Extensive Animal Nutrition

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The amazing foregut fermenter

- All camelids and ruminants are foregut fermenters
- Each species has slight adaptation of the mouth/teeth/tongue – important for selecting fodder and chewing cud (regurgitated forestomach contents)
- Multiple stomachs to enable digestion of food that monogastrics are not capable of surviving on e.g. cellulose (four stomachs in ruminant and three in camelids)
- Within the forestomachs (prior to the acidic stomach) massive population of bacteria and protozoa – these digest the fodder into protein and energy useable by the animal

Teeth

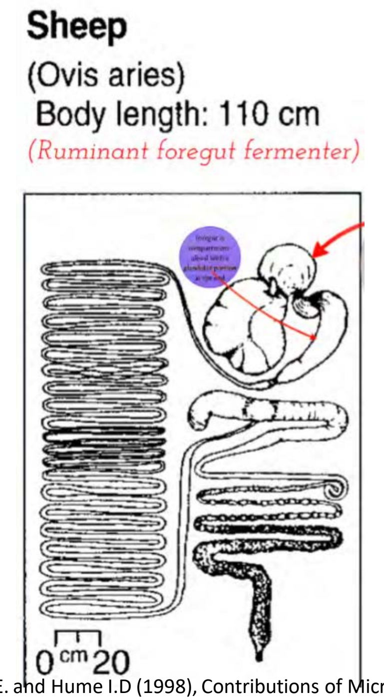
- The ability to chew is vital for a ruminant or camelid
  - Physical breakdown of food particles to enable access for microbes
  - Chewing produces saliva which helps buffer the forestomach pH

- Most feed is re-chewed multiple times depending on its digestibility and how rapidly it can be made small enough to pass into the later stomachs/intestines

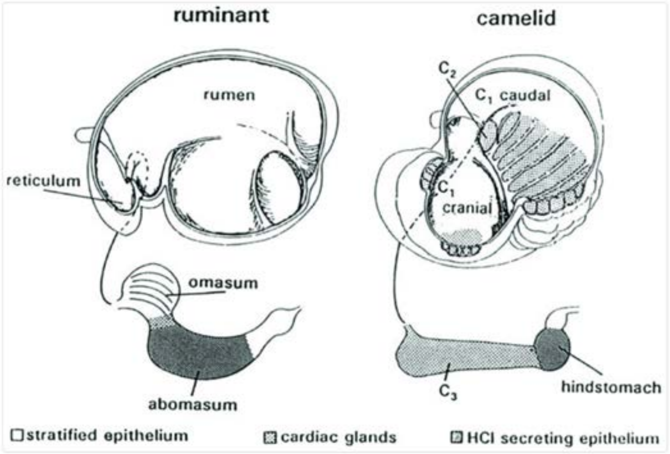
- Camelids have the ability to spit their cud if they take a dislike to someone/something

The stomachs

- Differences in physical structure between ruminant and camelid forestomachs
- Play the same role – breaking down feed into energy and protein that is useable by the animal with assistance of microbes
- Ruminants/camelids can survive on food not useable by humans (and produce human food)
- Forestomachs act as a feed reserve as they have a large capacity



From: Stevens, C.E. and Hume I.D (1998), Contributions of Microbes in Vertebrat Gastrointestinal tract to production and conservation of nutrients:. Physiol Re, 7 (2), 393-427



