WHAT'S IN A FOOD? FEED EVALUATION

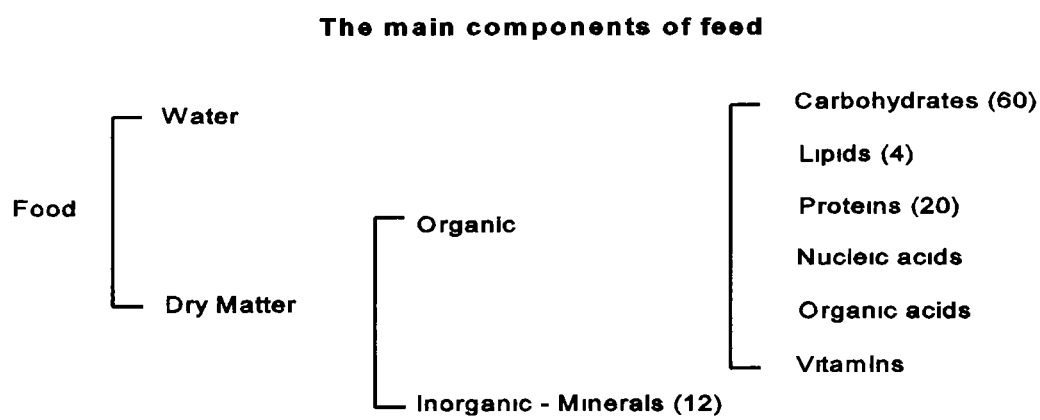
Peter Isherwood

WHAT IS A FOOD?

Food is the material which, after ingestion by animals, is capable of being digested, absorbed and utilised to meet the animals' requirements for maintenance and production We use the term 'food' to describe any edible material Grass and hay, for example, are described as food, but like all foods not all their components are digestible The food deer eat consists almost wholly of plants and plant products, the exception being milk pre-weaning or fish meal Feeds differ in value depending on source and quality and it is important to understand how they differ and why these differences are important

Plants and animals contain similar types of chemical substances and these can be grouped into classes according to chemical constitution, properties and function One way of splitting up these components can be seen in Figure 1

Figure 1



( ) = % of component in pasture dry matter

More simply we can group the above into the macro-nutrients

MOISTURE	ENERGY	PROTEIN	MINERALS AND VITAMINS

Only macro-nutrients are considered in this paper

2. ROLE OF, AND VARIABILITY IN WATER, ENERGY AND PROTEIN IN FEED

Water

Water is essential for life and seldom is water in the feed eaten in a sufficiently large quantity to meet total water needs of the animal, so water intake in food is supplemented by drinking

Common feeds available to deer contain a large variation in water content - from 95% to 10% (See Table 2 of feed values at end of this paper) It is not necessary to have knowledge of water intake or the ratio of feed water to drinking water However, we must still know about the water or moisture content of feeds for two reasons

a) Water contains no energy or protein so it needs to be excluded before we assess the energy and protein content When moisture is removed from a feed what remains is conventionally known as 'dry matter' (DM)

b) Water content may limit intake There is increasing evidence that the maximum feed intake of an animal may be influenced by the water content of a feed, this is most obvious in 'difficult to eat' food with a low dry matter i e large roots or tubers Animals appear to require regular periods where activities such as rest and rumination take place

Energy

All animals require energy to survive It is required for muscular activity, the maintenance of bodily functions and the production of milk and tissue (growth or foetus) There is a wide variation in the energy contents of common feeds, in the order of 100% per unit dry matter

Protein

Proteins are used as biochemical building blocks by animals The protein content in feed varies from around 3% to 35% of the dry matter (Table 1) It is difficult to accurately assess deer protein requirements and very little research work has been performed in the area The understanding of protein needs in ruminants is complex because of micro-organism activity in the rumen enhancing or depreciating the protein supply from the feed This is discussed presently

In general, however, it is usually energy rather than protein that is the limiting nutrient in deer feeding

3. FEED EVALUATION

To assess the amounts of constituents discussed above laboratory methods are required The standard methods are described below

a) Dry Matter

The most common and simple method for measuring the moisture content in a feed is by placing a known weight of feed in an oven ranging from 50-100°C until all the water has been evaporated (usually 24-48 hrs) The remaining dry matter is weighed and expressed as a percentage of the original weight e g

Weight into oven	**Weight out of oven**	**% Dry Matter (DM)**
230g	71g	= 30 9

There are sometimes problems with this method where compounds other than water are lost on heating This is most notable in the case of silage where significant amounts of volatile lower fatty acids and alcohols are lost A correction factor is required to account for these losses which in wetter silages can be over 2 percentage dry matter units

b) Energy

Available energy content of a food is less easy to measure A number of steps are involved

i) *Gross Energy (GE)*
The total energy content of most ruminant feeds varies little from 18 5 megajoules (MJ) of energy per kg DM This can be measured relatively easily in the laboratory using bomb calorimetry which determines the heat produced on combustion The value is known as the gross energy (GE) of the feed

ii) *Digestible Energy (DE)*
Not all the DE is available to the animal, some of it is tied up in complex biochemical structures, most significantly plant fibre, which can not be broken by the physical or biochemical processes of the animal and is lost in the faeces The most accurate method for assessing the degree that a feed is digestible is by performing a digestibility trial

