



**Harper Adams
University**



ROTHAMSTED
RESEARCH

Development of plants with improved composition for animal nutrition, product quality and environmental footprint – successes and opportunities

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Plants as Feed – Not a balanced Ration

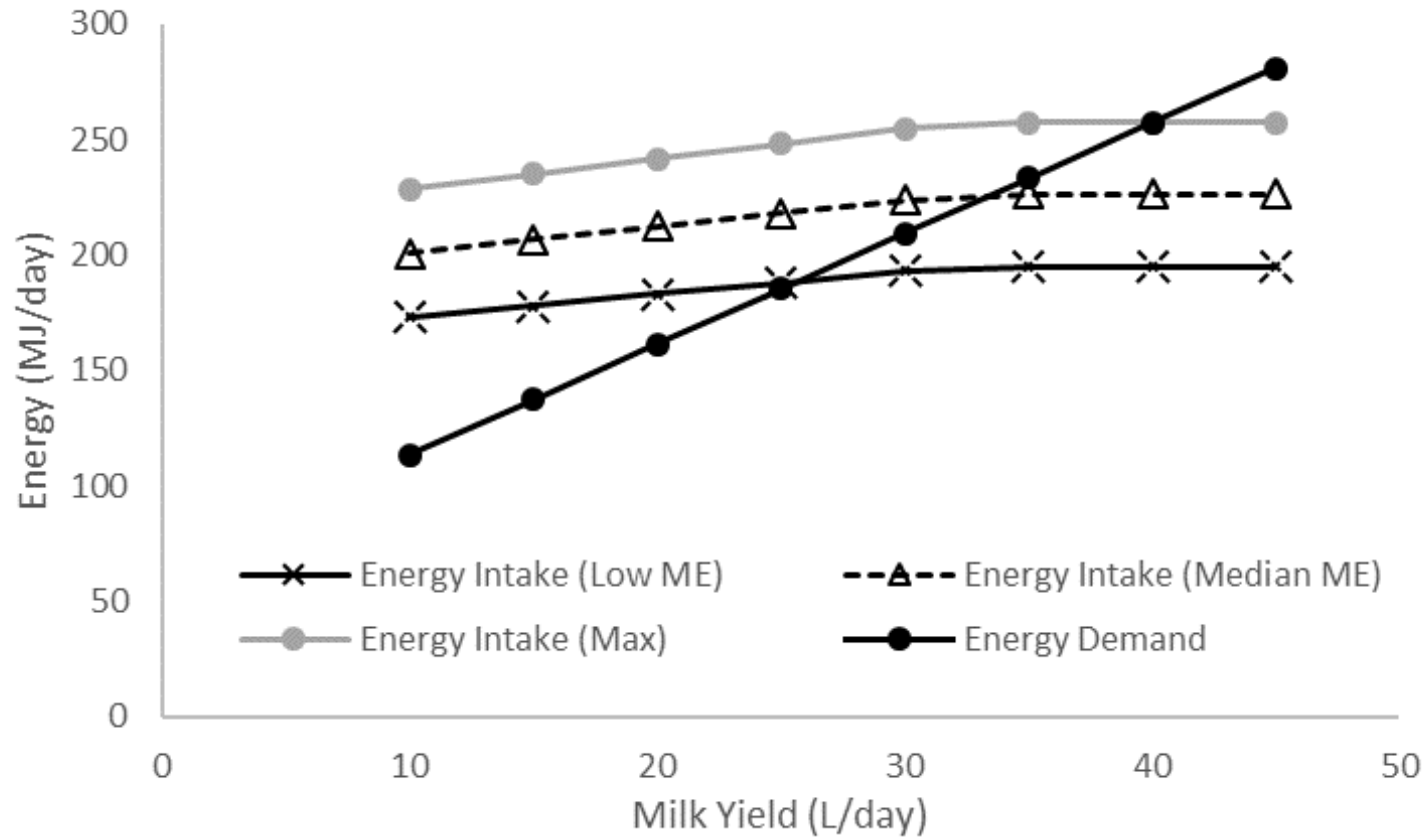


- What do we ration for:
 - Energy
 - Water-soluble carbohydrate
 - Fibre
 - Lipid
 - Protein
 - Minerals and Vitamins
 - Omit Anti-nutritional factors