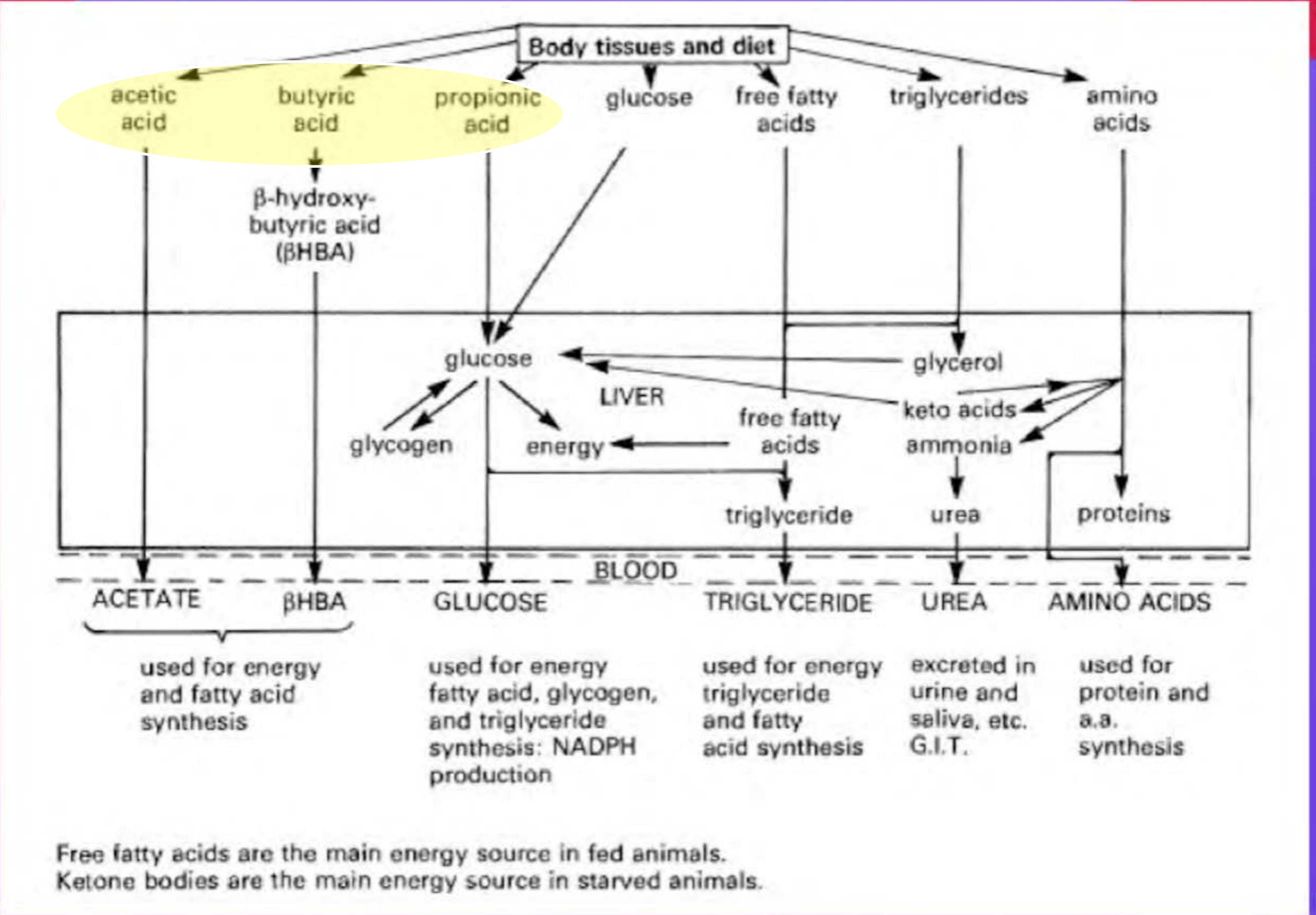
The compartmental forestomach of the camelids and the ruminants

https://line.17qq.com/articles/fpfpeofz.htm

Energy and protein

- Energy from
  - Acetic acid
  - Butyric acid
  - Propionic acid
- Absorbed across rumen

- Microbial protein
- Plant based protein



Example of processing and use of major body metabolites in ruminants

Source: McDonald P. Animal nutrition. 7th edn. Pearson, Harlow, England, 2011

Anatomy and physiology

- You will get further information on ruminant and camelid anatomy and physiology within digestion and other subjects

- Amazing combination to digest relatively indigestible feedstuffs!

- Now we need to talk about the plant part of the equation- first we need to understand how we measure plant quality as a feed

Quality: Testing feeds – what do we measure?

<table>
<tr><td colspan="2">Essential Nutrients</td><td>Chemical Components</td><td colspan="2">Analytical Procedures</td></tr>
<tr><td colspan="2">Fatty acids, Fat-soluable vitamins</td><td>Lipids, pigments, sterols</td><td colspan="2">Ether Extract</td></tr>
<tr><td colspan="2">Protein, amino acids</td><td>Nitrogen-containing compounds - Protein, Nonprotein nitrogen</td><td colspan="2">Kjeldahl Procedure (Crude Protein)</td></tr>
<tr><td colspan="2">Inorganic minerals</td><td>Ash</td><td colspan="2">Ashing (complete combustion)</td></tr>
<tr><td rowspan="6">Carbohydrates</td><td rowspan="2">Glucose</td><td>Sugars</td><td rowspan="2">Nonstructural Carbohydrates**</td><td rowspan="3">Nonfiber Carbohydrates+</td></tr>
<tr><td>Starches</td></tr>
<tr><td rowspan="4">Dietary Fiber</td><td>Soluable Fiber</td><td></td></tr>
<tr><td>Hemicellulose</td><td></td><td rowspan="3">Neutral Detergent Fiber</td></tr>
<tr><td>Cellulose</td><td rowspan="2">Acid Detergent Fiber</td></tr>
<tr><td>Lignin*</td></tr>
<tr><td colspan="5">*Lignin is not truly a carbohydrate compound but is so intimately associated with cell wall carbohydrates that it is often included as such.
**Newer methods are being used to measure starch content.
+Determined by difference (100 - CP - EE - NDF - Ash).</td></tr>
</table>

Table from https://extension.psu.edu/determining-forage-quality-understanding-feed-analysis

Average and variation of feed: why test?

