



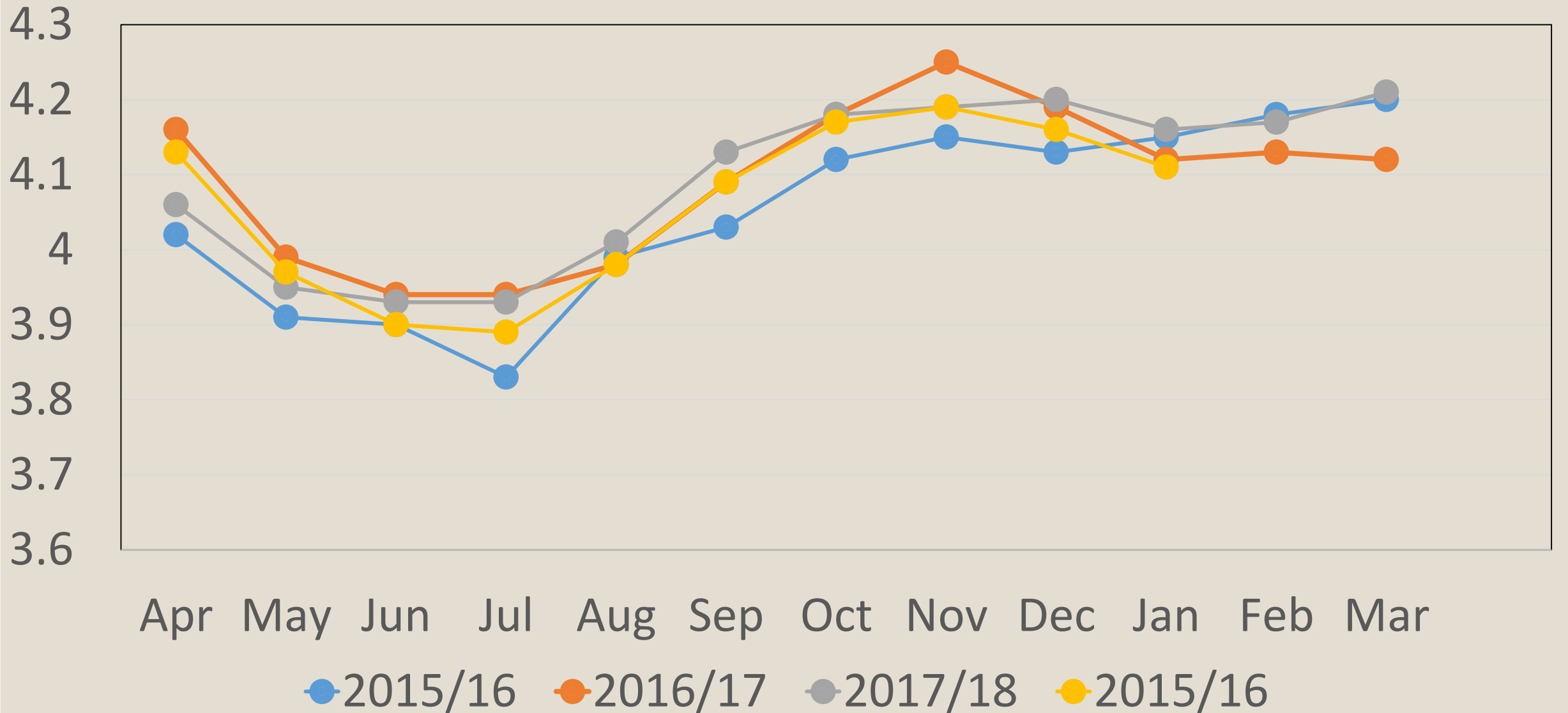
# ‘THE ART OF THE POSSIBLE’ – MANIPULATION OF COWS’ MILK

Dr Michael Rose – Aberystwyth University

# Contents

- Manipulating milk composition in cattle
  - Fat
  - Protein
- Future Foods
  - Who we are
  - Example project

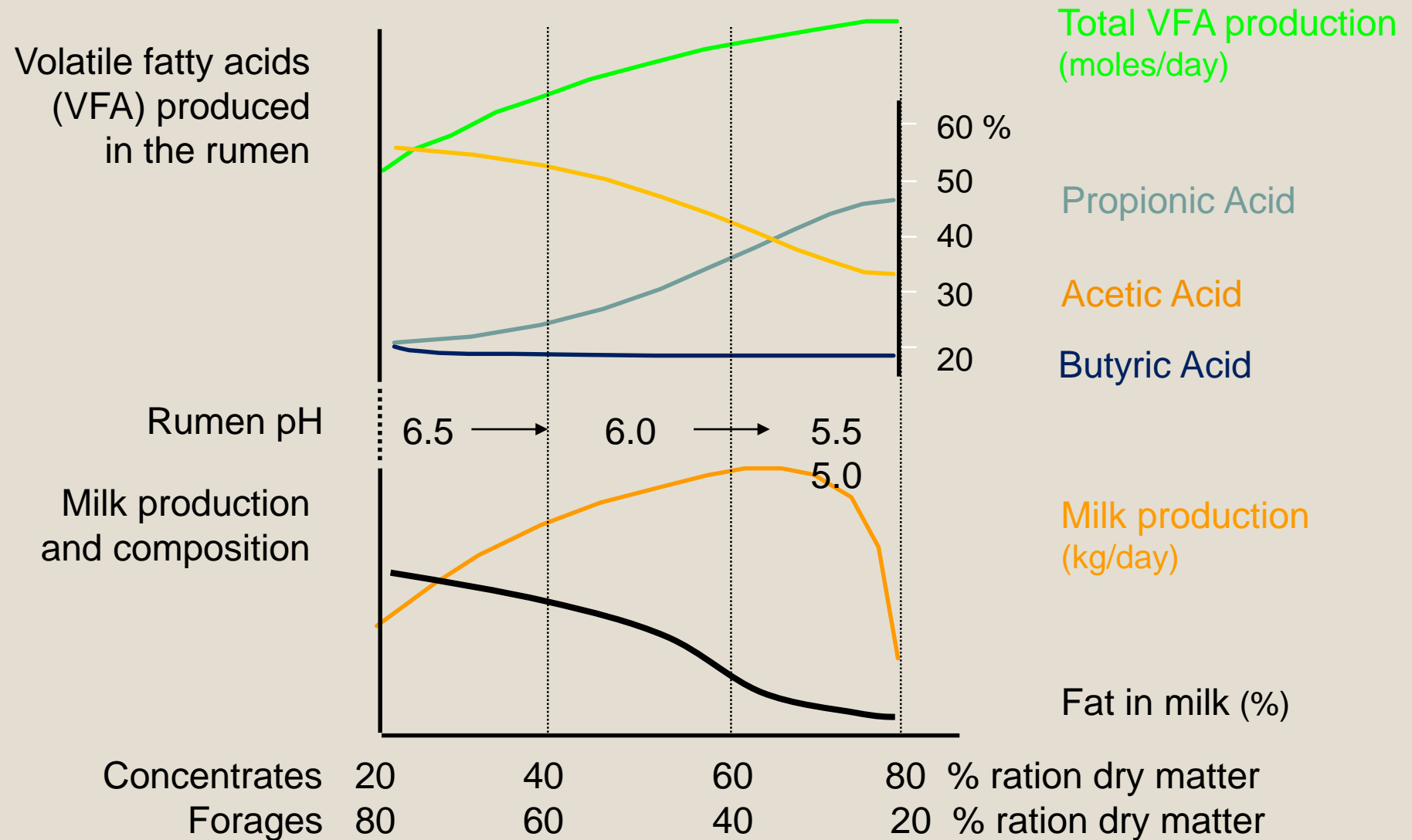
# Fat in Milk (AHDB Dairy – Website)