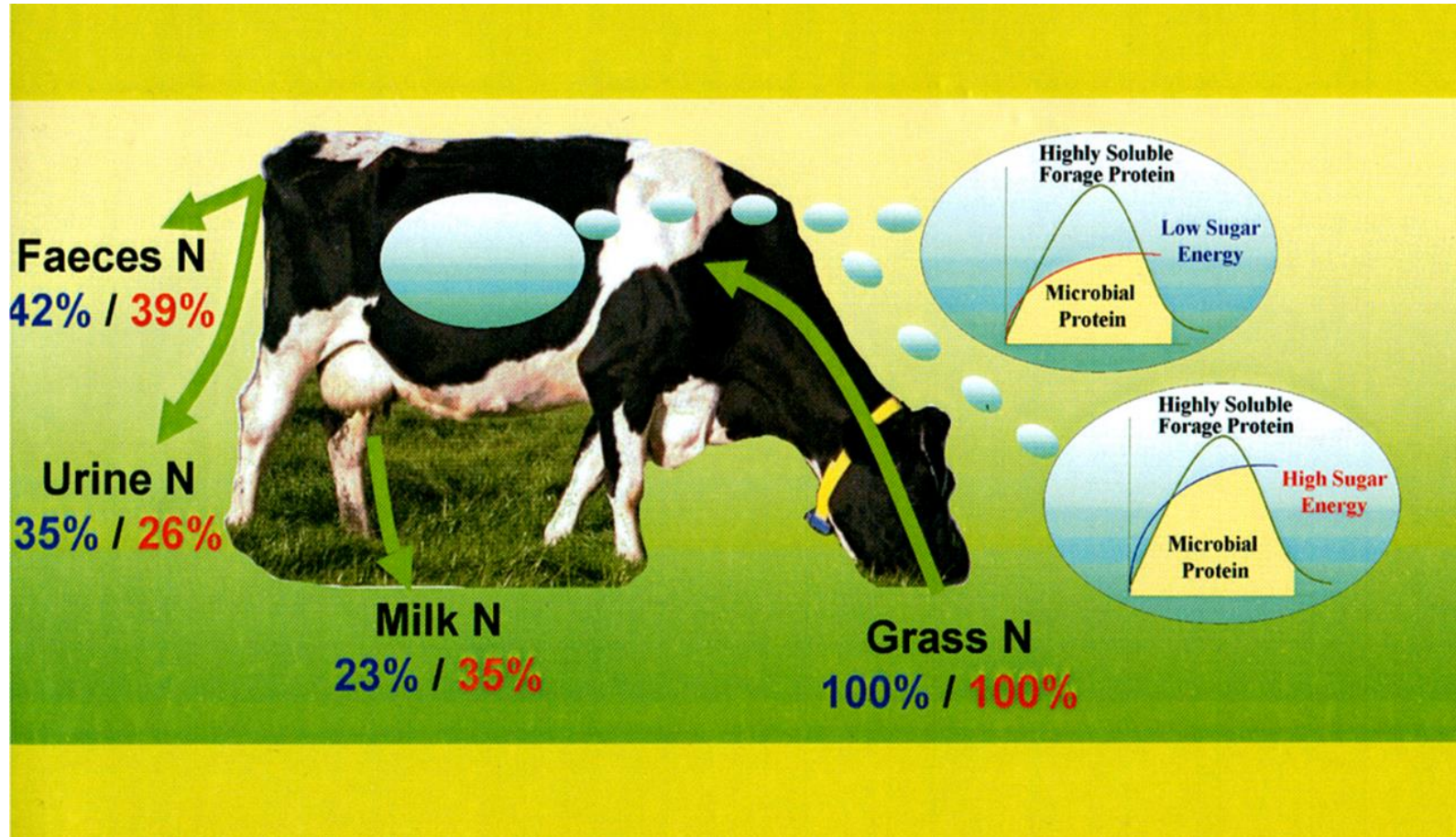
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Improving NUE - WSC success