Table showing mean & range of quality measurements of grain samples from the 2019/2020 season

Source: FeedTest 1 April 2019 - 30 April 2020

Product	No. of Samples		Bulk Density (kg/hL)	Crude Protein (CP) (% dmb) (N x 6.25)	Dry Matter Digestibility (DMD) (% dmb)	Metabolisable Energy (ME) (MJ/kg DM)	Neutral Detergent Fibre (NDF) (% dmb)	Acid Detergent Fibre (ADF) (% dmb)	Starch (% dmb)	Fat (% dmb)
Oats	86	Mean	50.0	12.8	71.7	12.4	33.4	13.8	48.4	7.4
		Range	32.1 - 59.0	8.9 - 18.7	57.3 - 80.3	10.0 - 14.2	19.3 - 47.6	8.4 - 22.6	31.3 - 58.9	3.4 - 10.1
Barley	402	Mean	63.1	13.1	86.9	13.2	16.7	7.6	63.6	NA
		Range	33.2 - 78.5	7.8 - 19.5	79.7 - 93.9	11.8 - 14.2	10.1 - 26.3	3.7 - 12.9	45.6 - 79.1	
Wheat	142	Mean	77.1	12.1	93.2	14.0	11.7	4.8	73.1	NA
		Range	49.7 - 85.3	9.1 - 22.3	84.3 - 96.4	12.9 - 14.5	5.5 - 20.4	2.9 - 8.9	57.0 - 82.0	
Triticale	< 20	Insufficient Data								
Lupins	61	Mean	NA	31.3	86.8	14.3	34.1	19.4	NA	NA
		Range		16.8 - 40.0	79.4 - 96.5	13.0 - 15.9	19.3 - 49.2	12.0 - 26.3		
Lentils	22	Mean	NA	26.3	93.1	13.2	13.5	5.5	NA	NA
		Range		22.6 - 29.8	84.4 - 97.5	12.7 - 14.6	9.4 - 24.4	3.8 - 11.0		
Maize	< 20	Insufficient Data								

PLEASE NOTE: This information is produced using data from FeedTest records, derived from samples submitted by clients. FeedTest produces tables for the information of clients, merely to demonstrate the range in quality which can occur for a given type of feed.

Extract from https://feedtest.com.au/index.php/about/feedtest-information

Table showing mean & range of quality measurements of cereal hay samples from the 2019/2020 season

Source: FeedTest 1 April 2019 - 30 April 2020

Product	No. of Samples		Crude Protein (CP) (% dmb) (N x 6.25)	Dry Matter Digestibility (DMD) (% dmb)	Metabolisable Energy (ME) (MJ/kg DM)	Neutral Detergent Fibre (NDF) (% dmb)	Acid Detergent Fibre (ADF) (% dmb)	Water Soluble Carbohydrates (WSC) (% dmb)
Hay, Barley	344	Mean	8.8	68.3	10.1	52.6	27.1	24.0
		Range	1.4 - 17.8	46.1 - 85.1	6.3 - 13.0	35.3 - 77.4	17.1 - 42.5	2.4 - 44.8
Hay, Oaten	1460	Mean	7.6	66	9.7	53.4	28.3	24.3
		Range	1.4 - 23.0	42.5 - 84.8	5.7 - 13.0	35.2 - 77.2	17.2 - 42.0	3.0 - 42.3
Hay, Triticale	<20	Insufficient Data						
Hay, Wheat	1058	Mean	9.0	64.8	9.5	54.3	28.2	23.4
		Range	1.2 - 22.5	36.7 - 79.8	4.7 - 12.1	35.9 - 82.7	17.0 - 47.9	2.4 - 44.6
Hay, Cereal (unspecified)	1318	Mean	8.1	65.0	9.6	52.9	27.6	23.8
		Range	2.1 - 18.6	39.2 - 88.4	5.1 - 13.6	30.5 - 82.5	15.9 - 44.9	1.1 - 42.4
Hay, Cereal & Legume	259	Mean	10.8	66.5	9.8	52.7	28.6	17.8
		Range	3.9 - 24.8	49.2 - 80.0	9.5	34.8 - 69.3	19.5 - 39.3	4.4 -34.7
Hay, Cereal & Pasture	232	Mean	7.6	64.3	9.5	56.8	29.9	21.2
		Range	1.2 - 19.6	39.9 - 83.1	5.3 - 12.7	39.2 - 81.2	19.5 - 46.8	2.2 - 37.8

PLEASE NOTE: This information is produced using data from FeedTest records, derived from samples submitted by clients. FeedTest produces tables for the information of clients, merely to demonstrate the range in quality which can occur for a given type of feed.

