12

Formulating a diet

This chapter

Explains how to formulate a balanced diet that takes account of the production goals.

The main points in this chapter:

- diet formulation involves matching the feed supplied with the specific requirements of the herd in the most cost-effective way
- to provide the nutrients calculated as being required, it is important to know how much feed a cow is capable of eating
- intake capacity depends primarily on size and weight of the cow, quality of the feed on offer and stage of lactation
- supplements should be compared on the cost of the nutrients they contain
- worksheets are provided to calculate cow requirements, nutrients supplied in the diet and their cost
- computer aids are available to assist in formulating diets as four software programs.

Formulating a diet is an important part of an everyday feeding strategy. It is a means of meeting production and financial goals by feeding to the specific requirements of the cow in the most economical way.

To formulate a diet, farmers and advisers need to know the quantity of nutrients the cow or herd needs to meet production and animal health goals, and the nutrient content of the feeds available.

A balanced diet is then one in which 'cow nutrient requirements = nutrients provided in the diet'.

Another consideration in balancing diets is whether the cow is physically capable of eating the amount of feed provided. The final consideration is the economics. The economic response from feeding specific nutrients must be more than their cost. This aspect is often forgotten.

Ration formulation is then:

1 setting the production targets for each cow or the entire herd
2 assessing what home-grown feeds are available
3 deciding what feeds should be purchased
4 ensuring that the ration can be consumed to achieve the production targets
5 ensuring that the ration is the most profitable, both at present and over the entire lactation.

Diet formulation is largely a set of mathematical procedures. However, close observation of cows is also important. Herd production, fertility, body condition and health are all good indicators of nutritional imbalances.

12.1 Information needed to formulate a diet

12.1.1 Cow requirements

Cow requirements should be calculated on realistic production goals. From Chapter 6, there are five factors to consider:

1 maintenance – which depends on live weight
2 lactation – which depends on the yield and composition of milk
3 pregnancy – which depends on the number of months pregnant
4 activity – which depends on the distance and terrain walked to and from the dairy
5 changes in body reserves – which depends on changes in live weight and/or body condition.

Machine chopping of greenchop maize reduces forage selection (Guizhou province, China).

Minerals and vitamins are necessary to fine-tune the system. Often trace element deficiencies are regional and seasonal. Their variability may depend on forage management. When the basal diet is predominantly improved grass species, most of these problems can be reduced by managing the sward well.

Minerals and vitamins have not been included in the exercises in this chapter, although it is important to know whether deficiencies are present on the farm.

As forages are generally the cheapest feeds (see Chapter 8), the main aim of supplementary feeds is to use them to fill in nutrient gaps that occur due to variations in forage availability and quality. In forage-based systems, the most limiting nutrient for milk production is energy. The poorer quality of tropical forages, compared to temperate forages, means that it they can only provide sufficient energy for low levels of milk production, 7 to 8 L/cow per day, which may also be associated with live weight losses. Excessive live weight losses can impair reproductive performance.

12.1.2 How to formulate a diet

Several worksheets are presented at the end of this chapter. Work sheet 1 is used to calculate the energy, protein and fibre needs of a cow, while Work sheet 2 is used to calculate the energy, protein and fibre content of a diet. Work sheet 3 is used to calculate the cost of energy and protein. These Work sheets are also presented in Appendix 6.

The exercises for this chapter (and in Appendix 6) introduce one way of calculating whether the diet is appropriate for cows to reach their expected lactation and live weight performance.

To fill in the worksheets, reference should be made to tables in Chapter 6 and this chapter, although the relevant tables are duplicated in Appendix 5. A calculator is also required.

12.2 Estimating the limits of feed intake

As well as knowing what the cow needs and what nutrients the feeds can provide, consideration must be given to whether cows can consume that amount of food to provide these nutrients. There are two 'rules of thumb' available for estimating how much cows will eat. It is difficult to measure intake of animals accurately, particularly if they are grazing.

12.2.1 Cow size and feed quality

Milking cows can generally eat 3% of their live weight (LWT) as dry matter (DM) (Target 10 1999). Therefore, a cow weighing 500 kg can consume no more than 15 kg DM/day, while a 450 kg cow can consume no more than 13.5 kg DM/day.

Live weight on its own is not always a good indicator of intake limits for individual animals as cows of the same live weight can differ in appetite, in rumen capacity or in eating habits. Feed of the same quality may be eaten in different amounts, depending on chop length, dry matter content or palatability.