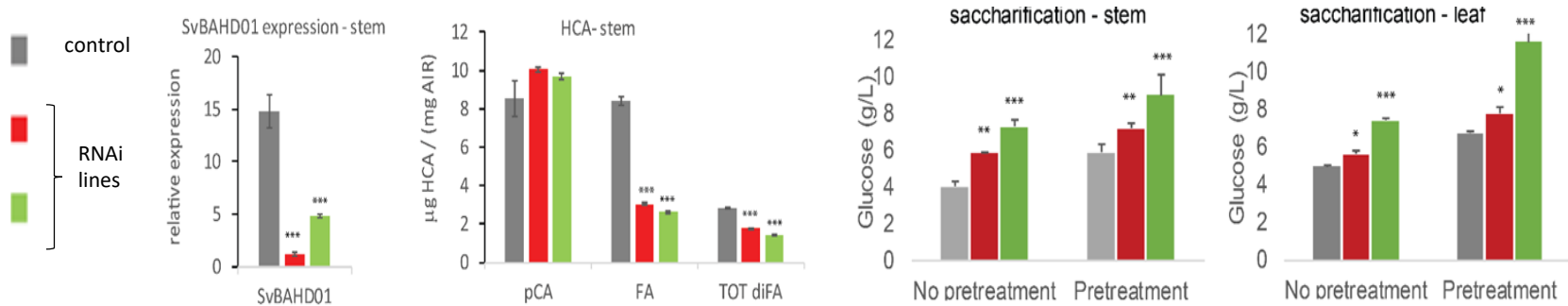




Digestibility potential in forages



Dramatic Improvement in Grass Digestibility in *Setaria viridis*



Suppressing a single gene



Leads to decreased ferulic acid in biomass

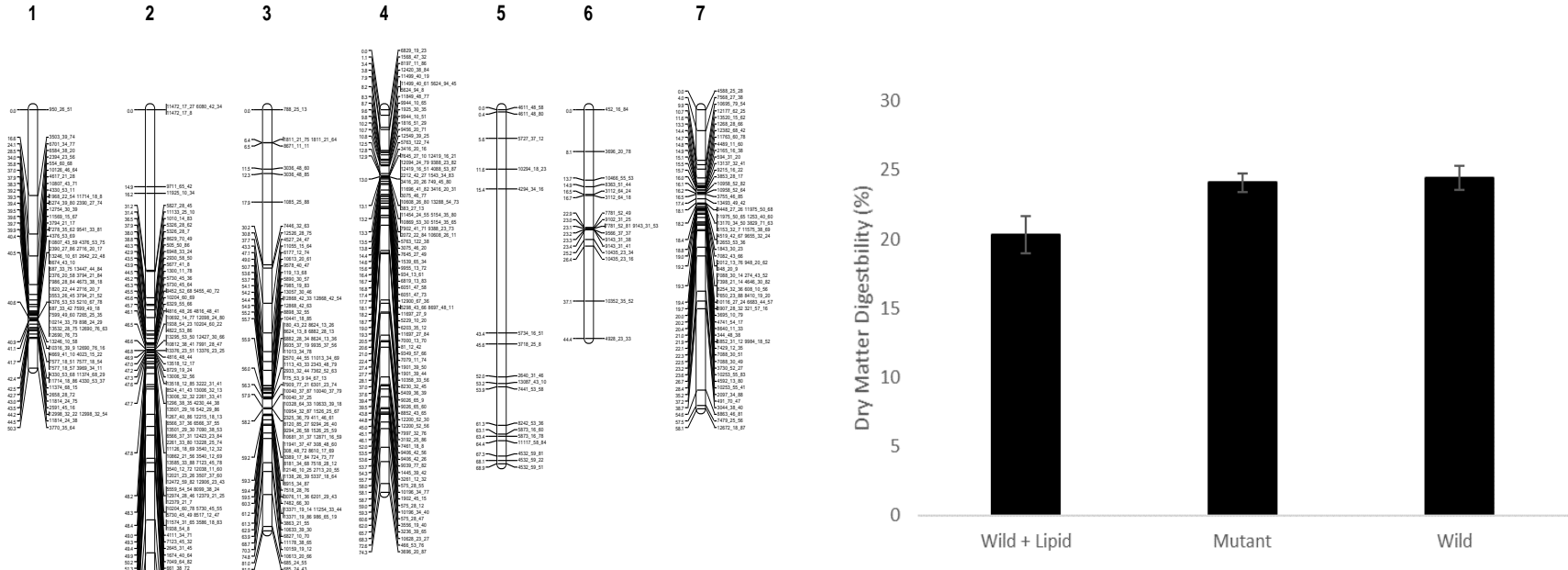


Gives greater digestibility

The same improvement could be achieved by non-GM means (e.g. EcoTILLING) in pasture grasses.



Foliar lipids for energy



In forage a 3% increase in lipid will supply an extra 1.1 MJ/kg DM (5 MJ ~ 1 litre of Milk)

Hegarty et al., (2013)

Dry matter disappearance during 12 h incubation in rumen fluid and buffer from Arabidopsis mutants with high cellular lipid (7.2-8.1%), wild type Arabidopsis and wild type + free oil to bring total lipid to the level of the mutant.

Lee et al., (2018)