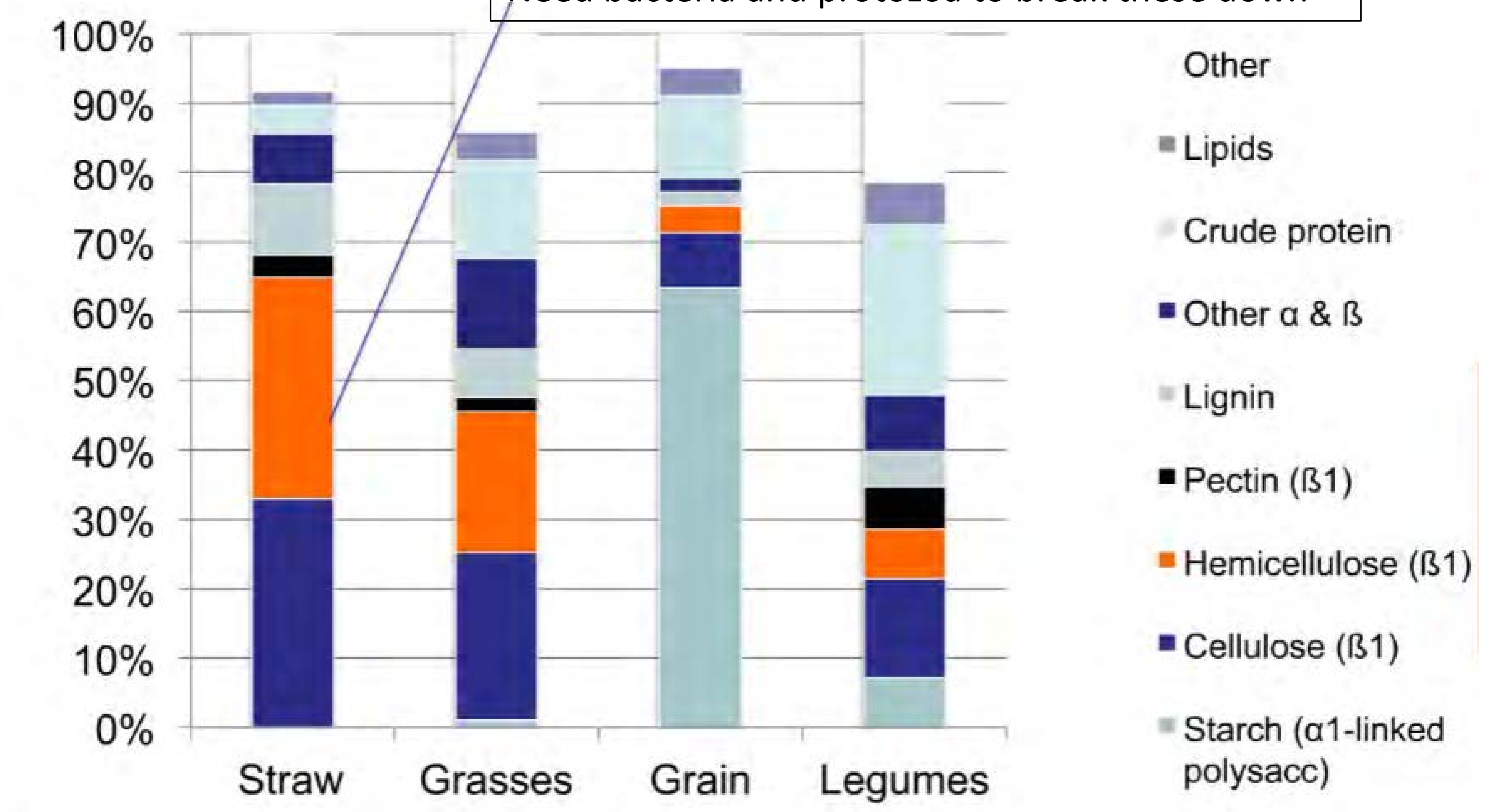
Plants

	Types	Energy Fibre Protein
Forage	Fresh Ensiled (silage) Dry • Hay • Paddock • Straw (stubble)	Varying content through year Usually higher than hay, cut early Moderate energy/protein Moderate, will degrade over time Low energy/protein
Concentrate	Seeds e.g. grains Fruits	Very high energy & good protein Varies

Extensive livestock also occasionally are fed other feed types not used by people or that are out of date etc. to avoid waste e.g. grape marc, brewers grain