Digestibility Trial

In a digestibility trial, the food under investigation is given to the animal in known amounts and the output of the faeces measured The feed is given to animals for at least a week before collection of faeces starts, which then continues for 5 to 14 days The amount of DM appearing in the faeces is considered to be the indigestible portion of the feed The DE of the feed and the faeces can be measured (or estimated) and a figure of the digestible energy content of the feed calculated For example

- The animal eats 12 kg of hay/day
- The hay contains 11 kg of dry matter (91 7% DM)
- The faeces contains 4 6 kg of dry matter/day
- The gross energy of the faeces and hay is 18 5 MJ/kg

	Amount of feed fed	Amount of faeces extracted	Digestibility
Dry Matter (kg)	11	4 6	58 2
Energy (MJ)	203 4	85 1	58 2

Digestibility of DM = 58 2%

Digestibility energy content = 203 4 - 85 1 = 118 3 MJ

DM digestible energy content = = 10 8 $MJ\,DE/kg\,DM$

There are inaccuracies with the above calculation Digestibility is not the whole story because we know that significant amounts of energy are lost through (a) methane production in the rumen (about 10-12% of the digestible energy of the food) and (b) urine (6-8% of the digestible energy) We can measure these losses directly, but with difficulty, or assume these losses account for 18% of digested energy, therefore The DE less the methane and urine energy losses is known as metabolisable (ME) energy

$$\frac{10.8}{1} \times \frac{100-18}{100} = 8.9\ MJM/kg\ DM$$

Chemical methods of estimating digestibility

Digestibility trials are laborious and expensive Laboratory methods simulating digestion may be used to predict digestibility and energy This can be done relatively accurately by treating the feed firstly with rumen liquor and then with pepsin The steps in the method are

1 Feed dried and ground
2 Rumen fluid added to 0 5 g feed
3 Incubated at 50°C for 60 hrs
4 Pepsin solution at pH2 replaces rumen fluid
5 Incubated at 50°C for 36 hrs
6 Dried

The percentage of the original 0 5g that remains represents the non-digestible fraction

This technique is called an '*in vitro* digestibility' test Both the DM and the organic matter digestibility are commonly measured (DMD and OMD)

The rumen liquor available may vary in its fermentative characteristics according to the diet of the donor animal resulting in variations in the estimations of digestibility To overcome this a broad spectrum cellulose enzyme solution can replace the rumen fluid

This method is accurate but slow, more rapid methods are available but these rely on purely chemical methods

a) Fibre - Acid detergent fibre (ADF) which is the residue after reflux with 0 5 M sulphuric acid and a detergent-acetyltrimethylammonium bromide ADF is a measure of the indigestible cell wall or crude lignin and cellulose components of the feed

   There is a reasonable relationship between ADF and digestibility for some types of feed i e forages, but less for others such as grains and compound feeds

b) Proximate analysis - Further analysis of a feed including crude protein, ash, fat and an estimation of the soluble carbohydrate content along with ADF gives a fuller picture of the feed's quality and allows for a more accurate energy estimation than ADF on its own

c) NIR (Near Infrared Reflectance Spectroscopy)

   This is a method increasing in popularity The principle is that infrared light is reflected off a sample being measured and analysed The light produced by an NIR instrument interacts with the material as absorption, diffraction, reflection, refraction and transmission Obtained spectra reflect molecular bonds in the feed (i e O-H, C-H and N-H) and these are compared to calibration spectra of similar feeds of known composition

The technique depends on the quality and number of calibrations in a database, the preparation of the sample and the interpretation of raw data Calibration samples are analysed by traditional chemical techniques so NIR can never claim to be a more accurate method It is, however, rapid and can predict a large number of components including energy, protein quality, fibre, and minerals

Protein

Methods for assessing the protein in a feed actually measure the nitrogen content The Kjeldahl technique is the most common and established method In this method food is digested with sulphuric acid, which converts all nitrogen presents except that in the form of nitrate and nitrite to ammonia This ammonia is liberated by adding sodium hydroxide to the digest, distilled off and collected in a standard acid and the concentration is then measured by titration

It is assumed that protein contains 16 percent nitrogen so by multiplying the N content by 100/16 or 6 25, an approximate protein value is obtained Because this figure contains non-protein fractions including, for example, ammonia and amines it is known as crude protein It gives little indication of protein quality, especially in some feeds such as silage