Providing long chain Omega-3
from oilseeds to replace fish
meal in aquaculture

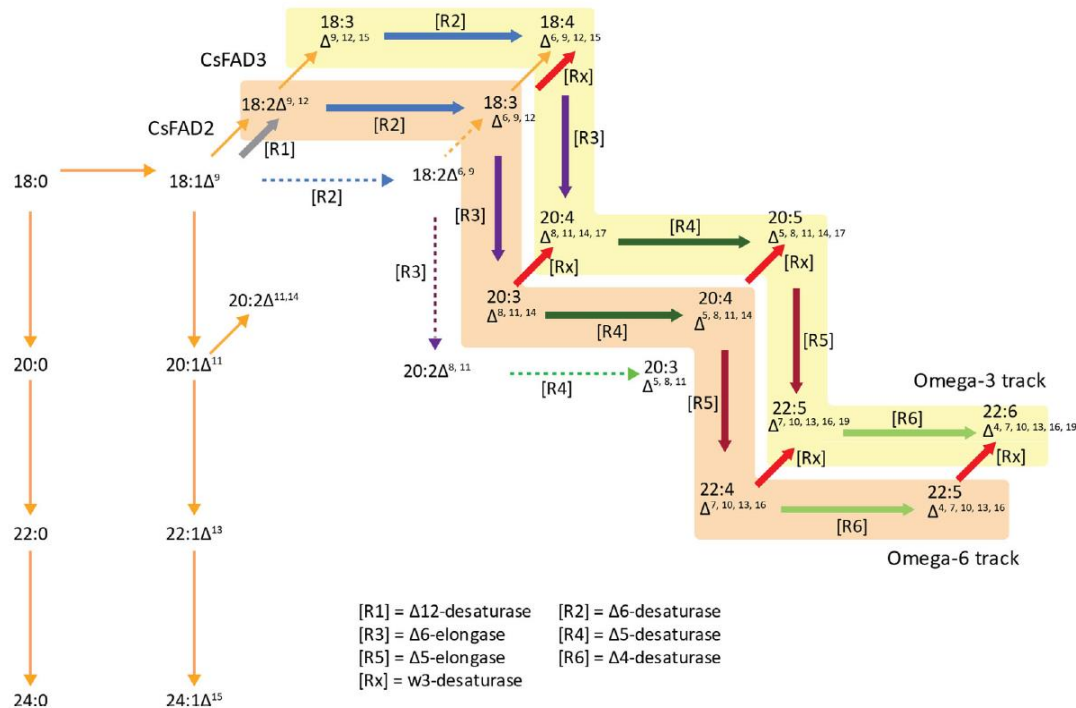


Figure 1 Schematic representation of omega-3 LC-PUFA biosynthetic pathway. The enzymatic conversion of fatty acids and the various routes for substrate