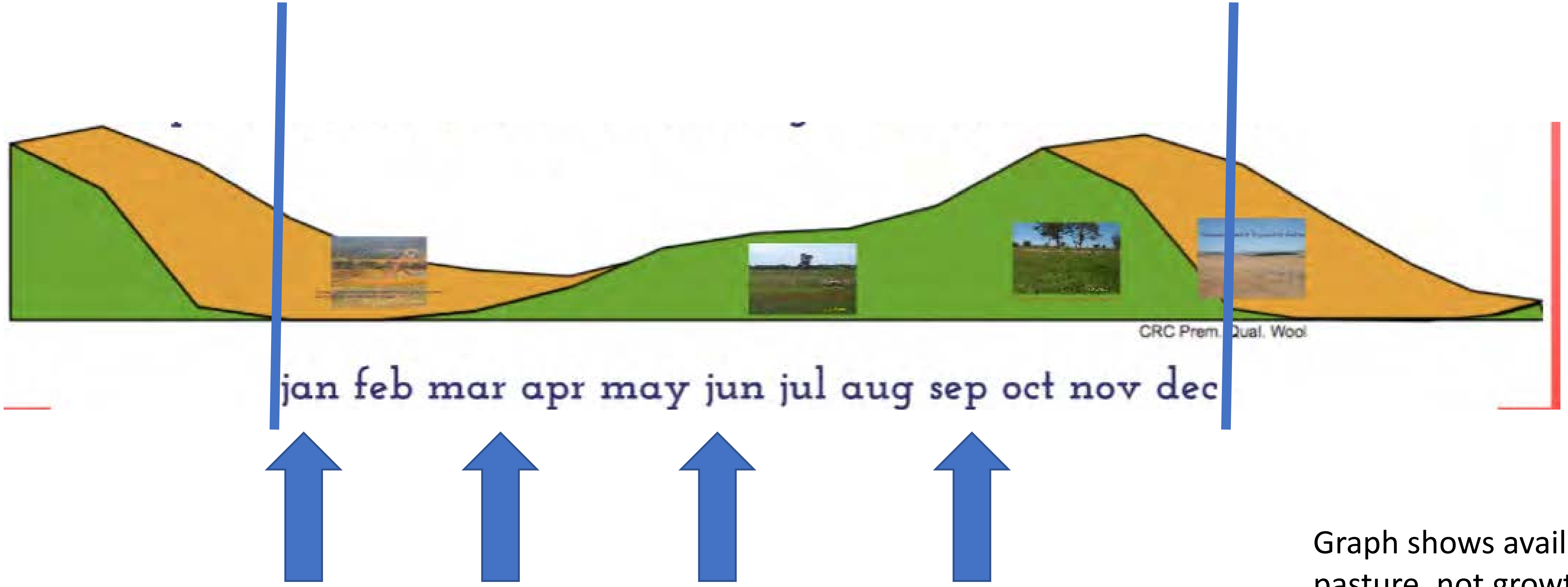
Variation in quality between categories

Need bacteria and protozoa to break these down



Physiology of Domestic Animals, p. 443

In SE Australia what does pasture look like throughout the year?



Quality low
Quantity high

Quality low
Quantity low

Quality high
Quantity low

Quality high
Quantity high

Graph shows available pasture, not growth rate

What does this actually look like on farm?

- Link to Dookie VR

- Not every year is a typical year 2018/19 was a significant rainfall deficiency at Dookie so reduced the expected pasture growth significantly
- 2020 was a much improved year but images not yet available on DookieVR

How do we measure animal requirements?

- The most limiting element of extensive grazing nutrition tends to be energy followed by protein
- Energy in ruminant diets is expressed as megajoules of metabolizable energy MJ of ME (or just MJ)
- Different sized animals at various stage of their lives will have varying requirements e.g. a 2 year old wether sheep weighing 45 kilogram may require 7.7 MJ ME/day, a late pregnant ewe 12 MJ ME/day, a lactating ewe 18 MJ ME/day, milking dairy cow 170 MJ ME/day, late pregnant beef cow 70 MJ ME/day, etc.

How can we simply compare?

- We can choose an example animal and use that as a reference point

THE **DRY SHEEP EQUIVALENT** OR **DSE**

In Victoria a DSE is a 2 year old 45kg Merino sheep (wether or non-lactating, non-pregnant ewe) at maintenance = 7.7 MJ of ME

Other systems

- Some feed program may use an adult equivalent (AE) based on a 450 kg Bos taurus steer at maintenance, 2.25 years of age, walking 7km per day = 72.6 MJ ME/day

- Livestock units (LSU) based on 650 kg dairy cow producing 3000kg milk annually = 124.9 MJ ME/day

- The above two are examples to demonstrate the range
- For beef/sheep material we tend to use the DSE

There is always a complication.....

- Unfortunately, sheep in NSW are overall a bit larger than Victorian sheep so the NSW version of a DSE is different

- In NSW the DSE = a 50kg dry sheep, not 45kg
- Hence the DSE MJ for a sheep in NSW is = 9.44 MJ of ME

- While we will use the 45 kg Victorian sheep version it is always important to ensure you are talking the same language as there is a substantial difference!