# Increasing Fat in Milk

- Increasing the forage to concentrate ratio.
- Feeding high fibre forages.
- Providing sufficient long fibre.
- Feeding high digestible fibre concentrates.
- Feeding concentrates little and often
- Avoiding too high levels of oil by-products like distillers grains.
- Avoiding whole oil seeds like full fat soya and whole rape seed.
- Feeding small amounts of a protected fat.

# Milk Fat and forage to concentrate ratio

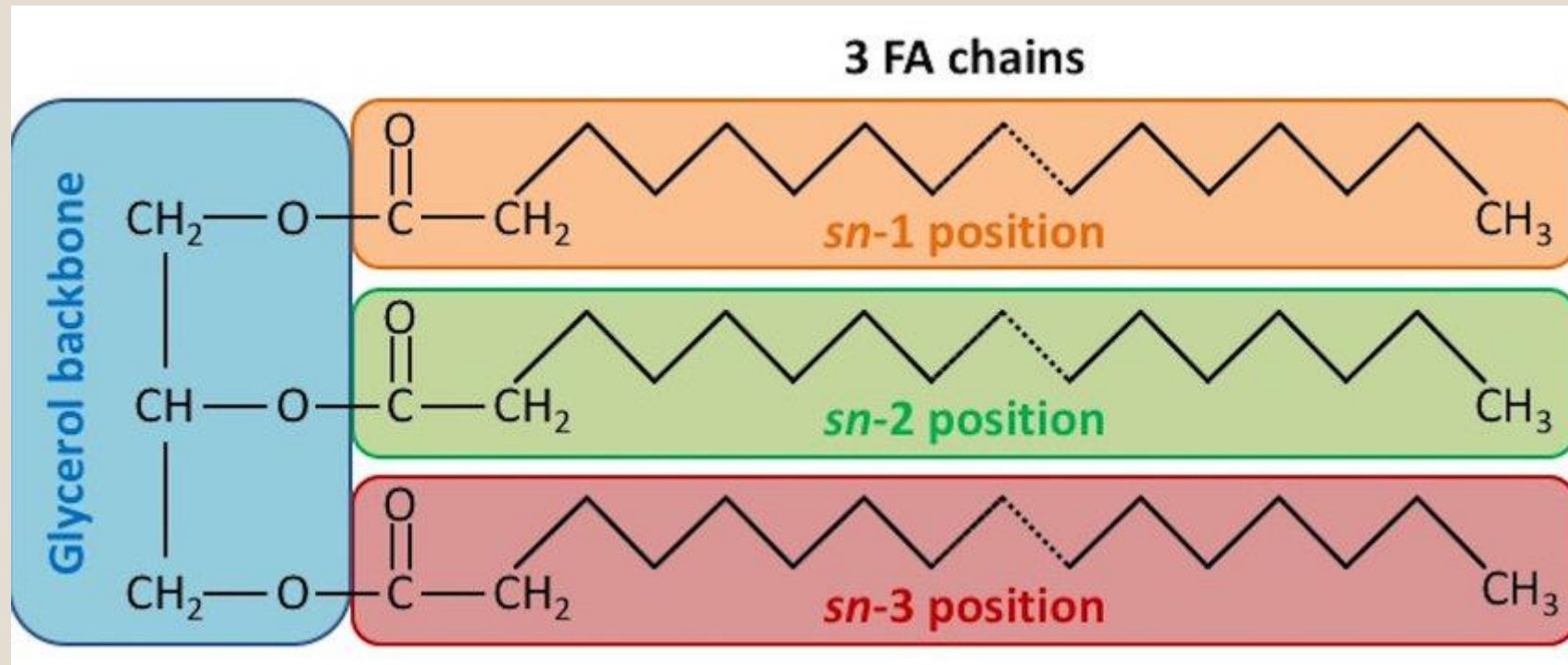


# Reducing butterfat

	Early Lactation		Mid Lactation		Significance (P)
	Control	Oats	Control	Oats	
Milk Yield (kg/d)	22.3	22.4	18.2	17.6	NS
Fat % (g/kg)	3.93	3.76	4.20	3.96	P<0.05
Fat yield (kg/d)	0.876	0.842	0.764	0.697	P<0.05