flux are indicated. The different transgene-encoded enzyme activities are represented by the coloured arrows and indicated in the figure. The colour coding is maintained in Figure 2a.



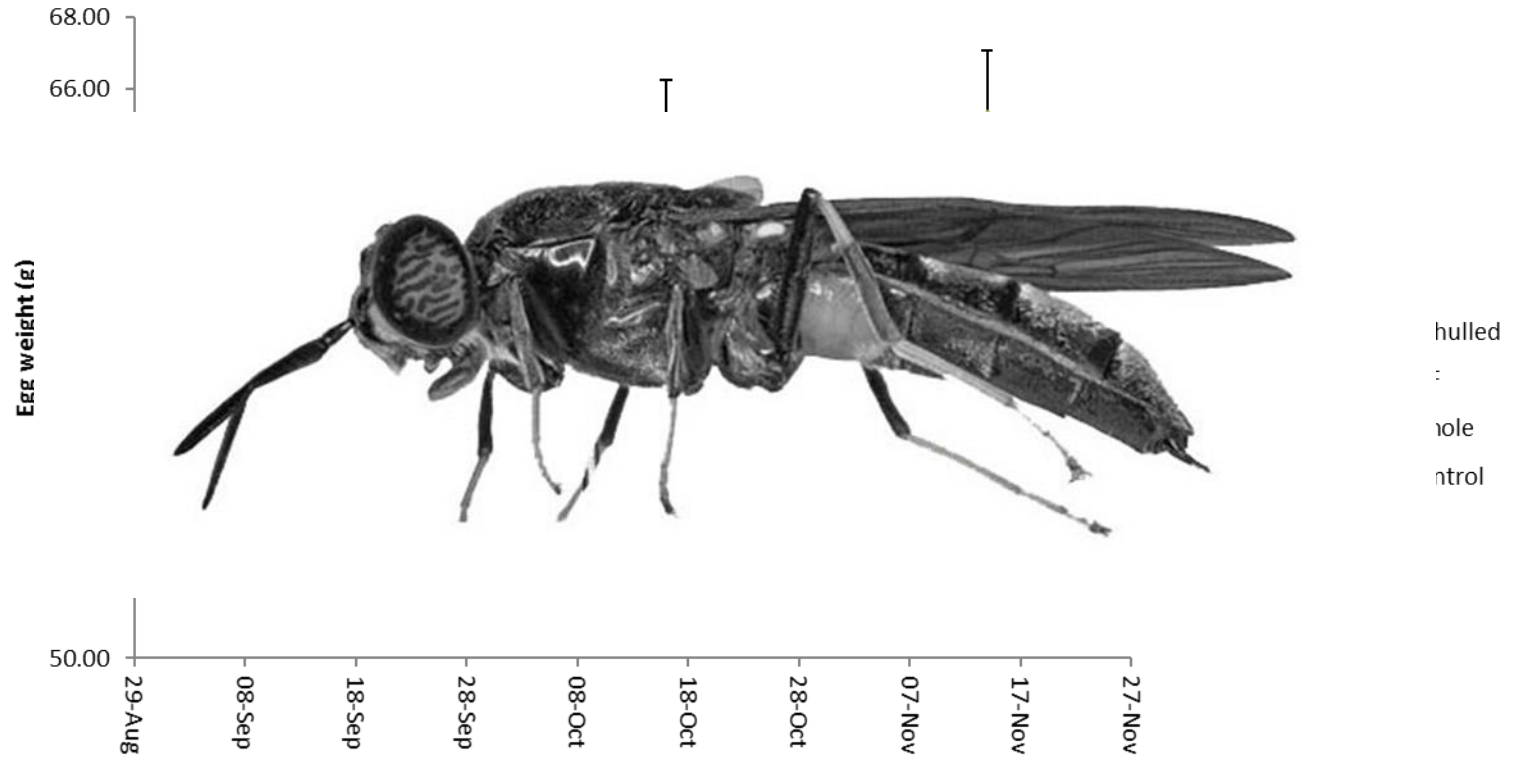
Protein – Monogastrics (Sustainable)