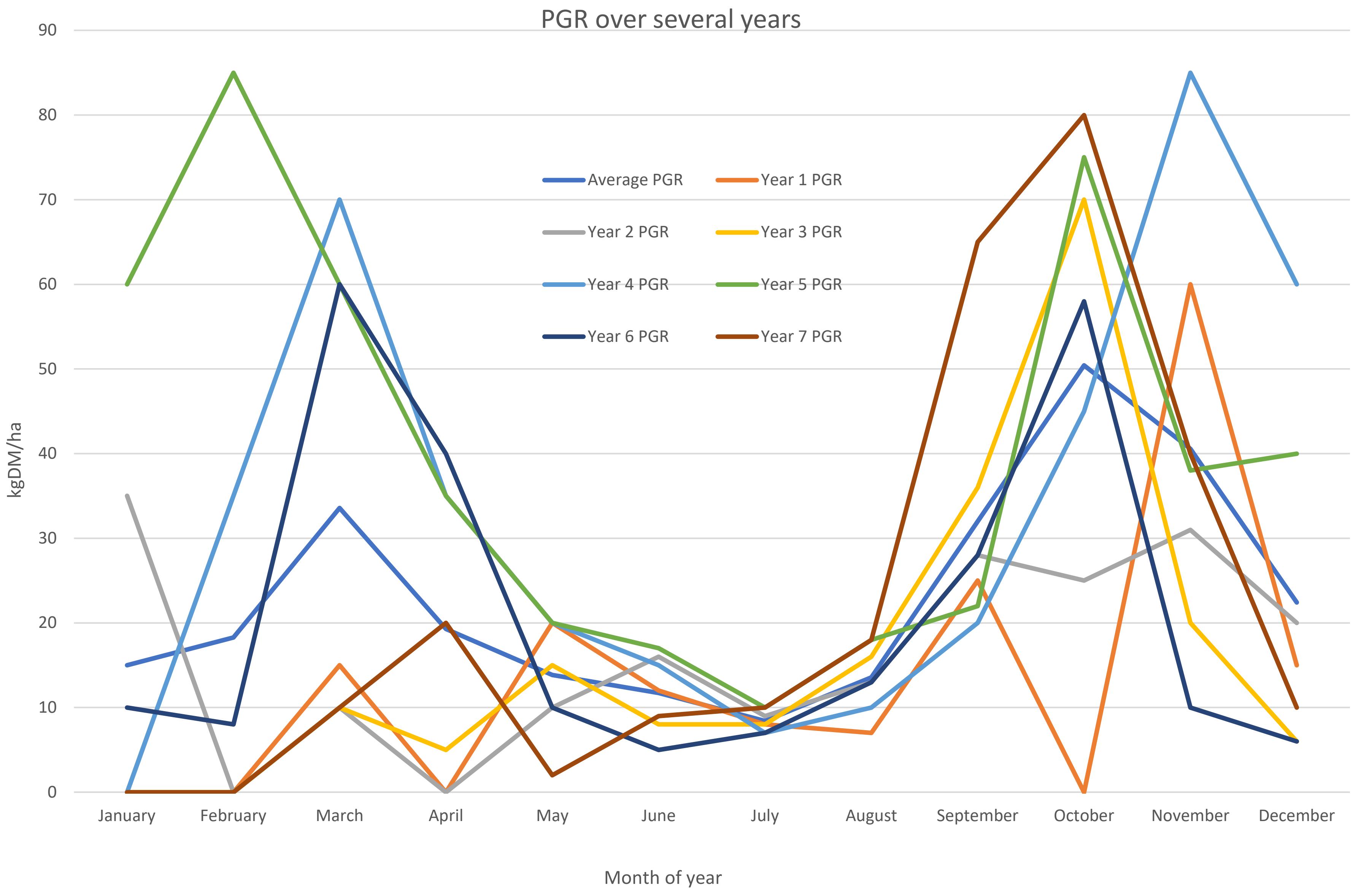
We can then turn MJ into DSE for our stock

Production class	Metabolisable energy				Crude protein	
	MJ/d	DSE	MJ/d	DSE		
	Sheep		Cattle		Sheep	Cattle
Weaners/yearlings	8	1	40-60	6-8	12-16%	
Steers			60-80	8-11		6-12%^
Dry or early pregnant	7.7	1*	60	8-9	6%	6-8%
Late pregnant	9–12	1.5	70	10	8%	9%
Lactating (Merino/beef)	18	2.5	84-130	12-17	10-12%	
Milking dairy cow (20 L/d)			170	23		14-20%
Rams / bulls	15	2	100	15		10%