Source: Fearon *et al.* 1996 J Sci Fd Agri **72**: 273

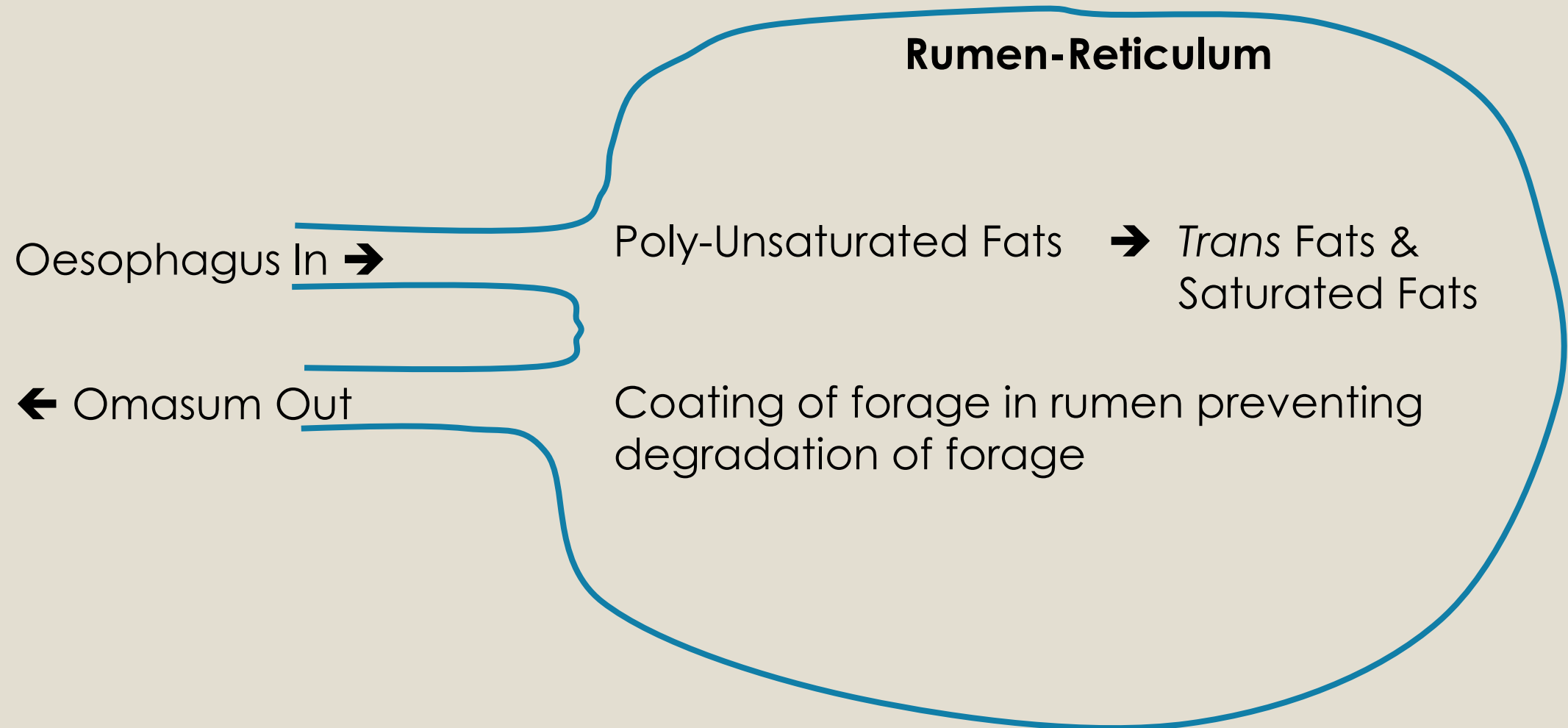
# Milk Fatty Acids: Triacylglycerol



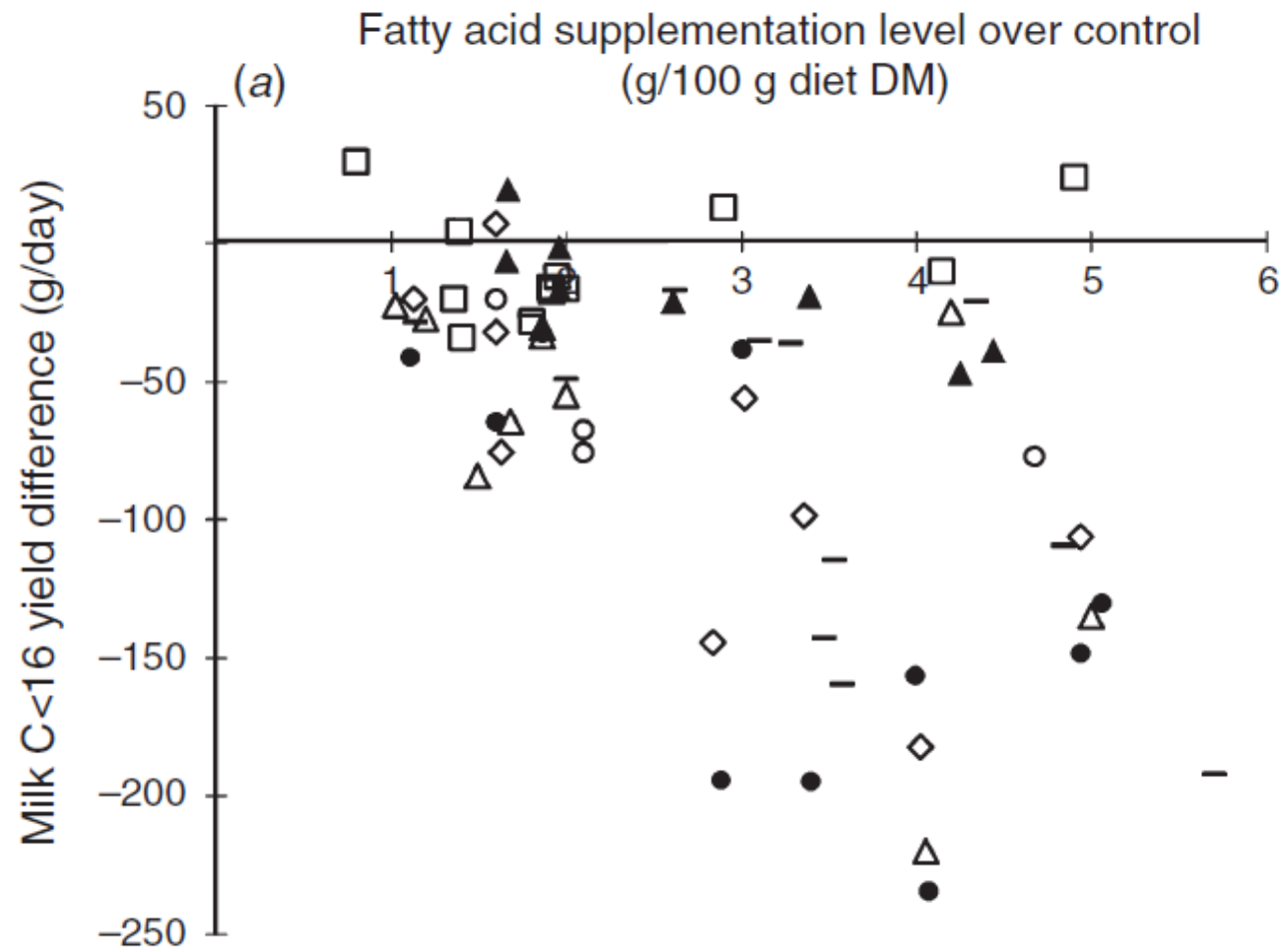
C14:0  
C14:1  
C16:0  
C16:1  
C18:0  
C18:2  
C18:3