Grain legume	Crude Protein	Lipid	Crude Fibre
Lupins			
<i>Lupinus angustifolius</i> (blue)	28-38	5-7	13-17
<i>Lupinus albus</i> (white)	34-45	10-15	3-10
<i>Lupinus luteus</i> (yellow)	36-48	4-7	15-18
Soyabean	39.6	25.3	12.8
Faba beans			
Winter	26.5	1.5	9.0
Spring	31.4	1.5	8.0
Peas	24.9	1.5	19.5



Protein – Monogastrics (Sustainable)



Quality is also essential – Lysine and Methionine often limiting in plant protein

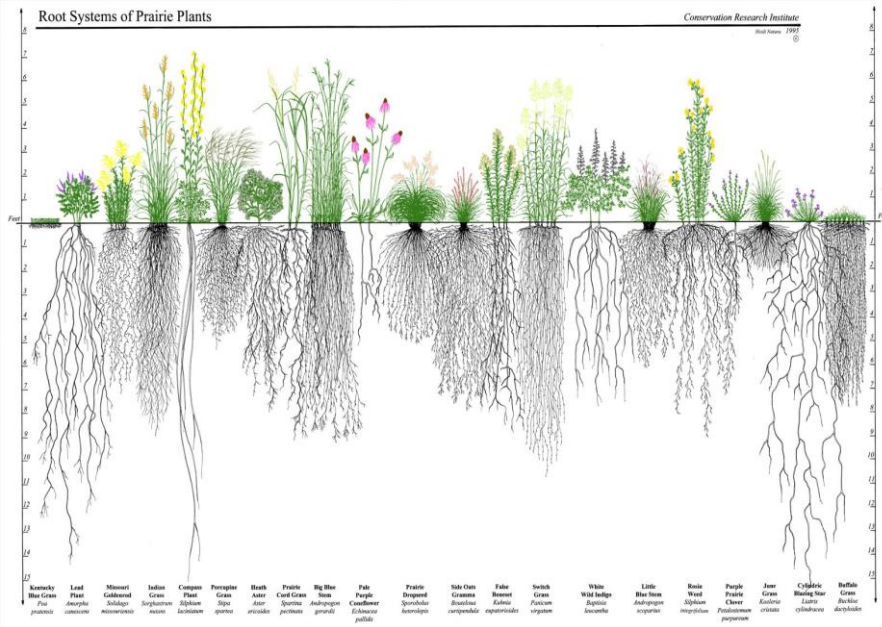
Lee et al., (2016)



