

TechNote 4

Feed composition and characteristics

IN THIS TECHNOTE

- 4.1 Pasture composition
- 4.2 Nutrient and mineral composition of different feeds
- 4.3 Characteristics and considerations of different feeds
- 4.4 Further reading

When feed management decisions are being made, it is important to consider the composition and characteristics of different feeds, and the implications of including them into the farm system.

4.1 Pasture composition

Pasture composition can vary with season, region and irrigation (see section 4.2). It is also influenced by grazing management.

The structural carbohydrates in good quality, leafy pasture are highly digestible and therefore high in energy. As the plant matures, lignin increases and the stem and stalk become hard and less digestible, reducing the available energy content of the pasture. Hard stem and dead material can also act as a barrier to grazing and reduce dry matter intake. Good pasture management that maximises the amount of green leaf in the forage will maximise energy available from pastures (Table 1).

Table 1. Typical digestibility and ME of ryegrass components.

Component	Green leaf	Soft stem	Hard mature stem	Dead material
Digestibility (%)	70-85	65-75	40-50	40-50
Available Energy (MJ ME/kg DM)	10.5-12.5	10-11	6.5	6.5



For more details see TechNotes 5: Carbohydrate metabolism, 8: Fibre metabolism, and 9: Pasture management, and online eLearning activity: Pasture management; dairynz.co.nz/feedright-module-8.

4.2 Nutrient and mineral composition of different feeds

FEEDSTUFF	DM %	ME MJ/kg DM	CP %DM	NDF %DM	SSS %DM	Starch %SSS	Fat %DM	Ash %DM	Ca %DM	P %DM	Mg %DM	K %DM	S %DM	Na %DM	Cl %DM
RYEGRASS/WHITE CLOVER DOMINANT PASTURE															
Spring	12-18	11-12.5	18-35	35-45	7-25	2-4	4-6	10-12	0.2-1.5	0.2-0.6	0.1-0.4	1.5-4.5	0.1-0.6	0.03-0.6	0.1-1.5
Summer	15-20	9.5-10.5	14-22	42-52	7-25	4-8	3-5	7-25	0.2-1.5	0.2-0.6	0.1-0.4	1.5-4.5	0.1-0.6	0.03-0.6	0.1-1.5
Summer dry	20-30	8-9.5	9-14	52-65	7-13	2-4	2-4	8-10	0.2-1.5	0.2-0.6	0.1-0.4	1.5-4.5	0.1-0.6	0.03-0.6	0.1-1.5
Autumn/winter	13-18	11.0-11.5	15-20	40-47	7-25	2-4	3-5	9-12	0.2-1.5	0.2-0.6	0.1-0.4	1.5-4.5	0.1-0.6	0.03-0.6	0.1-1.5
IRRIGATED SOUTH ISLAND PASTURE															
Spring	13-20	11.5-12.5	18-28	30-45	11-29										
Summer leafy	13-20	11-12.5	18-28	35-50	10-30										
Autumn/Winter	13-20	11-12.5	18-30	30-45	7-30										
SOUTHLAND PASTURE															
Spring	12-24	11-12.5	18-34	35-50	9-21		3-5								
Summer leafy	13-22	10-12.5	18-30	35-50	5-20		3-5								
Autumn/Winter	12-25	11-12.5	18-32	35-50	5-20		4-7								
KIKUYU															
Leafy	20-30	9-11	16-20												
Stemmy	40-60	7-9	6-10												
SILAGE															
Pasture, good	30-35	10-11.5	17	45-50	3-5	7	3	10	0.8	0.3	0.21	2.3	0.24	0.1	0.2
Pasture, poor	33-40	9	12-14	53-57	3-5	8	3.1	9.5	0.55	0.28	0.14	2	0.2	0.16	0.19
Baleage	35-45	9.5-11.5	12-17	45-55	5-10	2-4	3	8.3	0.52	0.29	0.19	2.57	0.24	0.12	0
Lucerne	30-50	9-11	19-23	36-48	4-6		1-3	9.5	1.29	0.29	0.25	2.84	0.29	0.05	0.34
Maize, high grain	33-38	10.8-11	8	42-45	35	75-80	3.1	4	0.25	0.23	0.18	1.2	0.13	0.01	0
Maize, low grain	28-40	10-10.5	8	45-50	30	70-80	3.1	4	0.25	0.23	0.18	1.2	0.13	0.01	0
Pea	33	9-9.5	13-16	59	20	35	3.3	9	0.87	0.34	0.23	3.08	0.25	-	-
Wheat	36	10.5	13	59	10	100	3.6	8.3	0.57	0.32	0.2	2.85	0.25	0.07	0.07
Oats	30	9	9.5	54	10	100	6	10	0.4	0.3					