Saturated fats and Unsaturated fats

# Unprotected Fat in the Rumen-Reticulum





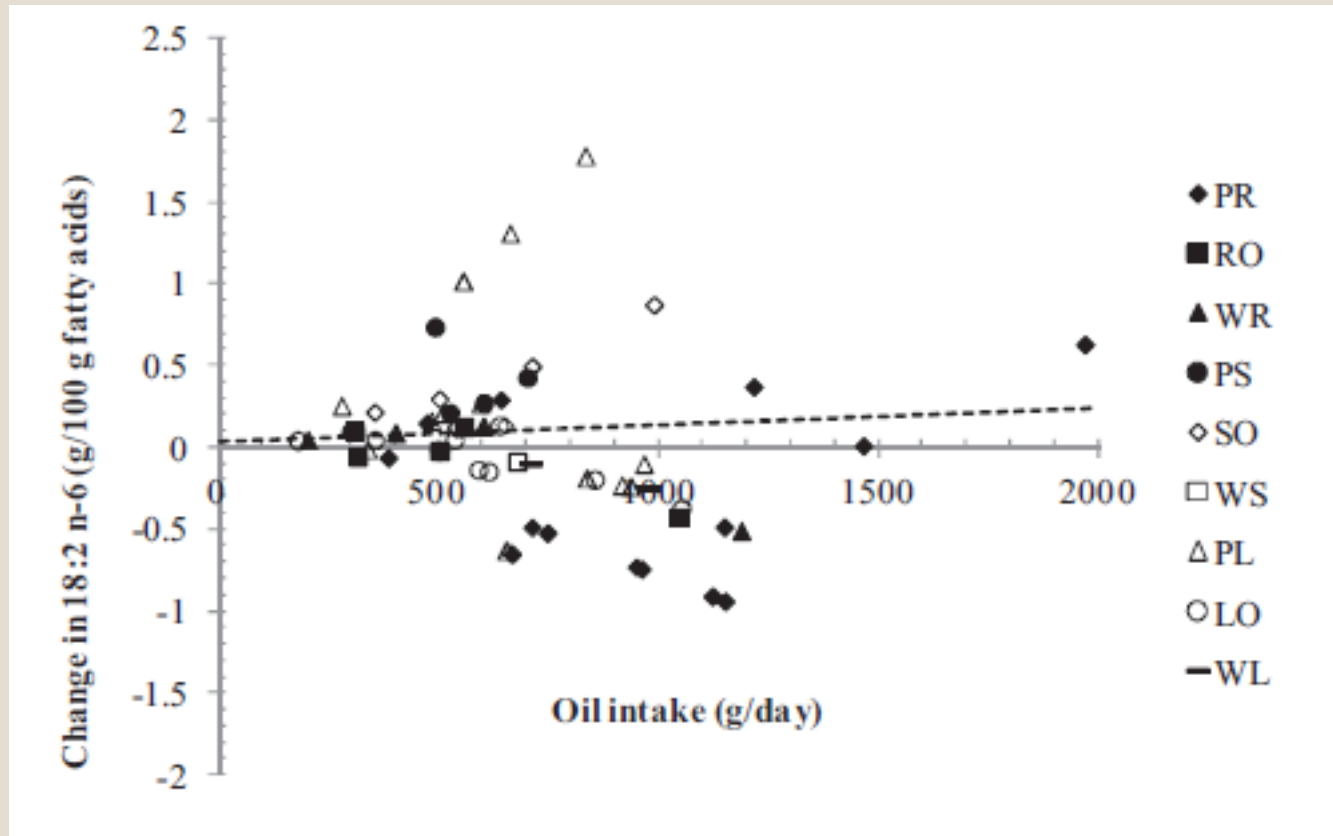


Changes in milk fatty acid yield (over control) in response to supplementing free fats consisting primarily of C16:0 ( $\square$ ), C16:0+C18:0 ( $\blacktriangle$ ), C16:0+C18:1 ( $\circ$ ), C18:1 ( $\diamond$ ), C18:1+C18:2 ( $\triangle$ ), C18:2 ( $\bullet$ ), C18:3 (-).