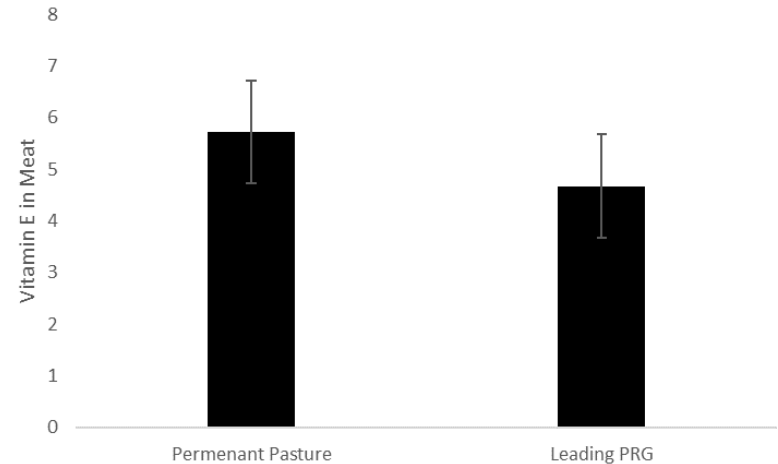
Protein – Ruminants (Balance)



- **Polyphenol oxidase**
- Oxidises phenols to quinones in the presence of oxygen
- Quinones are very reactive
- Quinones bind to proteins to give protein-quinone complexes



Dry Matter yield increases can reduce mineral content due to dilution effect



Have we forgot about Vitamins?

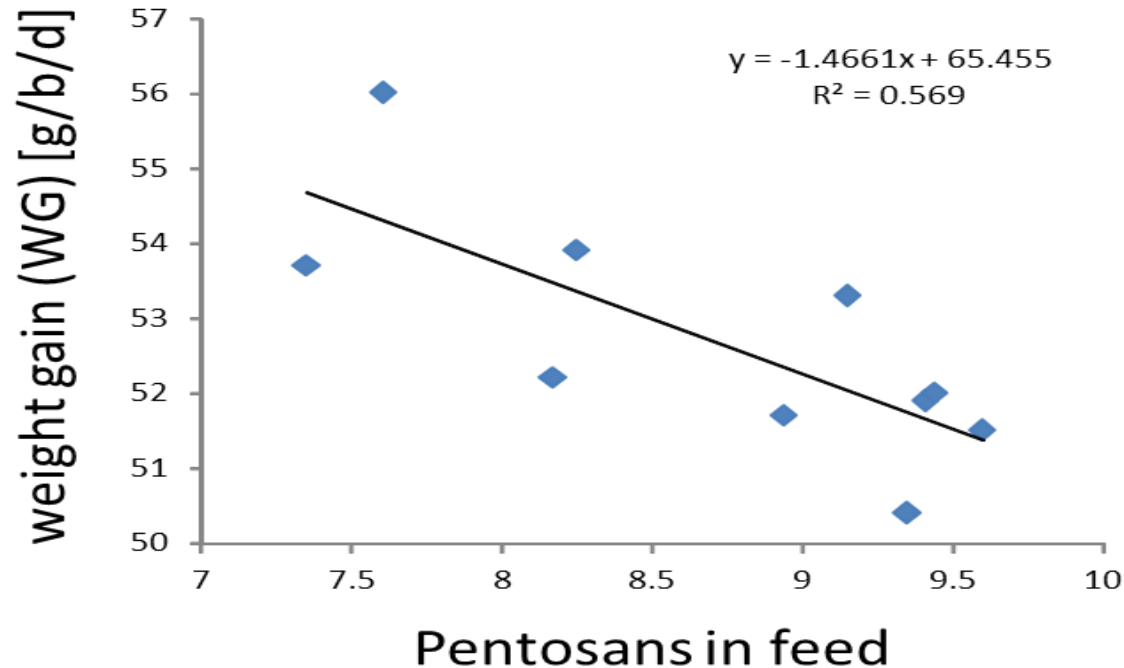
Root structure and mixed swards ability to improve mineral uptake in grazing ruminants





In wheat for poultry, high extract viscosity caused by Arabinoxylans is detrimental due to lack of breakdown in the gut of NSPs leading to sticky faeces.

Low viscosity mutations in wheat are being introgressed into breeding lines.



Less pentosans lead to better food conversion rate.



Plant improvements as Feed – Can Deliver

- Animal Performance – matching genetic improvements
- Reduce Environmental impact
- Sustainable sourcing
- Increasing nutritional value



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