Digestible crude protein can be measured, but this is inaccurate because protein can

a) be used by micro-organisms to build new microbial cells These may then be flushed into the small intestine, digested and absorbed by the host animal

b) be broken down by micro-organisms as an energy source releasing ammonia, which may be used by the micro-organisms themselves or absorbed into the bloodstream where it may be recycled as urea in the saliva or excreted in the urine

c) pass through the rumen without interference to be digested and absorbed in the small intestine

d) pass through the gastro intestinal tract undigested and unabsorbed

There is limited knowledge of these values for feeds, but methods are available to measure them

Measurement of degradable protein

The most successful method for estimating protein quality is the nylon bag technique Food (3-5g) is placed in small pore nylon bags, (up to 20 bags are needed for each food being tested)

Bags are placed in the rumen via a cannula and removed at intervals from 0 to 72 hours The bags are then washed, dried and the remaining material measured for nitrogen The rate of disappearance is calculated and values for degraded and undergraded protein obtained

Again this method is expensive and open to errors associated with, for example, washing and incomplete availability of feed in bags to micro-organisms There is also a lack of knowledge as to the fate of protein/nitrogen in the small intestine

It must be remembered that, generally, a food with a high crude protein will provide adequate protein to the small intestine

PHYSICAL FEATURES OF FEEDS

While laboratory techniques give us accurate results and feed evaluation tables (Table 2) give us an indication of dry matter and energy and protein content, often a quick, immediate assessment of the quality of a feed is required `Is this a good or bad silage'? Our sense of touch, sight and smell take over For example

Colour

Feeds vary in colour and this variation says something about quality For example

1 Green reflects young, freshly grown material which has not been weathered Young fresh grown material has less indigestible structural plant components

2 Brown reflects the other extreme (except in silage were some `yellow/browning' is normal) It is associated with older and/or weathered plant material of lower feed value

3 Dark brown to black material is found in overheated material and is usually of very poor quality

Smell

Sweet, fresh smell equates with good preservation and minimal loss of nutrient value and musty, sour smells indicate deterioration and lower feeding values

In silage, putrid smells are associated with poorly preserved butyric acid fermented material Wet silages contain more fermentation acids and will tend to have a stronger odour than drier silages However, silages with anything but a lactic acid odour, including those with traditional good smell qualities such as `whisky' or `tobacco', will usually contain other acids indicating a poorer quality fermentation

Breaking strength

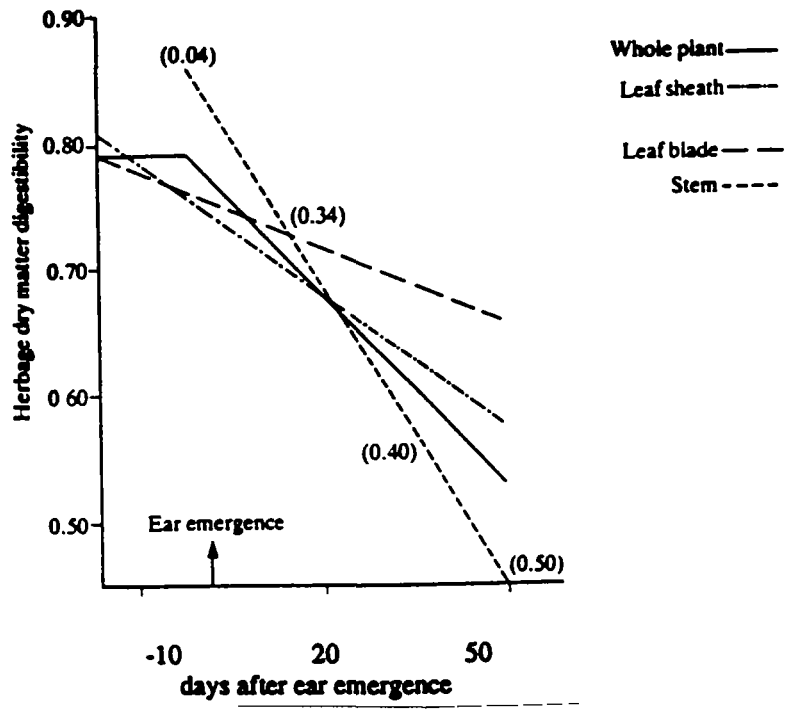
Higher feeding values are usually associated with material that is easily broken, an exception being with rotted material Stronger materials contain more indigestible fibre For example, young stems will break quite readily when tested but older more indigestible stems are really tough

Proportion of components

(a) Leaf and stem

The most important indicator of quality in forages is the leaf to stem ratio, the higher this ratio the higher the feeding value Figure 2 shows how this ratio falls with time decreasing the quality A high leaf/stem ratio indicates a young immature plant

Figure 2. The digestibility *in vitro* of the dry matter in the whole plant, and in the leaf blade, leaf sheath, and stem fractions of S.37 cocksfoot during first growth in the spring. Figures in parentheses are the proportions of stem in the whole plant.



