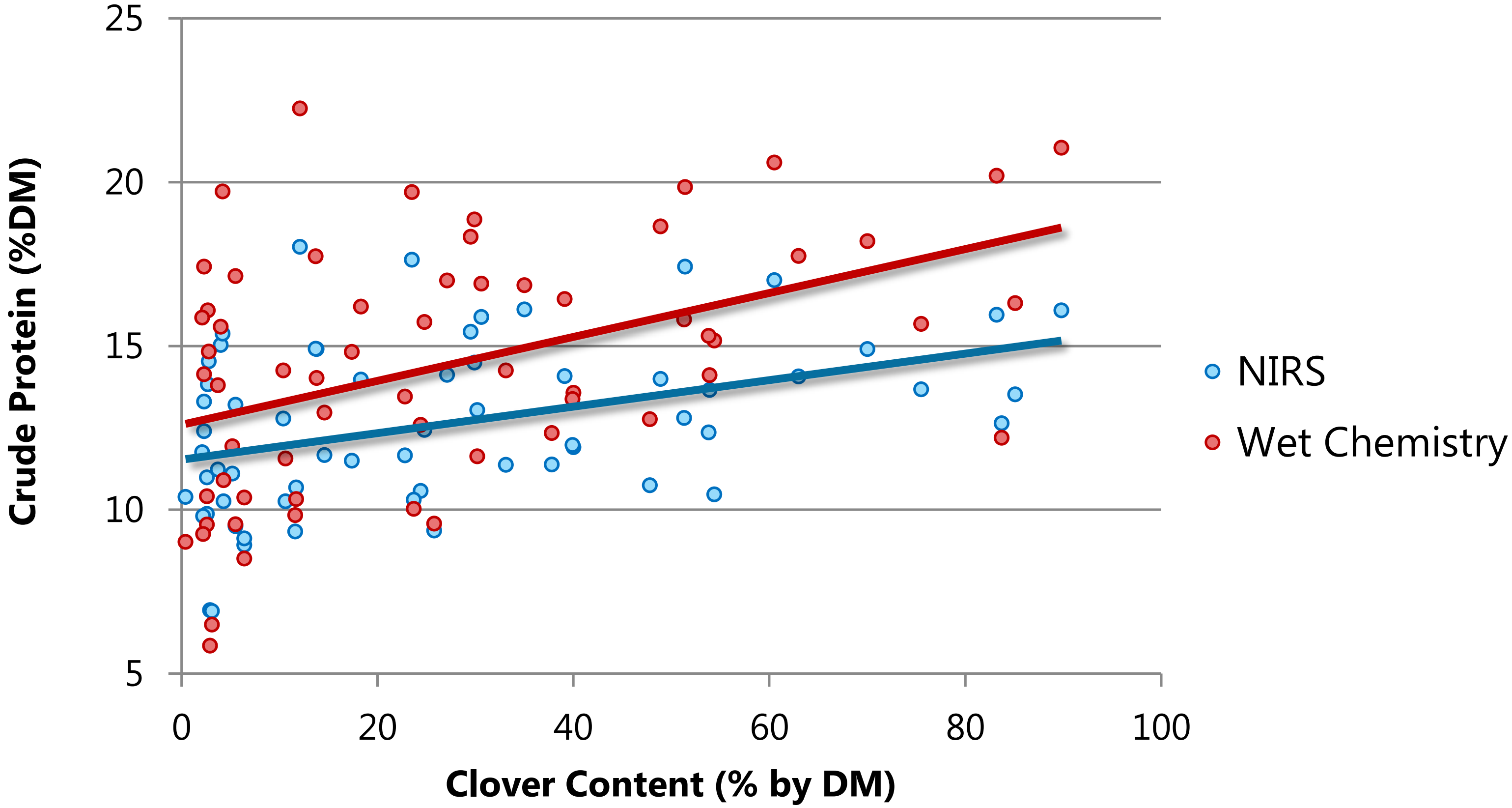
AC0122 – WP Lactation Trial Rolling Average CP Concentrations