**Changes in yield of milk fatty acids 14 carbon atoms and less ( $\leq$ C14).**

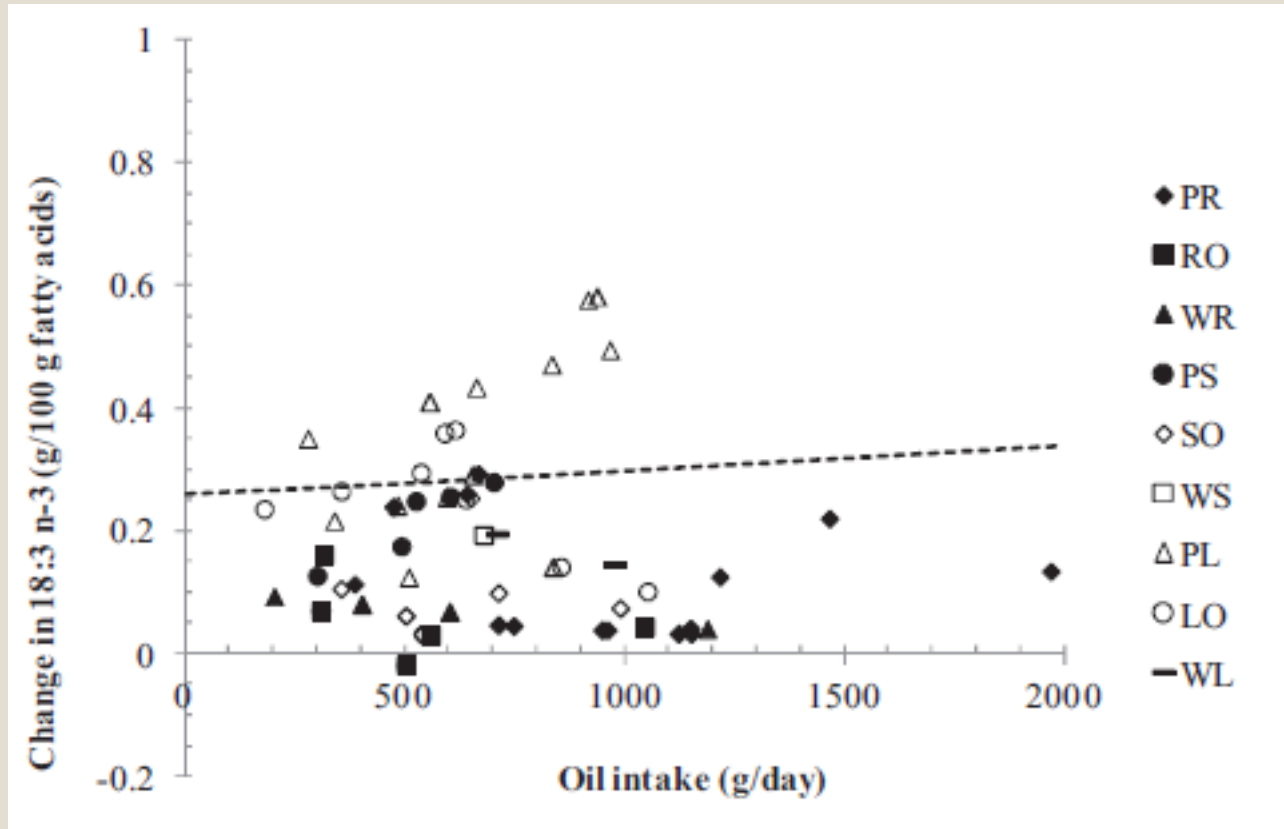
Dorea and Armentano (2017) Animal Production Science 57: 2224

# Supplementing Ruminants with Polyunsaturated Fat Barely Affects C18:2 in milk



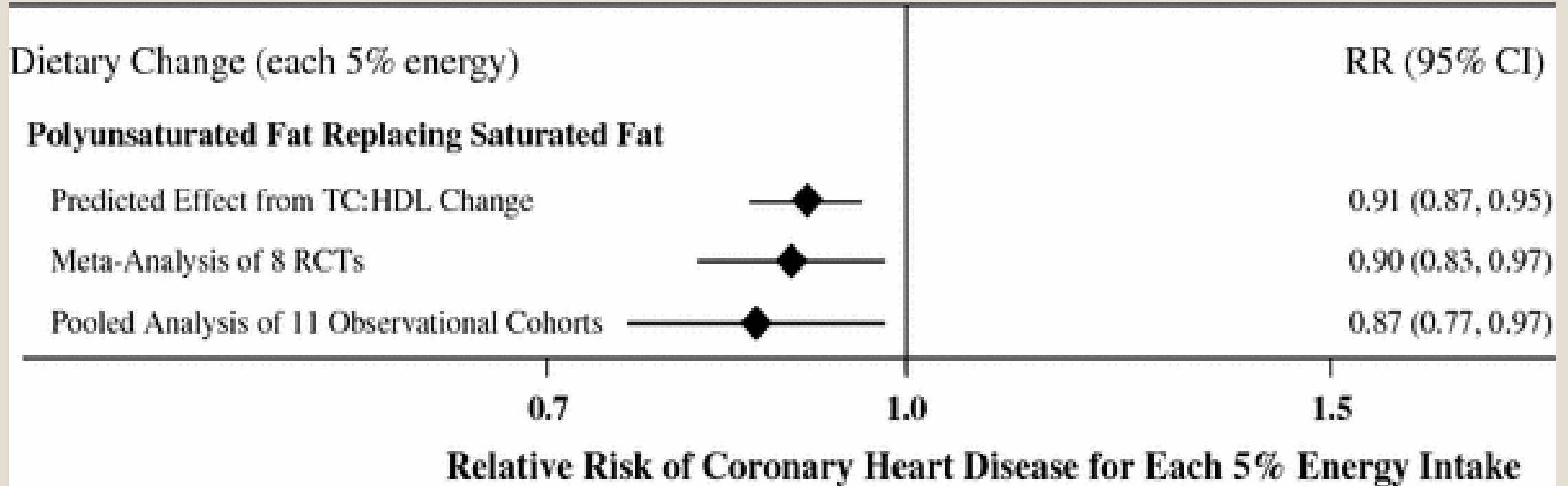
PR, processed rapeseeds;  
RO, rapeseed oil;  
WR, whole rapeseeds;  
PS, processed soyabeans  
SO, soyabean;  
WS, whole sunflowerseeds;  
PL, processed linseed;  
LO, linseed oil;  
WL, whole linseeds.