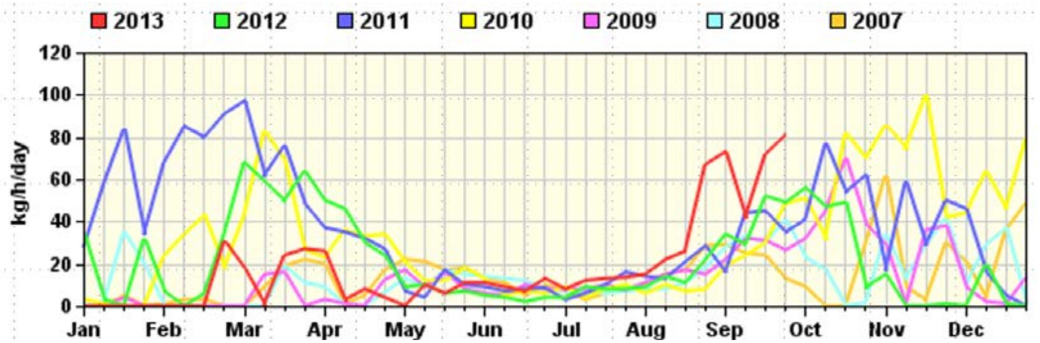
•DSE = 'dry sheep equivalents'
• different DSE 'standards' exist, depending on the reference sheep's weight!
•A 45 kg wether requires ~7.2 MJ ME/d for maintenance; 1 DSE = 7.7 MJ/d is now also frequently quoted
^ higher protein levels required for weight gain

Primary challenge of extensive animal nutrition

- Calculate feed supply average and range over years and how varies from month to month
- Utilise this knowledge to design stocking rate, management timing/decisions and purchases/sales of livestock
- Some environments may not be suitable to continual stocking or only occasional rotational grazing due to low rainfall/high temperature

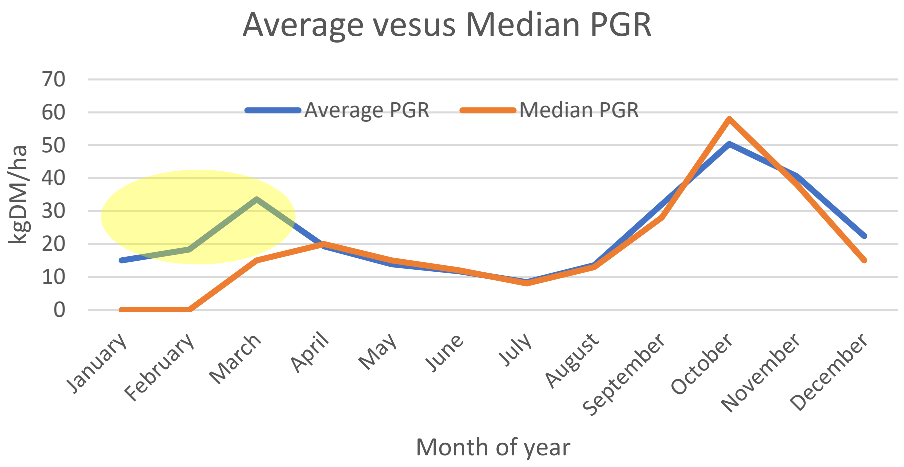

PGR over several years
kgDM/ha
0
10
20
30
40
50
60
70
80
90
January
February
March
April
May
June
July
August
September
October
November
December
Month of year
Average PGR
Year 1 PGR
Year 2 PGR
Year 3 PGR
Year 4 PGR
Year 5 PGR
Year 6 PGR
Year 7 PGR