2. Take progressively smaller subsamples

AHDB Dairy Grass - Clover Silage NIRS Project

How clover content influences the difference between analyses



Dietary Protein and Dairy Production

- Numerous (!) studies examining the effect of dietary protein concentration on animal performance
  - Concerns over environmental impacts – lower protein levels
  - With and without changes to dietary energy supply
  - Fermentable energy and net energy both important
- Short-term, cross over designs, periods of weeks
  - Dietary adaptation – changes to labile protein pool
  - Differential response to dietary protein content
    - Low to high different from high to low
- Recent interest in lower protein diets with rumen-protected amino acids
  - Lysine and methionine (also histidine) considered first limiting
  - Metabolic versus digestive effects of protein supply

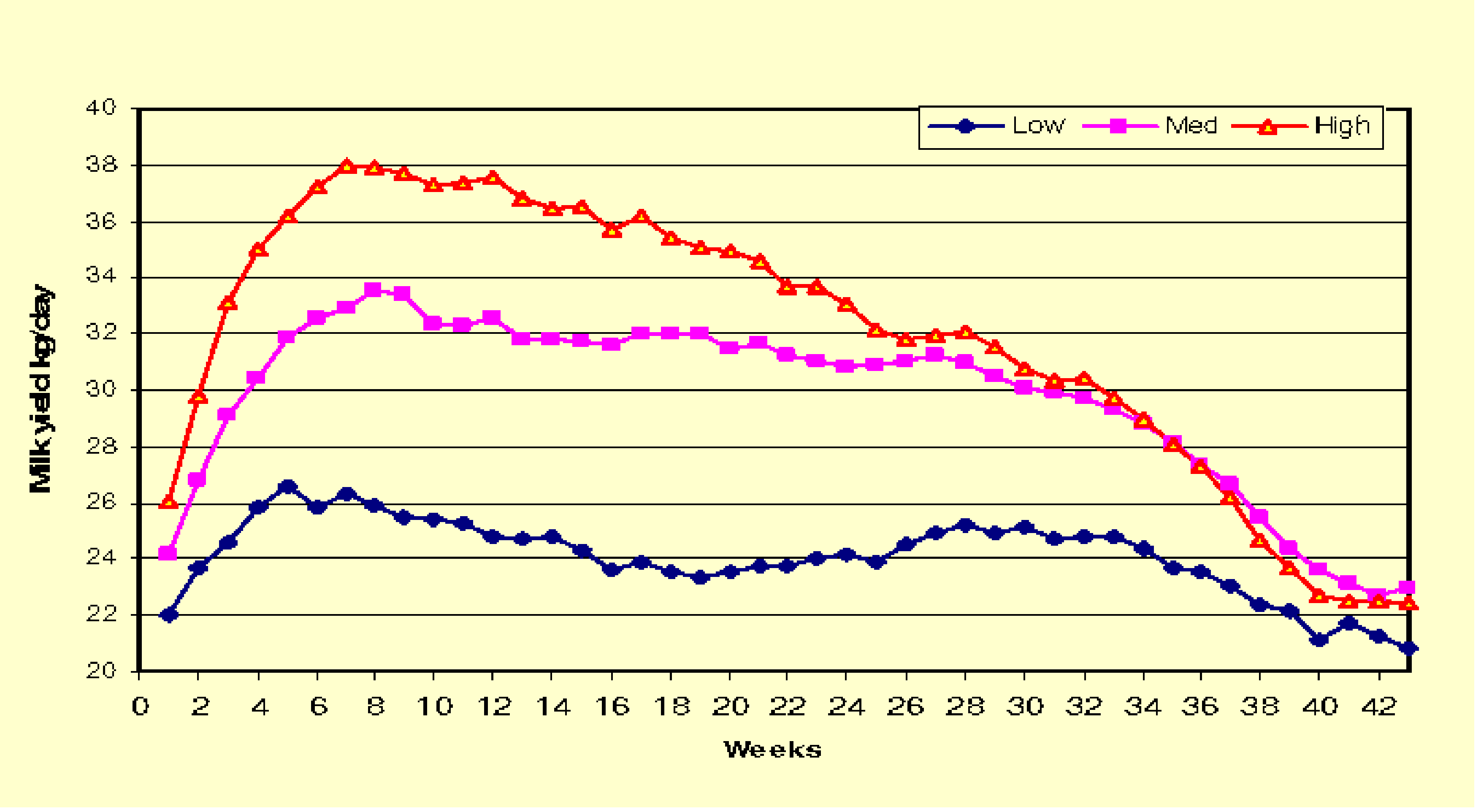
- <u>Long-term studies over an entire lactation(s) lacking</u>