# Supplementing Ruminants with Polyunsaturated Fat Slightly Increases C18:3 in milk



PR, processed rapeseeds;  
RO, rapeseed oil;  
WR, whole rapeseeds;  
PS, processed soyabeans  
SO, soyabean;  
WS, whole sunflower seeds;  
PL, processed linseed;  
LO, linseed oil;  
WL, whole linseeds.

# Substitution of SFA with PUFA lowers mortality for CVD



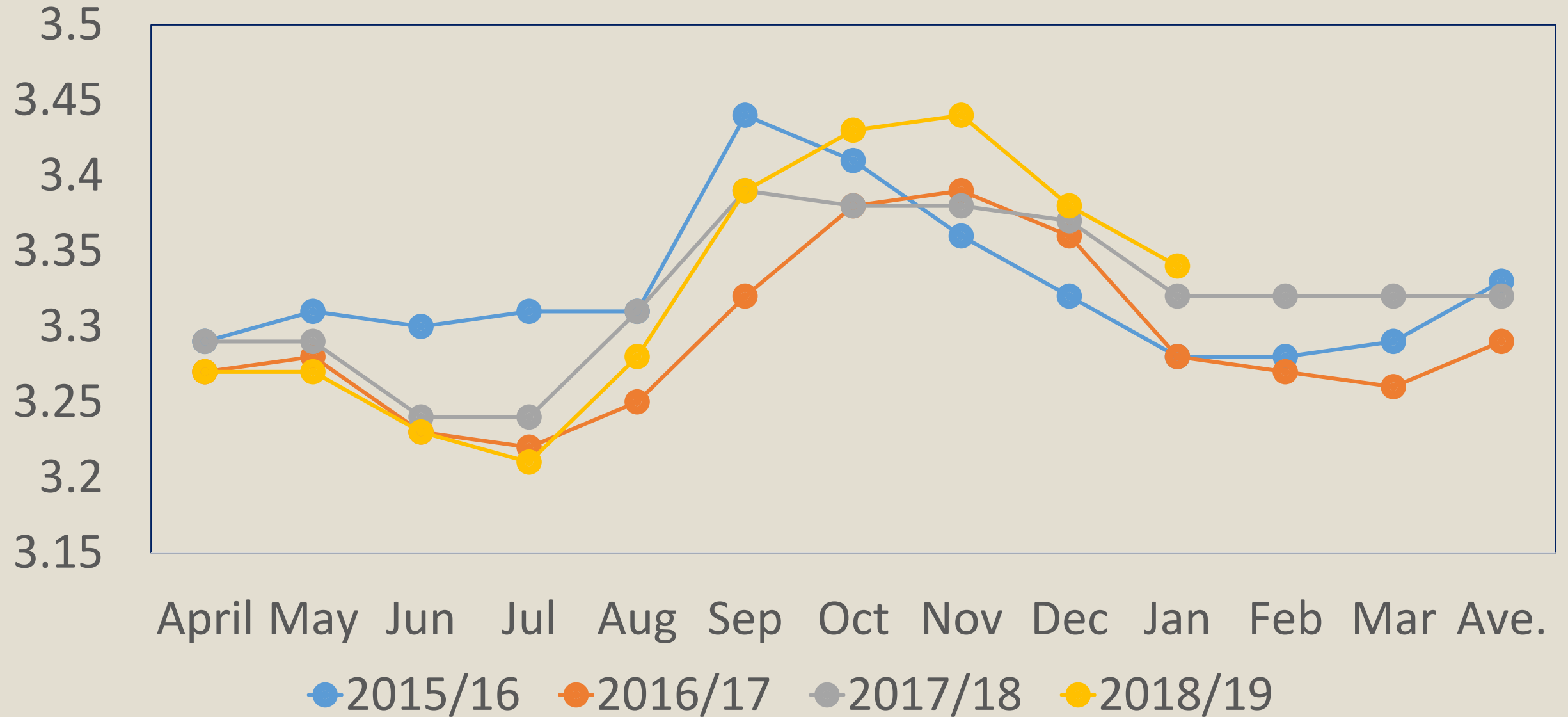
“Calculated” reduction in mortality for CVD by feeding polyunsaturated fats to cattle and increasing PUFA in milk: ~0.3%

Micha and Mozaffarian (2010) *Lipids* **45**: 893

# Summary: Manipulating milk fat/fatty acids

- Total fat in milk relatively easy to manipulate
- Feed fat supplements can be used to alter milk FA composition
  - *Limited contribution to public health policies?*
  - *Clinical data required to establish the effects of altering milk fat composition on human consumers.*