(b) Grains and seeds

Grains on their own will usually have a higher feeding value than leaf, but as a complete crop the advantage of the grain is offset by a high stem content

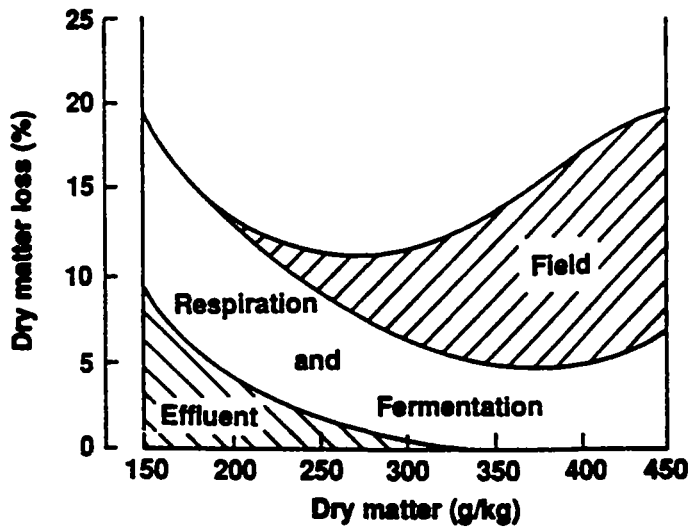
(c) Tubers and bulbs

Roots and tubers generally have a high feed value Variation, as with grains, tends to be small, and values deviate little from those found in a table of feed values (Table 2)

Losses during hay and silage production

Losses of nutrient value are associated with most stages of hay and silage production, from cutting to feeding out Even when making conditions are suitable and good methodology is followed losses are inevitable Figure 3 shows typical losses in silage

Figure 3



Model of dry matter losses in well managed silage systems

Losses are associated with the following processes

- Respiration losses due to plant metabolism and enzyme activity soon after cutting
- Fermentation losses are due to micro-organisms activity which occur in the period between the stacking of material and the halt of fermentation when adequate pH levels are achieved
- Field losses associated with mechanical damage and cut material left in the paddock
- Effluent losses occur when moisture is lost from plant cells, usually in the early stage of fermentation
- Feeding out

Typical losses for grass hays and silages can be seen in Table 1 where it can be noted that losses (from cutting to actual animal consumption) in hay making are typically around 40% and silage 30% All these four types of losses are unavoidable, but it can be seen that fewest losses occur in silages with a DM of around 25-35%

Table 1: Typical Losses during Grass Hay and Silage Production

			Dry Matter Loss (% DM)	
Silage			Range	Normal
Respiration			2-8	5
Rain damage			1-5	2
Other field losses			1-5	1
Chopping			1-8	3
Storage			6-16	10
Feeding out			5-20	10
Hay				
Respiration				
Rain Damage	5mm		2-8	5
	25mm		1-3	2
	50mm		4-14	8
			8-27	15
			1-20	2
Raking				
Other field losses	inside		2-9	5
Baling		outside	2-9	5
Storage			3-9	5
			5-22	12
Feeding out				
			5-20	10

(Adapted from Rotz and Muck)