HARPER ADAMS AND NOTTINGHAM UNIVERSITY
AHDB DAIRY FUNDED STUDY

	HAU	NOTTS		Con	LPSE	LPHE
A. Milk yield						
Yield (kg/d)	40.1	**44.2**		42.8	41.3	42.3
Fat (g/kg)	34.6	36.0		34.2	36.6	35.1
Protein (g/kg)	30.4	29.5		29.9	30.0	29.9
Fat yield (kg/d)	1.39	**1.64**		1.49	1.54	1.52
Protein yield (kg/d)	1.17	**1.30**		1.25	1.21	1.25
Urea (mg/dL)	16.3	**20.2**		25.8	**15.1**	**13.5**
Urea (g/d)	6.4	**8.9**		10.9	**6.3**	**5.7**
B. N efficiency (%)						
g milk N/ g N intake	35.1	34.4		31.3	**36.0**	**37.2**

18% CP (Con) or 15% CP with increased starch concentration at 2 levels (LPSE and LPHE)
Maize silage based diets

Effects of Diet Protein Concentration - AFBI Study Over One Lactation



60:40 Grass:maize silage – 12%, 15%, 18% CP diets

Law et al 2009; 2010

Efficiency of Dietary N Utilization for Milk Protein Production

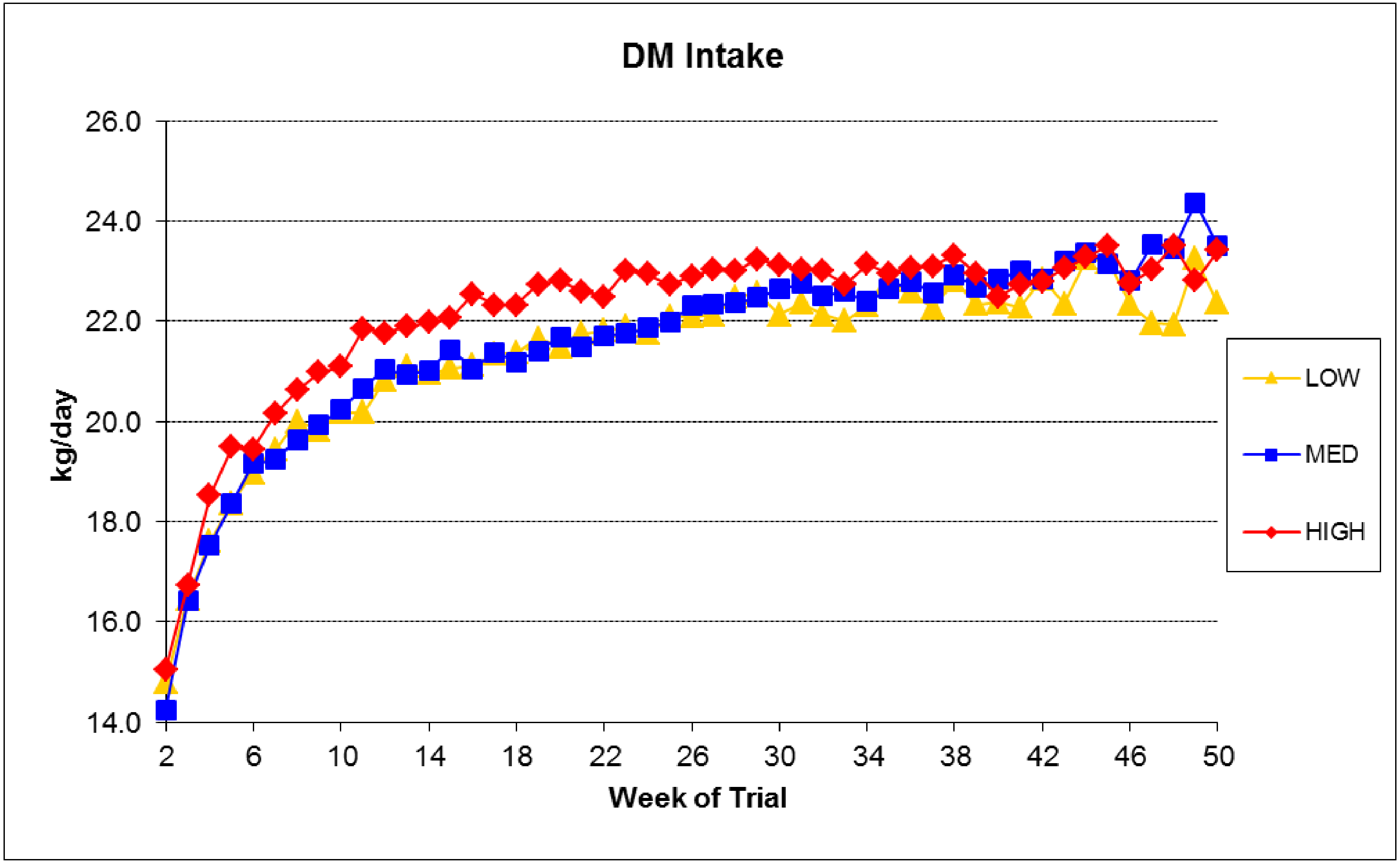
Long term effects???? Defra AC0122

Reading, IBERS, SRUC, Rothamsted

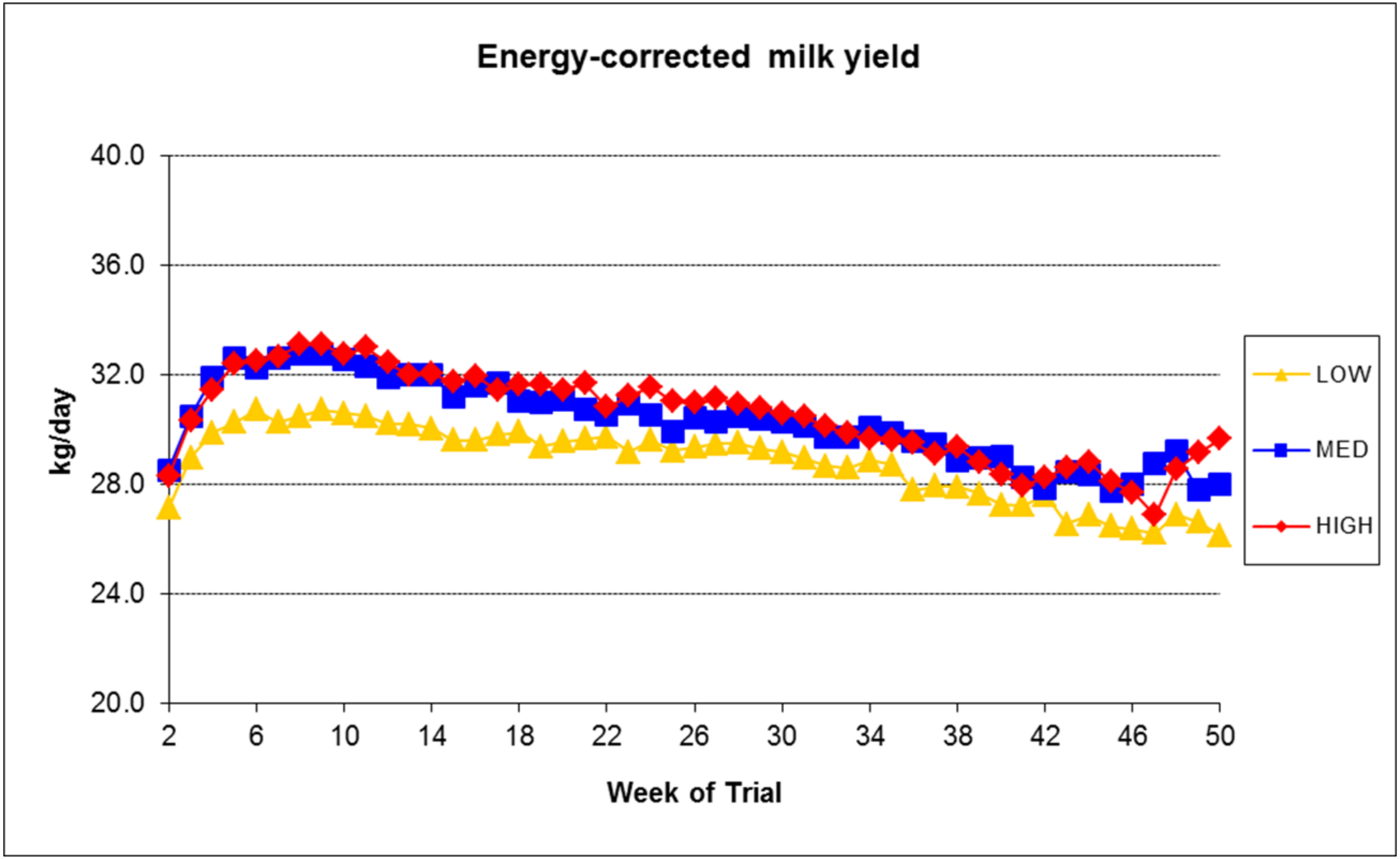
Similar diets – 3 lactations – 210 heifers