Pasture growth rate

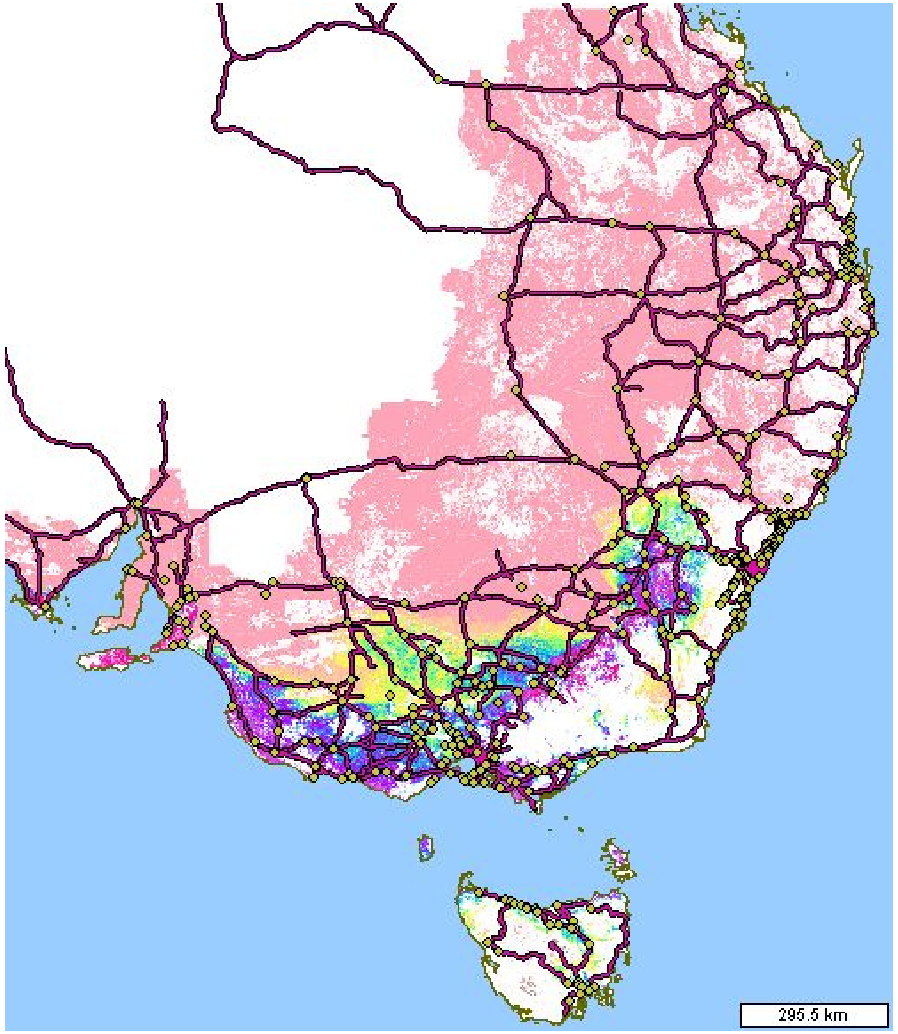


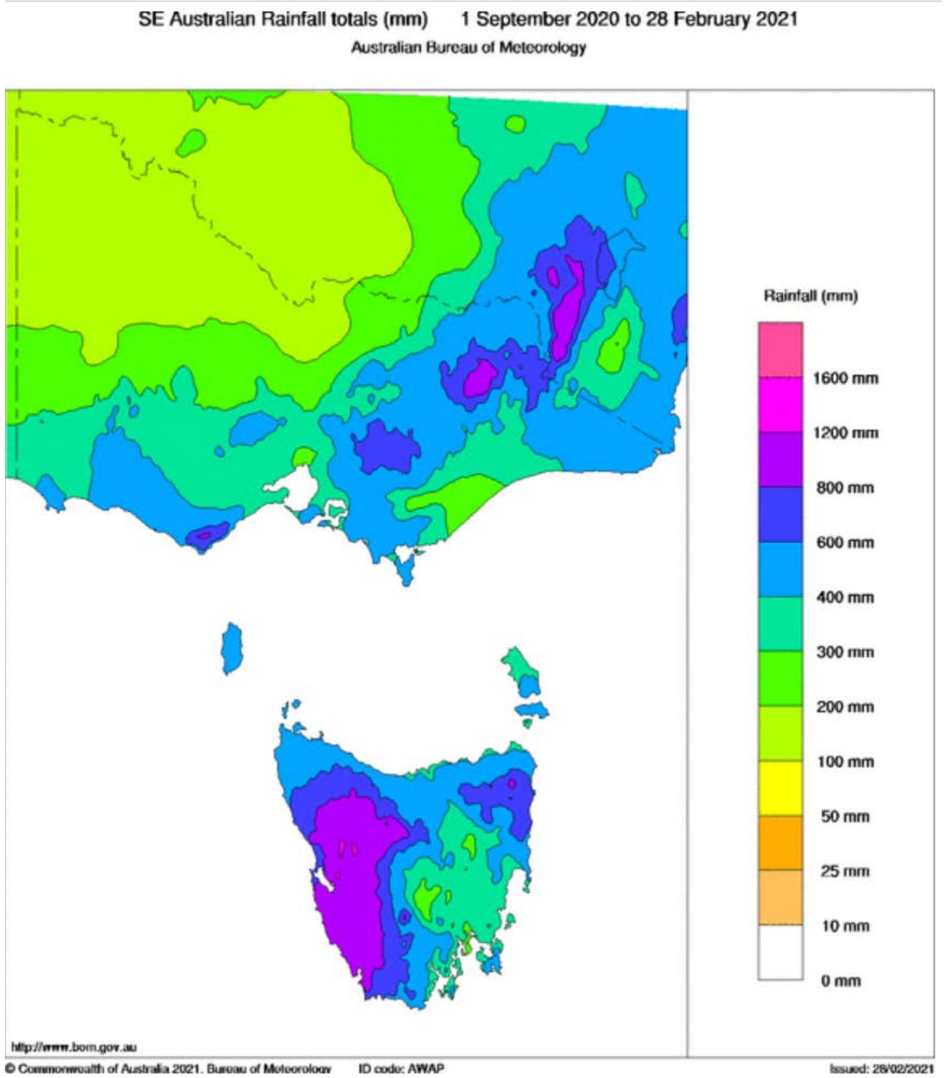
- When is limiting time/s?
  - In this example – winter maximum routinely limiting
  - Most summers to early autumn = low growth

- An example of where the average can be deceiving



Pasture growth rate varies across region





Decide on the PGR to work with

- Attitude to risk
- Attitude to longer term climate issues eg drying climate and lesser rainfall potentially shorter growing season but relatively gradual
- SE Australia – research has produced equations such as the French equation (and others) to aid calculations of optimal stocking rate (SR) based on rainfall