Importance and use of feed evaluation

Feed quality, and a measure of it is important for the following reasons

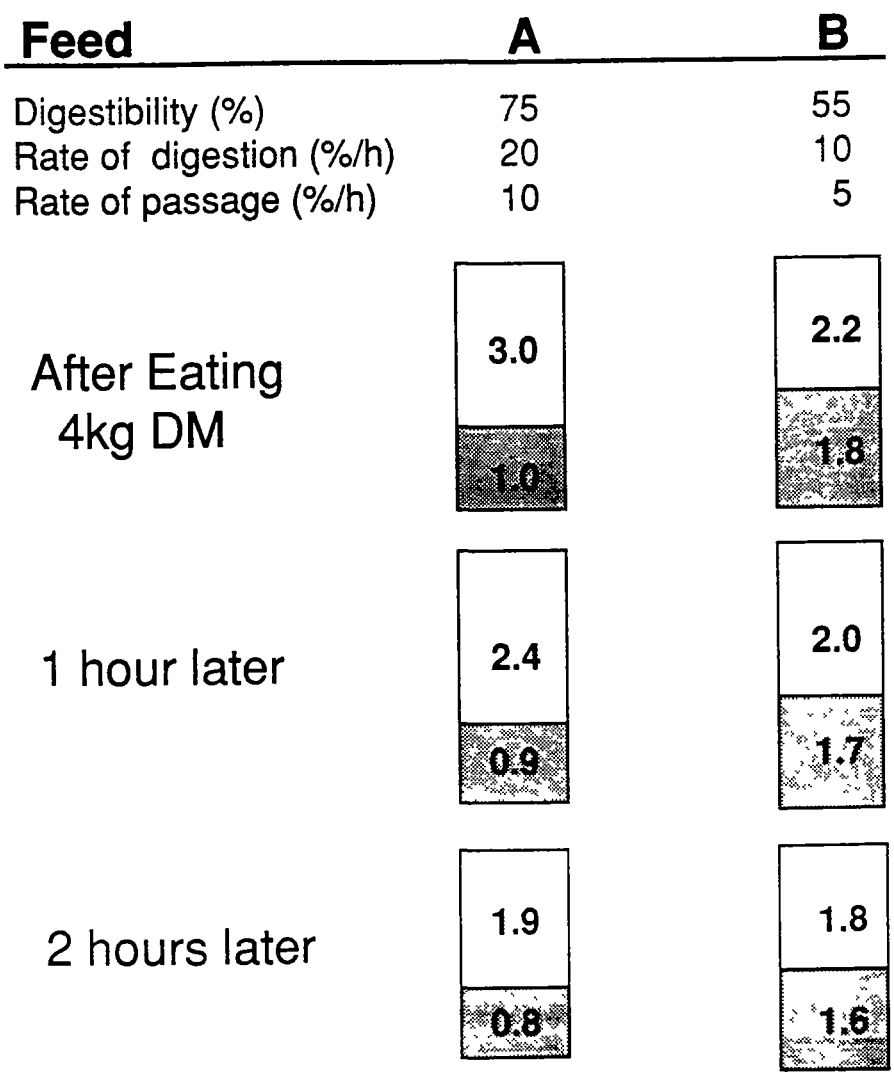
1 Effect of feed quality on intake

The intake of a high quality feed (over 10 5 MJME/kg DM) is limited by how much the animal needs and by the quantity made available However, the intake of pasture, which is usually high quality, is limited by how much is allocated

Intake of low digestible feeds (e g hays, most silages and straw) on the other hand are limited mainly by restricted digestion of the feed Lower quality feeds are digested in the rumen at a slower rate than high quality feeds This means the rumen empties more slowly Secondly, with low digestibility, there is more indigestible material to leave the rumen and although it leaves in greater quantities, it takes longer to empty the rumen (Figure 4)

Thus low feed quality is a double edged sward on its effect on rumen emptying, rate of digestion is slower *and* rate of passage of indigestible material is slower

Figure 4. Example of the effect of rate of digestion and passage on rumen emptying



2. Balanced diet

A knowledge of feed values allows a balanced diet to be formulated containing, for example, adequate protein and energy

3. Quantities to feed

In order to avoid over or under-feeding of supplements their relative feeding values should be known

4. Price comparison of feeds

The most obvious need for a feed value, is when decisions have to be made on feed purchases Good commercial decisions can be made on the basis of feed evaluation calculations For example

'Should I buy a good sample of barley at $240/ton or some potatoes at $50/ton'

The answer involves calculating the cost of available energy (MJME) in the two sources The steps in the arithmetic are

1 Calculate the price per kg of feed

	Price (per tonne)	Weight (kg)	Price/kg
Barley	$240	1000	$240/1000 = 24c/kg
Potatoes	$50	1000	$ 50/1000 = 5c/kg

Note: You must check the weight of 'bales' 'bags' etc , when the price is not quoted per unit weight

These figures must next be adjusted for the different dry matter and energy value for each feed

2 Find (look up the feed values) the dry matter and energy for both feeds in Table 2

	Dry Matter %	Energy Value (MJME/kg DM)
Barley	86	12 5
Potatoes	23	12 5

3 Calculate the cost per kg *dry matter* by dividing the cost of the feed by the dry matter percentage Then the calculate the cost per unit of available energy, divide the cost per kg dry matter by the energy content

	Cost per kg (cents/kg)	Cost/kg DM (cents/kg DM)	Cost (c/MJ ME)
Barley	24	24/0 86 = 27 9	27 9/12 5 = 2 23c
Potatoes	5	5/0 23 = 21 7	27 7/12 5 = 1 74c

In this example potatoes cost 1 74c per unit energy, considerably less than barley at 2 23c per MJME

4 These steps can be simplified using the following formula

$$\text{Cost per MJME} = \frac{\text{Market price (\$)}}{\text{unit weight x dry matter x energy content}}$$

For example Barley

= 2 23 c/MJME

Consequences of miscalculation feed value

Examples of the consequences of under-estimating the DM or ME value of a feed are illustrated below

1. Overfeeding

200 hinds require to be maintained at a steady liveweight over 60 days in winter You assume your silage has an energy value of 9 5 MJME/kg DM

In fact its value is 10 0 MJME/kg DM and over the period the hinds gain 60g/d You will feed out 9 tonnes (of 30% DM) more silage than was actually required

This is similar to an error in estimating the DM of a 25% DM silage when it is in fact 23 5%

2. Underfeeding

100 weaner stags need 1 kg of 10 5 MJME/kg DM silage/d as a supplement to winter grass to grow at 80g/d

If your silage is only 8 65 MJME/kg DM the stags will only grow 30g/d Over a 100 day winter this represents 8 kg less liveweight gain

Which is a difference of 100g/d/animal compared to your target?