# Protein in Milk



# Nitrogen economy of the lactating cow

**N intake  
~3000 g/d**

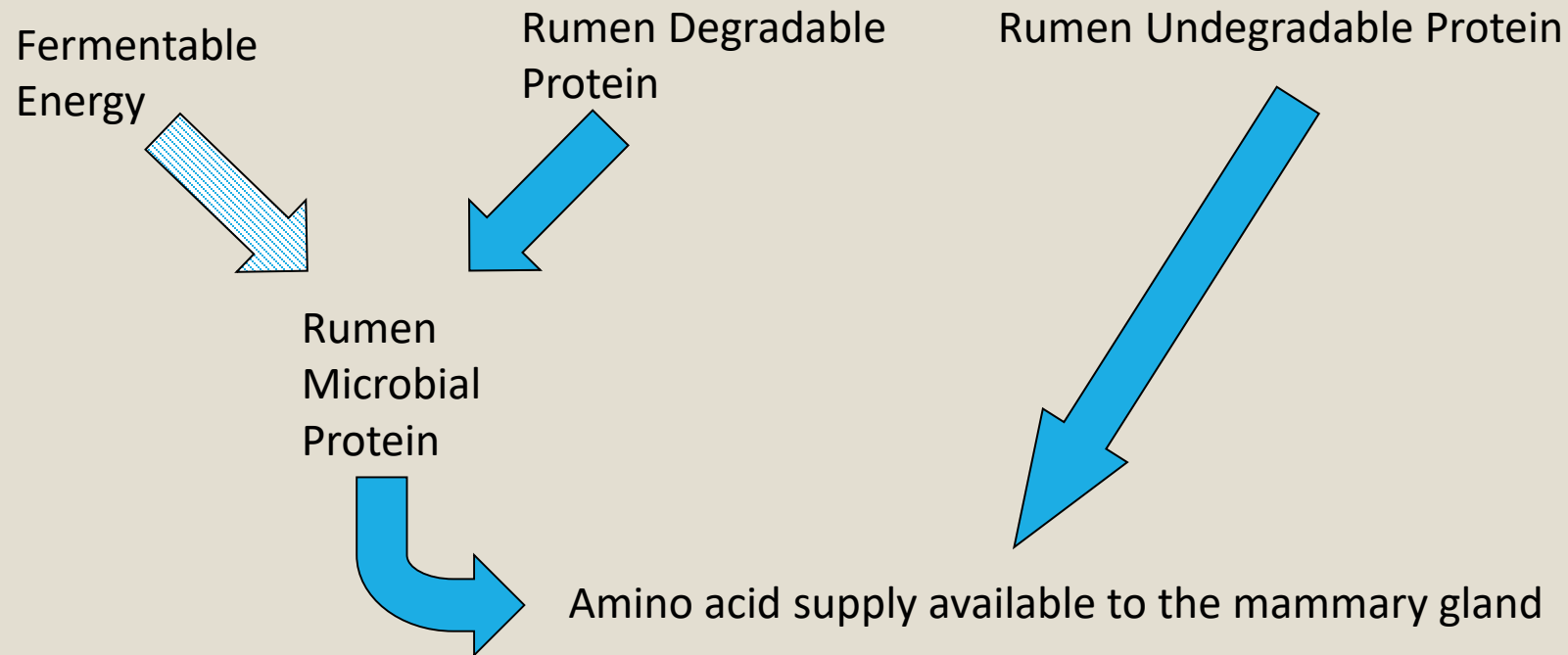


**N Urine 37%**

**N Faeces 33%**

**N Milk 28%**

# Increasing protein supply for milk protein synthesis



- Provision of more fermentable energy  
Especially on silage diets
- Increasing post-ruminal amino acids supply



# Increasing milk protein content

- Increase dietary energy content
- Increase dietary starch content

} ↑ Microbial protein supply

- High ME silages of high intake potential
- Mixture of forages
- Calving management

} Maximise feed intake

- Increase rumen undegradable protein supply or sources of rumen protected amino acids - responses are variable

} ↑ Amino acid supply

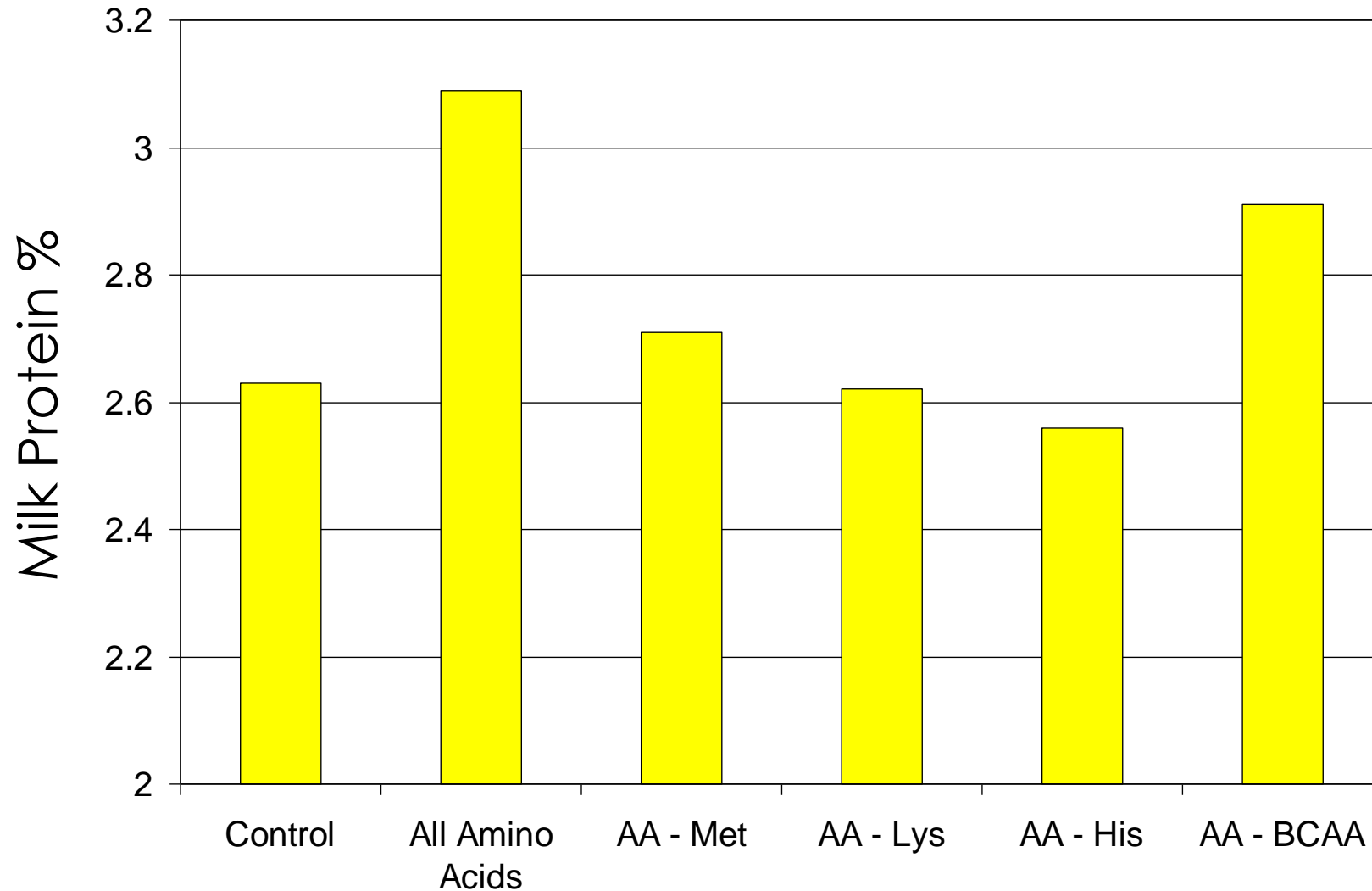
# Biological value (relative to Milk Protein)