DEFRA Project AC0209 – N intakes lower for grass-based ration

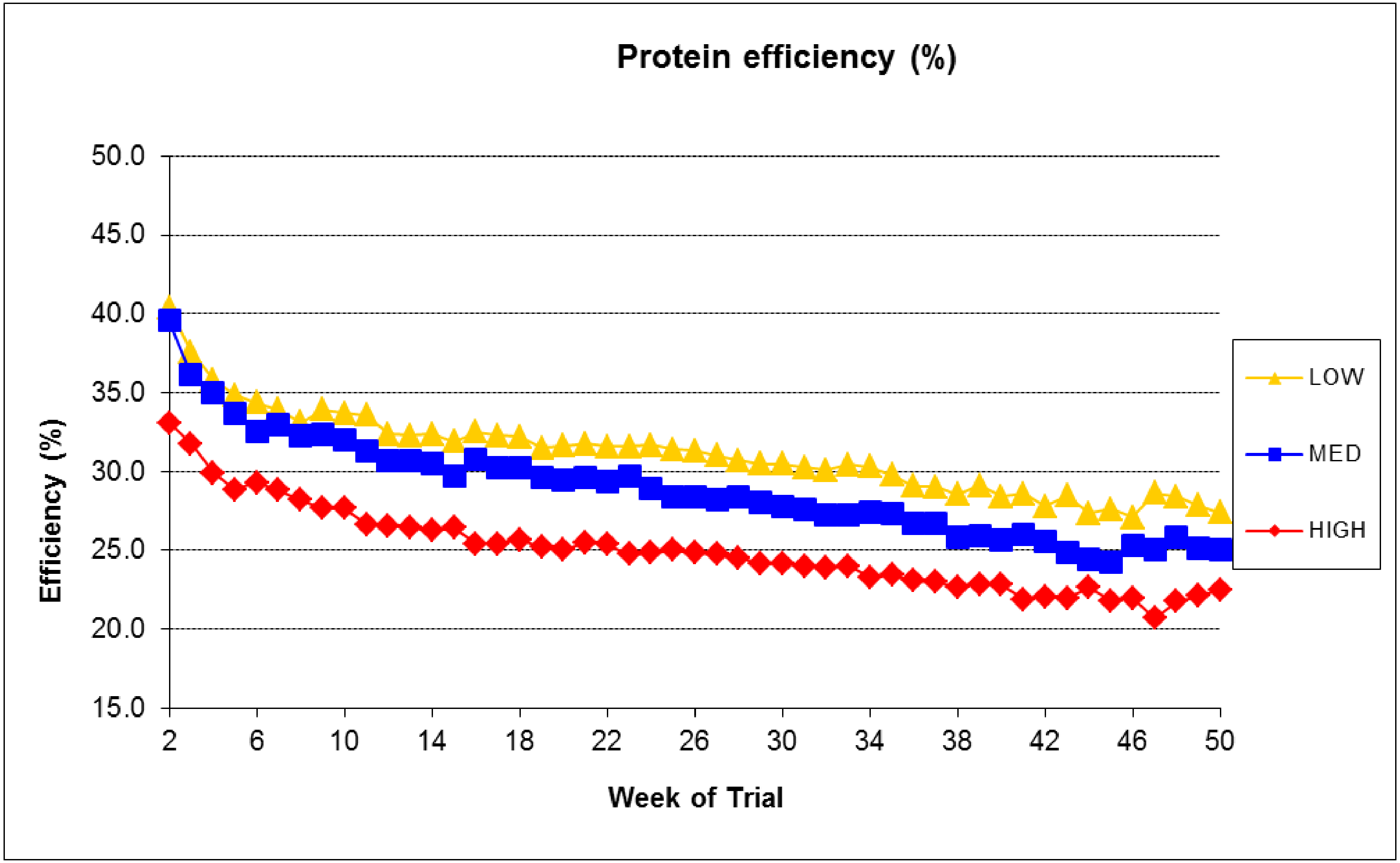
Long-term Study - Lactation 1



Long-term Study - Lactation 1



Long-term Study - Lactation 1



AC0122 - First Lactation Results

- Reductions in milk yield less than expected
  - Heifers vs multi-parous cows
- DMI reduced for lowest protein diet
- Improvements in N use efficiency apparent, but with large animal variation
- Responses in second and third lactation may (will) differ
- Variation in composition of feeds a challenge
- Further analysis of fertility, health, longevity, etc. to come

Why grow legumes as a protein crop?

- Reduced inorganic fertiliser