FEEDSTUFF	DM %	ME MJ/kg DM	CP %DM	NDF %DM	SSS %DM	Starch %SSS	Fat %DM	Ash %DM	Ca %DM	P %DM	Mg %DM	K %DM	S %DM	Na %DM	Cl %DM
HAY/STRAW															
Pasture, good	85	9-10	15-20	50-58	10-15	2-4	2.6	9	0.8	0.4	0.2	2.32	0.26	0.2	0.62
Pasture, poor	85	7-8	5-10	60-70	5-10	2-4	2.6	6.3	0.40	0.30	0.18	1.67	0.20	0.15	0.60
Barley straw	87	6-7	4-5	80	5-8	100	1.9	7.1	0.30	0.07	0.23	2.37	0.17	0.14	0.67
Pea straw	85	7-8	6	59	-	-	2	10	1.60	0.12	0.39	1.40	0.25	0.01	0.67
Wheat straw	89	6-7	3-4	79	7-9	100	1.8	7.8	0.18	0.05	0.12	1.42	0.19	0.14	0.32
CONCENTRATE															
Barley	87-89	12.5	11	21	61	90	2	2.8	0.06	0.44	0.18	0.57	0.17	0.03	0.18
Bran (wheat)	85	10-11	17	51	20	95	4.4	6.9	0.13	1.31	0.6	1.5	0.25	0.04	0.05
Canola meal	90	11.5	38	30	10	10	3.5	7.4	0.75	1.1	0.53	1.41	0.73	0.07	0.04
Lupin	89	12-14	34	33	11	50	5.5	5.1	0.26	0.44	0	0.91	0	0	0
Maize grain	86-89	13.5	8	9	75	99	4.3	1.6	0.02	0.31	0.12	0.4	0.12	0.003	0.05
Oats	89	11.5	13	31	42	90	4.9	3.6	0.1	0.41	0.15	0.53	0.19	0.01	0.11
Peas	87	13	24	23	55	90	1.8	5	0.14	0.43	0.17	1.8	-	0.01	-
Soya bean meal	90	12.5-13.5	50	14	27	90	1.4	7.3	0.3	0.68	0.3	2.12	0.37	0.01	0.08
Soya bean hulls	88	11.5	13.5	60	7	75	2	4.8	0.4-0.6	0.18	0.25	1.51	0.12	0.01	0.05
Tapioca	88	12.5-13	5	8	82	95	2	6.2	0.2	0.1	0.15	1.1	-	0.03	-
Wheat	89	12.5-13.5	13	11-14	70	90	1.5-2	2.6	0.07	0.36	0.13	0.46	0.16	0.01	0.08
Whole cotton seed	88	12	23	44	4	60	18	4.5	0.16	0.6	0.37	1.2	0.26	0.01	-
Cotton seed meal	89	12	43	20-23	8.5	40	0.3	6.7	0.2	1.15	0.61	1.64	0.4	0.03	0.03
CROPS/ROOTS															
Chicory	8-19	12.5-13.0	20-26	30-38	4-9	-	-	-	1.49	0.34	0.28	3.64	-	0.21	-
Fodder beet	14-20	12.0-12.5	9-14	11-16	60-65	5	-	-	0.32	0.17	0.26	3	0.2	0.4	-
Kale	11-15	11.0-13.5	12-18	20-35	35-40	-	2.1	7	0.8	0.35	0.5	4	0.7	0.1	-
Lucerne	24	11	16-20	30	6	-	2.5	11	1.6	0.3	0.25	2.5	0.3	0.06	0.35
Plantain	9-20	11-12	16-28	23-36	11-20	-	-	-	1.9	0.4	0.3	3.3	0.5	0.6	-
Swedes	9-12	11-13	12-20	16-30	45-50	0	-	6	0.4	0.35	0.1	0.5	0.7	0.2	0.2
Triticale	30	12	9-13	50	68	67	-	9.7	0.57	0.33	0.19	3.01	0.21	0.05	-
Turnips	9-11	12	12-18	27	17	10	2	-	1.75	0.37	0.23	3	0.33	0.28	1.45