	His	Phe	Leu	Thr	Met	Arg	Val	Ile	Trp	Lys
Microbial Protein	90	97	54	100	97	79	66	61	99	100
SBM	89	100	56	74	56	89	60	55	75	70
MGM	67	100	100	60	100	36	48	40	30	18

$(\text{aa in feed protein kgDM}^{-1} / \text{aa in milk kgDM}^{-1}) \times 100$

Santos, F.A.P. *et al.* (1998) Effects of UDP on dairy cow performance: A 12 year literature review.  
*Journal of Dairy Science* 81: 3182

**Milk protein content of cows fed a low protein diet (Control), infused with all amino acids, or all amino acids minus one or several (Weekes et al. 2006; JDS 89:2177)**



## Aberystwyth University & BIC Innovation Collaborative Project

**IBERS**

Athrofa y Gwyddorau Biolegol, Amgylcheddol a Gwledig  
Institute of Biological, Environmental and Rural Sciences

PRIFYSGOL  
**ABERYSTWYTH**  
UNIVERSITY

  
**bicinnovation**  
believeinchange

 UNDAE EWWROPAID  
EUROPEAN UNION  
 Llywodraeth Cymru  
Welsh Government  
**Cronfa Datblygu  
Rhanbarthol Ewrop  
European Regional  
Development Fund**



Cefnogir gan  
**Lywodraeth Cymru**  
Supported by  
**Welsh Government**

***“Delivering world class expertise ... to ambitious Welsh-based food businesses seeking to develop healthy, market-creating products targeted at UK and international markets.”***

Tailored Support:

- *Collaborative R&D (More than one beneficiary)*
- *Effective Commercialisation*
- *Sustainable Growth*

Goal:

- *Improve competitiveness*
- *Underpin future growth and sustainability*



# FutureFoods

Collaborate to Succeed | Cydweithio i Lwyddo



**Professor John Draper**  
*Diet, health and metabolomics*



**Dr Mike Rose**  
*Dairy systems and Milk Quality*



**Professor Alison Kingston-Smith**  
*Genetic x Environment interactions*



**Rattan Yadav**  
*Millet Breeding*



**Dr Christina Marley**  
*Animal Systems and meat products*



**Dr Gordon Allison**  
*Chemotyping and biochemistry for food products*



**Dr Jon Moorby**  
*Dairy systems and milk quality*



**Hilary Worgan**  
*Technical Management & Gut Microbiology*



**Dr Danny Thorogood**  
*Plant genetics and heritage products*



**Alan Gay**  
*Phenotyping and hyperspectral analysis for foods*



**Dr Rhys Thatcher**  
*Interactions between diet and exercise on human health*



**Dr Ana Winters**  
*Crop Biochemistry and Processing*



**Dr Matt Hegarty**  
*NGS for provenance and genome selection*



**Dr Joe Gallagher**  
*Biorefining for food additives and microbiology*



**Dr Dylan Jones**  
*Horticultural development and the environment*



**Manfred Beckmann**  
*Biomarkers*

Campws Arloesi a  
Menter Aberystwyth

Aberystwyth Innovation  
and Enterprise Campus



## Opening in 2020 £40.5m 'development hotel'

**For ambitious companies** to develop their products and services in **food and drink, biorefining, industrial biotechnology and agri-tech sectors.**



- Facilities, equipment and access to academic experts
- Support and advice on growing your business and applying for grant funding.
- Acceleration of your innovation and R&D in a low risk development environment.



Campws Arloesi a  
Menter Aberystwyth



Aberystwyth Innovation  
and Enterprise Campus



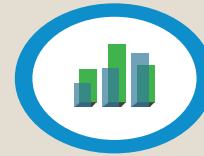
### Future Food Centre

*Meat, dairy and liquids processing  
Packaging and storage facilities  
Food quality testing laboratories  
Microbiology laboratories  
Sensory Testing Suite  
Demonstration Kitchen*



### Bioprocessing Centre

*Primary processing room  
Downstream processing unit  
Fermentation unit  
Industrial Biotechnology Unit  
Bioprospecting Area  
Synthetic Biology incl. Robotics  
Low Carbon Laboratory*



### Analytical Science Centre

*Bioprospecting Area  
Extraction facilities  
LC-MS and HPLC Laboratories  
Gas Chromatography Room  
Microbiology Laboratories  
Clinical trials capabilities  
Data Processing Suite*





# Eligibility criteria for Future foods

- Are you an SME located in, or have links with the West Wales & Valleys Convergence region?
- Have 10+ employees or on an accelerated growth programme?
- Have a feed or food product or concept for research and development?
- Then please contact the project manager for further discussion:
- Hilary Worgan [hjw@aber.ac.uk](mailto:hjw@aber.ac.uk)
- [www.futurefoods.wales](http://www.futurefoods.wales)



# Exemplar project - Dairy as a delivery method for plant-based bioactive extracts

## Plant extract (Q)

- Bioactive
  - Arthritis
  - Gut Health



Q?  
Q?  
Q?  
Q?  
Q?  
Q?



## Dairy medium

- Extract (Q) in food
- Bioactive?



# R&D Partnership: Functional Food?

## Collaborative R&D for Functional Food Product

- Test batch manufacturing
- Food composition analysis (stability, consistency)
- Consumer acceptability
- Plan pilot clinical trial to evaluate health benefits
- Raising investment for clinical trials



## Clinical Trial of Enhanced Dairy Product

- Test for compliance in food interventions
- Bioavailability assessment
- Health and well-being benefits/claims
- Physiological, metabolic & body composition benefits/claims



# Summary

- Manipulating total milk fat in cows relatively easy
  - Fatty acid composition of milk more difficult
- Manipulating total protein difficult
- Future Foods / Innovation Campus