- Rising cost of bought-in protein

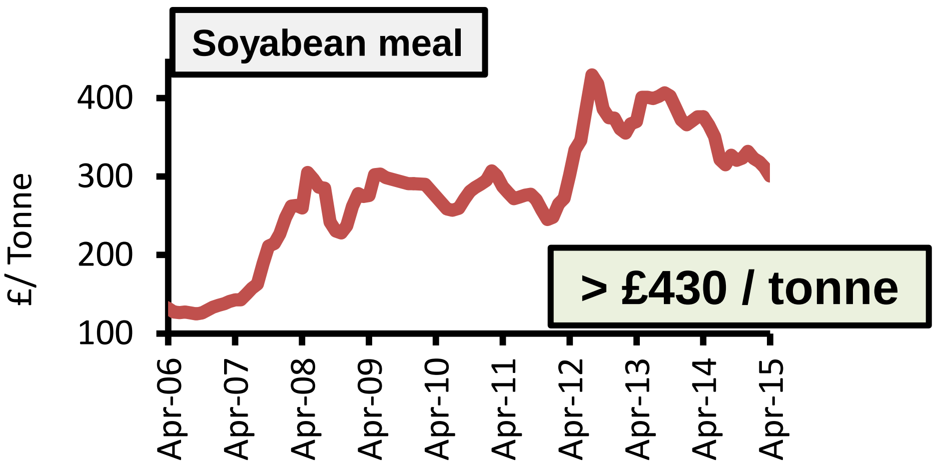
Self reliance

- Helps meet environmental targets
- Potential animal health benefits

Sustainability

- Legume leys can contribute to new CAP requirements
- Legislation on slurry storage and application

Legislation



LIVESTOCK | PROTEIN CROP

Lucerne is now a crucial part of the total mix

Looking for a home-grown protein source that doubles as an option for the CAP three-crop rule? **Gemma Claxton** finds out how lucerne could be the answer

Two years into trialling lucerne and dairy farmer James Foote has successfully reduced his bought-in feed costs by 8.7p a cow a day by producing a quality home-grown protein.