FEEDSTUFF	DM	ME	CP	NDF	SSS	Starch	Fat	Ash	Ca	P	Mg	K	S	Na	Cl
	%	MJ/kg DM	%DM	%DM	%DM	%SSS	%DM	%DM	%DM	%DM	%DM	%DM	%DM	%DM	%DM
BY PRODUCTS															
Apple pomace	22	10.4	5.4	41	44	100	4.7	5	0.23	0.11	0	0.53	0.11	0	0
Bread	63	14	13	18	65	90	5.7	3	0.17	0.15	0.4	0.19	-	0.8	-
Brewers grains	24	10	23	49	7	90	7.3	4.4	0.3	0.6	0.1	0.1	0.36	0.2	0.17
Broil (Wheat midds)	85	10.5-11	12-18	45	22	90	5	4.3	0.15	0.8	0.5	1.5	0.19	0.01	0.09
Cabbages	8	13.2	19	29	60	-	3.4	9	0.6	0.3	0.19	3.13	-	0.23	-
Carrots	12	13.2	9.9	9	59	-	1.4	8.2	0.4	0.35	0.2	2.8	0.17	1.04	0.5
Condensed distillers syrup	42-45	15-17	17-20	1-2	65	-	4-8	-	-	-	-	-	-	-	-
Dried distillers grains	90	12-13	30-37	30	7	55	3.5	4.5	0.18	0.83	0.33	0.1	0.44	0.3	0.26
Fishmeal	92	12-13.5	67	1.47	2	90	10.5	20.8	5.65	3.16	0.16	0.76	0.49	0.43	1.1
Kiwifruit (ripe)	14	12-12.5	12-17	20	50	2-4	3	0.64	0.03	0.04	0.03	0.33	0	0.05	-
Kiwifruit (hard)	20	12-12.5	6-10	25	30	2	3	-	-	-	-	-	-	-	-
Molasses	75	12	5-8	1	65	0	1	13.1	1.1	0.09	0.43	4.6	0.4	0.05	3.1
Palm kernel extract	90	11-11.5	14-18	70	4	50	8-12	6	0.25	0.65	0.3	0.8	-	0.02	0.5
Potatoes	23	13	10	7.6	67	95	0.4	4.8	0.04	0.24	0.14	2.17	0.09	0.09	0.28
Pumpkins	8.4	12.9	16	5.9	67	100	1.2	9.5	0.25	0.52	0.14	4	-	0.01	-
Tallow	99	31	0	0	0	0	99	1	0.57	0.06	0.06	0.32	0	0.01	0
Urea	99	0	281	0	0	0	0	0	0	0	0	0	0	0	0

DM, dry matter; ME, metabolisable energy; CP, crude protein; NDF, neutral detergent fibre; SSS, soluble sugars and starch; Ca, calcium; P, phosphorus; Mg, magnesium; K, potassium; S, sulphur; Na, sodium; Cl, chloride. Pasture: North Island and dryland South Island. The data in this table have been derived from a variety of sources including: DairyNZ Facts and Figures; NRC, 1989; Kolver, 2000; Holmes et al. 2002; Westwood and Mulcock, 2012.