This level of error is similar to using a dry matter of silage to have DM of 33% when its true figure is 40% DM Or assuming a silage of 40% DM and 10 5 MJME/kg DM contains 36 8% DM and an energy value of 9 6 MME/kg DM

Summary:

In this paper I have

- Identified the major component of a food and shown how these can be measured by chemical and animal based methods
- Explained the importance of feeding value and illustrated how poor feeding decisions can be made when inaccurate feeding values are used

References

McDonald, P , Henderson, A R , Heron, S J E (1991) The Biochemistry of Silage John Wiley and Sons, Chichester, UK

Wilkinson, J M (1988) Journal of the Royal Agricultural Society of England, 149 158-67

Rotz, C A., Muck, R E (1994) Changes in forage quality during harvest and storage In Forage Quality, Evaluation and Utilization Ed Fahey, C G American Society of Agronomy, Inc Madison, Wisconsin, USA

McDonald, P , Edwards, R A , Greenhalgh, J F D (1981) Animal Nutrition, Longman, London

Figure: **Results of pasture silage (pit, stack and wrapped silage) analysed by the Analytical Services Unit, Lincoln University, January - April 1996 (n=920).**

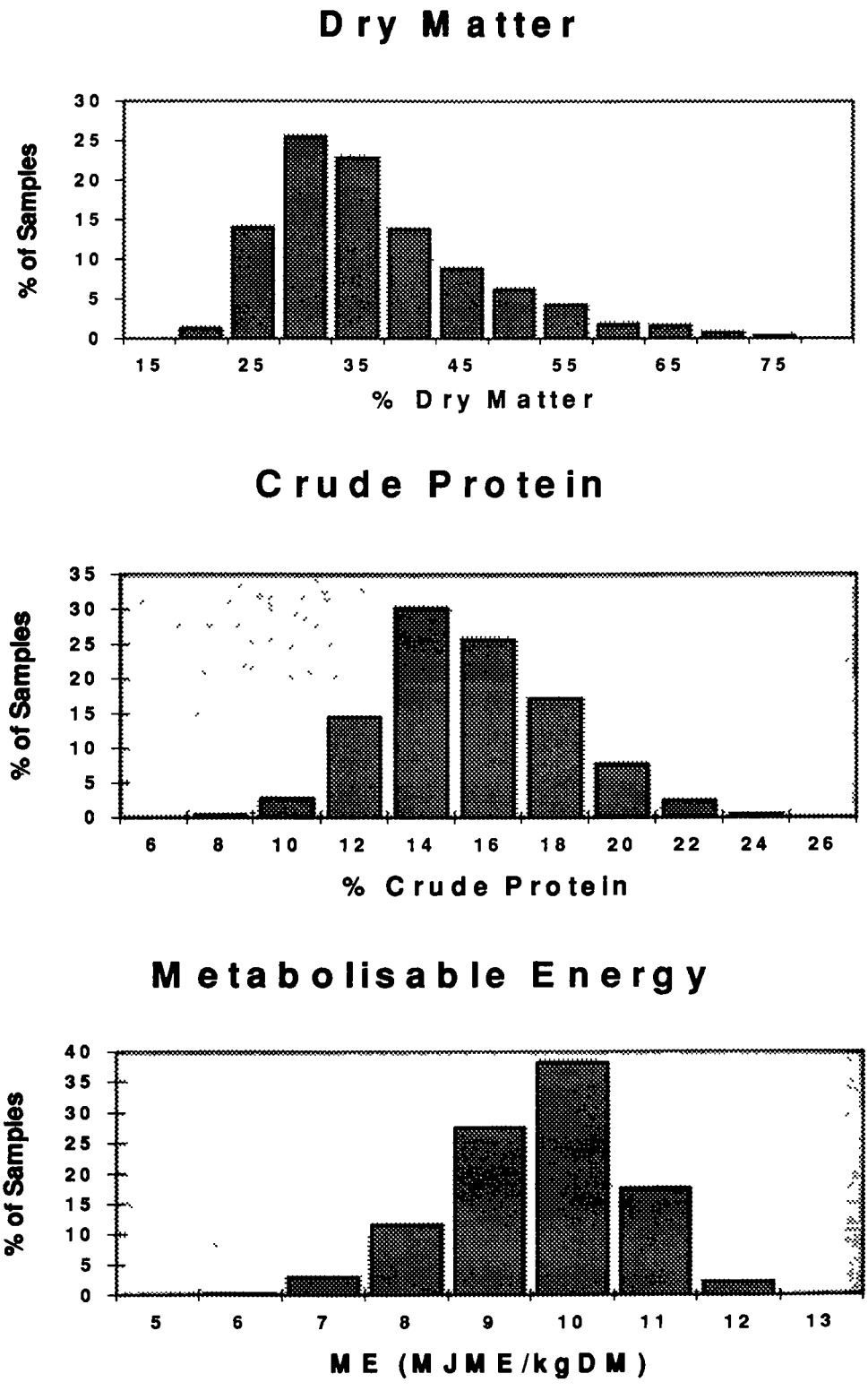


Table 2:

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Table of typical feed value of common feeds