Chynoweth Farm in Truro, Cornwall, currently a DairyCo-BGS demo farm, is putting lucerne research trials into practice in the field.

"Being part of the demo means we've paid more interest in home-grown forage production costings. It's all too easy to become blinkered into dairy and milk production

the high protein and low starch content of lucerne means it complements maize, which is the opposite, and yet they both suit similar growing conditions.

FEED SAVINGS

The 290 head of Holstein Friesians have been housed year round since 2010 after a series of wet years meant they

James (right) and Robert Foote have reduced the amount of bought-in rapeseed and soya by 0.6kg a head.

The introduction of lucerne into the diet has already reduced the amount of bought in rapeseed and soya blend by 0.6kg a head. This equates to a 8.7p a cow a day saving, based on an average

owned and 77ha are on cropping licenses. After trying other home-grown protein sources with marginal success, he believes lucerne is a good option, as it should last for the duration of the tenancy on the rented ground.

"It compares favourably with other high-protein crops such as a lupin cereal mix or clover in terms

Typical Nutritive Value of Silages

	Lucerne	Red clover	Grass	Maize
DM, g/kg	300-500	250-350	250-350	300
Crude protein	190	190	140	80
Fibre				
NDF	440	364	450	400
ADF	350	266	300	230
Lignin	70	41	50	25
Starch/sugars	--	--	20-50	320
ME (MJ/kg DM)	8.5-10.0	10-11	10.5-11.5	10.5-11.5
Calcium	14	14	6	4

Fibre in lucerne:

- High amount of indigestible fibre
- Fibre that is available is digested rapidly

Defra AC0115:
Effects of Biodiverse Forage Mixtures

- Effects of incorporating legumes and tannin-rich species into mixed grass-based swards on methane yield and N balance
- ryegrass
- ryegrass and red clover
- ryegrass and bird's foot trefoil
- ryegrass swards enhanced with a mixture of diverse species

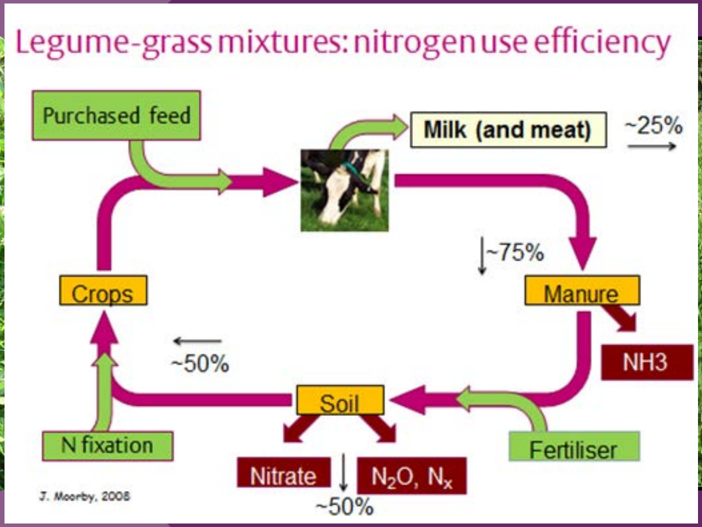

Ryegrass


Clover


Trefoil


Flowers

Diverse forage mixtures to optimise ruminant animal production, nutrient use efficiency, environmental impact, biodiversity and resilience



BBSRC SARIC Project BB/N004353/1

University of Reading, Rothamsted North Wyke, Duchy College, Cotswold Seeds Ltd.

Take Home Messages

- Economic and environmental pressure to reduce dietary protein inputs (especially imported)
- Lower protein diets more ‘efficient’ but need to consider longer term effects at systems level
  - Energy supply key to maximum N use efficiency
- Precision feeding lower protein diets requires accurate feed analysis to minimize yield loss
- Home grown legumes (less fertilizer N) are protein sources that are generally drought tolerant
  - Savings on purchased feed costs

Thank you