Feed	Type	Characteristics and considerations	Feed	Type	Characteristics and considerations
Apple pomace	By-product	Moderate energy content but low in protein and minerals. Moderate starch and risk of acidosis at high feeding rates or quick introduction into the diet.	Brewers grains	By-product	Moderate energy and high in protein. High in digestible fibre but low in starch so not likely to cause acidosis. Dry matter % may vary between batches.
Barley	Concentrate	High energy and low protein. High starch and risk of acidosis at high feeding rates or quick introduction into the diet. Requires crushing and best fed through a customised feed system or mixed in a ration on a feed pad.	Cabbage	By-product	High energy and moderate protein. High in sugars and starches and less fibrous than kale. Eaten readily and usually need feeding immediately after delivery.
Barley straw	Straw/Hay	Low in energy and protein. High in effective fibre. Not suitable as a milking cow feed unless the diet is short of effective fibre. Can be used as part of a dry cow ration.	Canola meal	Concentrate	Moderate energy with high levels of by-pass protein. Best fed through a customised feed system or mixed in a ration on a feed pad. Not very palatable and some meals can contain high levels of glucosinolates.
Bran (wheat)	Concentrate	By-product from soft wheat milling. Moderate energy and protein levels. Moderate starch and risk of acidosis at high feeding rates or quick introduction into the diet.	Carrots	By-product	High energy and moderate protein. High soluble sugars and starches with risk of acidosis at high feeding rates or quick introduction into the diet. Very palatable and a good source of beta-carotene; however, prolonged use at high levels can colour milk fat.
Bread	By-product	High energy, but low protein High starch and risk of acidosis at high feeding rates or quick introduction into the diet. Soft oils in the bread can oxidise, so does not store well and goes off quickly.	Chicory	Crop	Good source of energy and protein. Management is similar to turnips with time required to adjust to crop. Ready to graze at 25-35 cm height; graze down to 5-10 cm. Do not graze lower than 5 cm. For more information, refer to DairyNZ Farmfact 1-72 – Chicory.

Feed	Type	Characteristics and considerations	Feed	Type	Characteristics and considerations
Condensed distillers syrup	By-product	High energy, and a good source of available crude protein. Very low fibre content and can contain high levels of fat.	Kale	Crop	High energy, protein and calcium levels. Utilisation 75-80% in ideal conditions; 50-60% when wet. Anti-nutritional factors include: S-methylcysteine sulfoxide (SMCO): greatest risk in mature kale crops; use little to no sulphate fertiliser. Nitrate poisoning: excessive fertiliser use and exacerbated by certain weather conditions.
Cotton seed meal	Concentrate	High energy levels. A good source of by-pass protein; however, the amino acid profile is poorer than soya bean meal.	Kiwifruit	By-product	High energy content but relatively low protein. High in soluble sugars and risk of acidosis at high feeding rates or quick introduction into the diet (particularly ripe fruit). Be aware of streptomycin treated plants.
Dried distillers grain	By-product	High energy and moderate protein. High oil which can affect milk fat if the percentage of total fat in the diet exceeds 6%. Low in starch. Be aware of over-heated product (brownier tinge rather than yellow-blond) as this is less palatable and protein may be indigestible.	Lucerne	Crop	Moderate energy and protein content. Perennial legume with long tap root making it drought tolerant; however, quality declines as the season progresses and stem component increases. Should be introduced gradually as can cause bloat.
Fish meal	By-product	Moderate energy content. Excellent protein source with high levels of by-pass protein. Rich in lysine, sulphur, minerals and vitamins.	Lucerne silage	Silage	Higher protein content than grass silage. Lucerne taken for silage should be wilted to 25-30% dry matter.
Fodder beet	Crop	High in energy and low in protein. Very high in sugar and risk of acidosis at high feeding rates or quick introduction into the diet. Cows need to be transitioned carefully over a 14 – 21-day period depending on target intakes and fed additional fibre. Supplement with phosphorus and magnesium.	Lupin	Concentrate	Good source of energy and seeds contain high levels of protein. Fresh forage or ensiled with maize/cereals, but the thick, juicy stem makes them unsuitable for hay. Lupin meal or flakes are the seeds processed to remove the fibrous coat.