Feed Type		Dry Matter (%)	Available Energy (MJME/kgDM)	Crude Protein (% DM)
Hay				
Meadow hay	- good, green, leafy	86	9 0	15 0
	- poor, brown, stemmy	86	7 5	12 0
Lucerne hay	- green, leafy	86	9 5	18 0
	- brown, stalky	86	7 5	12 0
Oaten hay	- green	86	8 5	9 0
	- golden	86	7 5	6 0
Clover hay	- leafy	87	9 5	16 0
	- stalky	87	7 0	8 0
Straw				
Barley straw	- leafy, some grain, golden	87	7 0	4 5
	- stemmy, brown, weathered	87	5 5	4 0
Oat straw	- average	87	6 5	3 0
Wheat straw	- average	87	6 0	4 0
Ryegrass straw	- leafy, soft	87	6 0	6 0
	- stalky, hard	87	6 0	6 0
Pea straw	- average	87	7 0	8 0
Maize	- residue (in paddock)	80	7 5	5 0
Silage				
Pasture	- leafy, direct-cut	18	9 5	14 0
	- stalky, direct-cut	22	8 0	12 0
	- leafy, wilted	28	9 5	14 0
	- stalky, wilted	32	8 0	12 0
Maize	- good grain content	32	10 5	7 0
Grain				
Barley	- good sample	87	12 5	9 0

	- pinched grain	87	11 5	9 0
Wheat	- good sample	87	13 0	12 0
	- pinched grain	87	11 5	12 0
Oats	- good sample	87	11 5	12 0
	- pinched sample	87	10 0	12 0
Maize	- good sample	87	13 5	9 0
Peas		85	13 0	30 0
Lupins		85	13 0	30 0

Feed Type		**Dry Matter (%)**	**Available Energy (MJME/kgDM)**	**Crude Protein (% DM)**
Greenfeeds and root crops				
Oats	- leafy	1275	12 0	
	- early flowering	20	9 0	7 0
Wheat, barley, ryecorn, sorghum (as for oats above)				
Italian Ryegrass		15	12 0	18 0
Turnips		11	12 5	18 0
Swedes		9	13 0	20 0
Kale	- leaves and soft stem	15	12 5	16 0
	- hard stem	25	8 0	12 0
Rape		17	12 0	16 0
Horticultural crops				
Apples		18	11 0	3 0
Kiwifruit		20	12 0	5 0
Carrots		13	13 0	7 0
Cabbage		12	13 0	14 0
Cauliflower		12	13 0	14 0
Potatoes		23	12 5	10 0
Pumpkin		25	12 5	16 0
Squash		25	12 5	16 0
By-products				
Bran		87	9 6	14 5
Pollard		87	12 3	16 5
Broll (mixture of Bran and pollard)		87	dependent on mix	dependent on mix
Brewer's grains		35	10 0	25 0
Linseed meal		87	12 0	40 0
Apple pomace (fresh)		25	8 5	6 0

Grape pomace	25	8 0	7 0
Processed pea residues 18	10 5	15 0	
Proprietary feeds			
High energy, fat fortified dairy rations	86	13 5	16 0
Grain based pellets	86	12 5	14 0
General purpose stock pellets	86	10 5	12 0

(Note: check specification of individual products)

Pasture

Ryegrass/white clover			
Spring	12	13 0	25 0
Summer	16	10 0	20 0
Autumn	15	11 5	18 0
Winter	15	11 5	18 0

FEED ANALYSES

The following table contains a feed analysis undertaken at the Lincoln University Laboratory, of a range of feeds available on the farm used during the on-farm workshop

Included is a range of different silages and notes on interpretation

'Dry' Feeds

Sample	% Dry Matter	% Organic Matter	% Crude Protein	% Dry Matter Digestibility	Predicted Metabolisable Energy (MJME/kgDM)
Barley Straw	87.9	94.6	4.2	35.9	4.1
	85-89	*92-95*	*5-7*	*55-62*	*7 2-8 5*
Pea Vine Hay	84.6	90.2	8.0	57.2	7.7
	82-87	*92-95*	*6-12*	*60-70*	*8 2-10 0*
Bad Hay	85.6	94.5	10.1	48.2	6.1
	82-87	*92-95*	*6-12*	*60-70*	*8 2-10 0*
Poor Hay	84.1	94.4	8.6	52.3	6.8
	82-87	*92-95*	*6-12*	*60-70*	*8 2-10 0*
Good Meadow Hay	83.1	89.7	16.7	66.0	9.2
	82-87	*92-95*	*9-15*	*60-70*	*8 2-10 0*
Lucerne Hay	80.8	88.9	15.2	55.8	7.4
	82-87	*92-95*	*15-20*	*60-70*	*8 2-10 0*
Barley	87.2	97.0	12.3	83.8	12.8
	86-88	*95-98*	*8-13*	*80-88*	*11 5-13 0*
Oats	88.7	97.3	14.5	77.1	11.5
	86-88	*95-98*	*8-13*	*77-85*	*11 0-12 5*
Oak Leaves	44.1	93.7	17.3	52.6	6.8
	?	*?*	*?*	*?*	*?*