Feed	Type	Characteristics and considerations	Feed	Type	Characteristics and considerations
Maize grain	Concentrate	<p>High energy but low protein.</p> <p>High levels of starch and risk of acidosis at high feeding rates or quick introduction into the diet.</p> <p>Digested relatively slowly, so risk of acidosis is less than barley or wheat.</p> <p>Needs to be crushed before feeding it.</p>	Oat silage	Silage	<p>Can be lower in energy than pasture silage as quality changes with maturation: protein declines, soluble carbohydrate increases.</p> <p>Oats can be used for spring-harvested silage and also following winter grazed kale to reduce N leaching.</p> <p>Requires top management, can get high wastage if poor quality.</p>
Maize silage	Silage	<p>Moderate energy levels.</p> <p>High starch content but low protein.</p> <p>Can feed up to 40% of diet to milking cows and 50% of diet for dry cows if other protein sources in the diet.</p> <p>For short periods (up to a month) can feed up to 80% of diet for dry cows.</p> <p>At high intakes requires supplementation with Ca, Mg and Na.</p>	Palm kernel extract (PKE)	By-product	<p>Moderate energy and protein.</p> <p>High in NDF but low in effective fibre.</p> <p>Low in soluble sugars and starches, therefore no risk of acidosis.</p> <p>Fonterra recommendations are to feed no more than 3 kg DM/cow/day to milking cows to avoid FEI grading.</p> <p>Good feed for gaining body condition in dry cows.</p> <p>At high intakes review copper supplementation.</p> <p>High in phosphorus so limit feeding to springing cows to reduce risk of milk fever.</p>
Molasses	By-product	<p>High energy and low protein.</p> <p>High sugar content and high risk of acidosis.</p> <p>Max intake 1.0-1.5 kg DM/cow/day (i.e. 2 l/cow) and must be introduced gradually to the diet.</p> <p>Very palatable and can be used to mix with less palatable feeds or minerals.</p>	Pasture hay, good	Straw/Hay	<p>Low energy and high fibre content.</p> <p>Suitable feed for dry cows, or to reduce risk of acidosis and bloat.</p>
Oats	Concentrate	<p>Moderate energy although lower ME than wheat or barley and higher fibre content.</p> <p>Higher in unsaturated oil.</p>	Pasture hay, poor	Straw/Hay	<p>Very low energy and high fibre content.</p> <p>Not suitable as milking cow feed.</p> <p>Can be fed to dry cows if fibre is needed in the diet.</p>

Feed	Type	Characteristics and considerations	Feed	Type	Characteristics and considerations
Pasture silage, good	Silage	<p>Good source of energy and protein.</p> <p>Can be used as a fibre source when feeding high sugar or starch feeds (e.g. fodder beet).</p> <p>Wastage needs to be considered if feeding out in paddocks in poor conditions.</p>	Potatoes	By-product	<p>High energy and low in protein.</p> <p>High in starch and high risk of acidosis at high feeding rates and/or quick introduction into the diet.</p> <p>Need to restrict to 3 kg DM/cow/day and introduce slowly to the diet.</p>
Pasture silage, poor	Silage	<p>Lower in energy and protein than good quality silage.</p> <p>Suitable feed for dry cows or as a fibre source to reduce risk of acidosis.</p> <p>Wastage needs to be considered if feeding out in paddocks in poor conditions.</p>	Soya bean hulls	By-product	<p>Moderate energy and protein levels.</p> <p>Good source of digestible fibre.</p> <p>Low in soluble sugars and starches and no risk of acidosis.</p>
Peas	Concentrate	<p>Can be used to replace soya and other protein sources but slightly lower in energy and high in sugar and starch, therefore risk of acidosis at high feeding rates and/or quick introduction into the diet.</p> <p>Similar to field beans with marginally lower protein.</p>	Soya bean meal	Concentrate	<p>High energy and high levels of by-pass protein.</p> <p>Has a good amino acid profile.</p>
Pea silage	Silage	<p>Lower energy and higher fibre compared with pasture silage.</p> <p>Can feed as a whole-crop to provide starch and protein in the diet.</p> <p>Peas are sometimes wilted in the field to 25-30% DM.</p> <p>Delaying harvesting beyond flat pod stage results in reduced digestibility and lower energy levels.</p>	Swedes	Crop	<p>High energy and moderate protein content.</p> <p>Can be low DM% which can limit intake.</p> <p>Good palatability and high in soluble sugars and starch therefore risk of acidosis at high feeding rates and/or quick introduction into the diet.</p> <p>Bolting or maturing swede crops, (e.g. elongated necks or flowering heads), increase the risk of anti-nutritional factors (e.g. glucosinolates).</p>
Pea straw	Straw/Hay	<p>Low in energy and high in fibre.</p> <p>Not suitable as a milking cow feed.</p> <p>Pea straw is usually a crop residual from harvesting field peas containing mostly dry stems and leaves.</p>	Tapioca	Concentrate	<p>High energy but low protein.</p> <p>Similar starch content to maize grain, but very high risk of acidosis as starch ferments very rapidly.</p> <p>Should only be fed via in-shed feeding or mixed on a feed pad.</p>
Plantain	Crop	<p>Good source of energy and protein particularly during hot, dry summers. For more informations refer to DairyNZ website 'Plantain'.</p>	Triticale	Crop	<p>Medium energy forage crop or whole-crop silage.</p> <p>Some autumn sown varieties can only be grazed once; others may be grazed twice and cut for silage.</p> <p>Can be harvested at an earlier stage before seed head is present (green chop) giving a silage value similar to high quality grass silage.</p>

Feed	Type	Characteristics and considerations	Feed	Type	Characteristics and considerations
Turnips	Crop	<p>High energy and moderate protein.</p> <p>Use long narrow breaks and introduce cows gradually to adjust to crop.</p> <p>Should not be fed at more than a third of the daily diet.</p>	Wheat silage	Silage	<p>Medium energy forage.</p> <p>Requires top management (small harvesting window) and not all regions are suited to growing quality cereal silage.</p> <p>Can get high wastage if poor quality.</p>
Urea	By-product	<p>No energy but concentrated source of non-protein nitrogen and contains 46% N.</p> <p>Should only be fed as part of a mixed ration as high risk of ammonia toxicity.</p> <p>Introduce slowly and only fed in small quantities (< 150g/day).</p> <p>Will only be of benefit as a protein source in a diet that is low in rumen degradable protein and high in soluble sugars and starches.</p>	Whole cotton seed	Concentrate	<p>High in energy and protein.</p> <p>High in fibre and fat.</p> <p>Intake should be limited due to chemical residuals from growing the crop and high fat content.</p>
Wheat	Concentrate	<p>Very high energy with average protein.</p> <p>High in starch, low in fibre, and risk of acidosis at high feeding rates or quick introduction into the diet.</p> <p>Higher risk of acidosis than with barley or maize grain.</p> <p>Must be crushed before feeding.</p>			



For more details see TechNotes 6: Protein metabolism, and 24: Use supplements and crops profitably.

4.4 Further reading

DairyNZ Facts and Figures. dairynz.co.nz/publications/dairy-industry/facts-and-figures/

Ewing, W. N. 1997. *The Feeds Directory - Volume 1 Commodity Products Guide*. Leicestershire, England: Context Publications.

Holmes, C. W., I. M. Brookes, D. J. Garrick, D. D. S. Mackenzie, T. J. Parkinson, and G. F. Wilson. 2007. *Milk production from pasture* (2nd rev. ed). Massey University: Palmerston North, New Zealand.

Kolver, E. 2000. Nutrition guidelines for the high producing dairy cow. *Proceedings of the Ruakura Farmers' conference*. 52: 17-28.

NRC. 2001. *Nutrient requirements of dairy cattle* (7th rev. ed). Washington, United States of America: National Academy Press.

Westwood, C. T., and H. Mulcock. 2012. Nutritional evaluation of five species of forage brassica. *Proceedings of NZ Grassland Association*. 74: 31-38.