Ensiled Feeds

Sample	% Dry Matter	% Organic Matter	pH	AmmoniaN as % of Total N	% Crude Protein	% Dry Matter Digestibility	Predicted Metabolisable Energy (MJME/kgDM)
Balage 1	**39.0**	**89.8**	**4.4**	**5.4**	**12.9**	**71.8**	**10.1**
	40-50	*92-95*	*4 7-5 4*	*2-8*	*9-15*	*60-75*	*8 2-10 8*
Balage 2	**48.6**	**90.9**	**4.2**	**5.5**	**12.9**	**71.5**	**10.1**
	40-50	*92-95*	*5 0-5 5*	*2-8*	*9-15*	*60-75*	*8 2-10 8*
Good Silage	**31.0**	**89.9**	**4.1**	**7.4**	**19.9**	**68.8**	**9.6**
	25-35	*92-95*	*4 2-4 9*	*2-8*	*9-15*	*60-75*	*8 2-10 8*
Oat Silage	**26.2**	**90.4**	**4.0**	**6.6**	**13.0**	**67.0**	**9.2**
	25-33	*92-95*	*4 0-4 7*	*2-8*	*6-12*	*60-75*	*8 2-10 8*

Interpretation of silage results

1. **Dry Matter %** - Depends on several factors, ie maturity of grass ensiled, wilting etc For stack pit silage ideal levels are between 25-35% Below 25% there can be problems with effluent and above 40% problems with consolidation are possible Typical values for wrapped silage are 40-50%
2. **Organic Matter%** - Ideal values 92-95% Figures below these are caused by soil contamination or losses associated with secondary fermentation Low levels dilute the value of the silage
3. **pH** - As acidity of the fermenting ensiled product increases the pH drops from about 6 (pasture) to 4 or less The lower the pH the more acid and better preserved the silage If the silage is wet a lower pH is required

	DM content		
	25	**30**	**35**
Poor	> 5 3	> 5 5	-
Moderate	4 7 - 5 3	4 9 - 5 5	> 5 2
Good	4 2 - 4 7	4 4 - 4 9	4 7 - 5 2
Excellent	< 4 2	< 4 4	< 4 7

> = greater than
< = less than

4. **Crude Protein** - An indicator of the protein of amino acids available to the animals (This value can be unreliable as it also includes non protein nitrogen containing substances (i e Ammonia))
5. **Ammonia Nitrogen** - If conditions during fermentation or subsequently allow spoilage organism to be active, plant protein is degraded to ammonia nitrogen and other non-protein compounds and lower the nutritional value of the feed (energy and protein) High levels also affect animal intake This test is the key to the 'how well the silage was made'

Quality of fermentation	**Ammonia Nitrogen (% of total Nitrogen)**	**Relative intake**
Excellent	< 5%	100
Good	5 - 8	98
Moderate	8 - 12	96
Poor	< 12	92

6. **ME** - is a measure of the energy available to the animal, it should be similar to that of the pasture from which it was made As the ME concentration of the silage increases so does its potential intake

MJME/kgDM (or M/D)	**Quality**	**Relative intake**
< 8 0	Poor	< 80
8 - 9 5	Average	80
9 5 - 11 0	Good	90
> 11 0	Excellent	100

Analytical Services, Lincoln University

Silage Analysis

Sampling

There are several ways to sample a stack/bale The most important thing to remember is that the material you send into the lab must be representative of what is in the stack/bale The laboratory test is only as good as the sample submitted for analysis

1 Core sampling - by using a corer, ie made from an individual stack from a length of milk pipe sharpened at one end, several samples can be taken Remove the portion of silage from the last few cm nearest the cover Two good cores should give a good representative sample - remember to repair the hole you will have made

2 Hand plucking - samples can be obtained by hand - again several handfuls should be taken from different parts of the stack Do not take samples from near the outer edges

3 From the face or when being fed out - take several samples from a newly exposed silage face or freshly opened bale Collecting 'stale' material will give misleading results This is probably the best way of taking samples from bales as damage from unwanted bacteria etc tends to occur even if the entry point is repaired

How much?

The lab tests only need a few grams of material but we would ideally like about ½ kg Very small samples are unlikely to be unrepresentative of the stack/bale and to go "off" in transit

If you have collected a number of samples from several sites, pool them together, give them a good mix and remove your ½ kg

Transporting the samples

It is important the sample be kept cool, store it in the freezer or fridge until you send it off in a well sealed, good, thick plastic bag after squeezing out the air

By post
Analytical Services
Animal and Veterinary Sciences Group
PO Box 84
Lincoln University
Canterbury

By courier
Analytical Services
Animal and Veterinary Sciences Group
Cnr Ellesmere Junction and Springs Roads
Lincoln University
Canterbury

Send the samples at the start of the week, to avoid danger of them getting held up over the weekend Samples will take a week to process.

Peter Isherwood
Analytical Services Manager