The second rule of thumb is based on the combination of percentage of Neutral

Detergent Fibre (NDF%) and live weight. As percentage of Neutral Detergent Fibre increases in forages, cows eat less according to the following formula:

$$\text{Maximum dry matter intake (kg/d)} = (120 \times \text{NDF\%}) \div (100 \times \text{LWT})$$

The following estimations for daily maximum intake for a diet containing 45% NDF are:

- for 450 kg cows, (120 ÷ 45) ÷ 100 × 450 kg = 12.0 kg DM/d
- for 500 kg cows, (120 ÷ 45) ÷ 100 × 500 kg = 13.3 kg DM/d

Table 12.1 lists these amounts for various live weight and Neutral Detergent Fibre contents.

Table 12.1 Maximum daily dry matter intake of cows (kg/d) as affected by cow live weight and diet Neutral Detergent Fibre (NDF) content
(Source: Linn and Martin 1989)

Live weight (kg)	NDF content (%)											
	25	30	35	40	45	50	55	60	65	70	75	80
100	4.8	4.0	3.4	3.0	2.7	2.4	2.2	2.0	1.8	1.7	1.6	1.5
150	7.2	6.0	5.1	4.5	4.0	3.6	3.3	3.0	2.8	2.6	2.4	2.3
200	9.6	8.0	6.9	6.0	5.3	4.8	4.4	4.0	3.7	3.4	3.2	3.0
250	12.0	10.0	8.6	7.5	6.7	6.0	5.5	5.0	4.6	4.3	4.0	3.8
300	14.4	12.0	10.3	9.0	8.0	7.2	6.5	6.0	5.5	5.1	4.8	4.5
350	16.8	14.0	12.0	10.5	9.3	8.4	7.6	7.0	6.5	6.0	5.6	5.3
400	19.2	16.0	13.7	12.0	10.7	9.6	8.7	8.0	7.4	6.9	6.4	6.0
450	21.6	18.0	15.4	13.5	12.0	10.8	9.8	9.0	8.3	7.7	7.2	6.8
500	24.0	20.0	17.1	15.0	13.3	12.0	10.9	10.0	9.2	8.6	8.0	7.5
550	26.4	22.0	18.9	16.5	14.7	13.2	12.0	11.0	10.2	9.4	8.8	8.3
600	28.8	24.0	20.6	18.0	16.0	14.4	13.1	12.0	11.1	10.3	9.6	9.0
650	31.2	26.0	22.3	19.5	17.3	15.6	14.2	13.0	12.0	11.1	10.4	9.8

If cows can select within their diets, allowance should probably be made for less fibre in the diet.For example, if the diet on offer tests at 50% NDF, then diet that is selected by the cow may be 5% to 10% lower, or 40% to 45% NDF.

The above rule applies to non-pregnant cows. The capacity of cows in late pregnancy is less because the rumen size is reduced by the increased size of the growing foetus.

Table 12.1 was developed in the United States, from studies conducted in temperate feedlot dairies, and may not be directly applicable to tropical small holder systems. Temperate forages generally have lower levels of fibre than tropical forages. Hence, at similar forage dry matter intakes, cows in South-East Asia would be consuming more fibre than would cows from say, southern Australia. Therefore, at the same live weight, such cows may be able to consume more NDF, hence have a higher maximum dry matter intake, than that predicted from Table 12.1.

To calculate the appetite limit for milking cows taking into account the fibre content of their total diet, the NDF content of each diet constituent must be known. To date, there are no such predictors of appetite restrictions based on Crude Fibre (CF) analyses. Furthermore, it is not possible to calculate Neutral Detergent Fibre from Crude Fibre because these two values measure different components of dietary fibre (see Figure 4.4). Crude Fibre measures alkali-insoluble lignin plus cellulose, whereas Neutral Detergent Fibre measures plant cell walls, which are comprised of alkali-soluble and alkali-insoluble lignin, hemicellulose plus cellulose.

The major (and possibly only) reason for measuring Crude Fibre in feeds is to calculate Total Digestible Nutrients. The newer measurement of Neutral Detergent Fibre is a more meaningful one of dietary fibre, as it quantifies the plant cell walls, which are directly related to digestibility and appetite restrictions.

Table 12.1 is based on dry matter intake of dairy feedlot ratios. Diets containing large amounts of freshly harvested forages may create another problem to milking cows, namely excess moisture content. Wilting fresh tropical forage increases dry matter intake in milking cows (Moran and Mickan 2004). Therefore, Table 12.1 should be considered only a very approximate guide as to the appetite limits of milking cows. It is unlikely that 500 kg milking cows fed good quality tropical pastures/concentrate diets supplying 10 MJ/kg DM of ME would consume more than 13 to 15 kg DM/d. Intake predictions for dry cows and young stock are discussed in the following section.

12.2.2 Examples of intake predictions

Holmes *et al*. (2002) estimated the maximum daily intakes of different classes of dairy stock for forage diets varying in ME content (Table 12.2). These are for grazing animals, so may underestimate intakes in housed animals. Intakes for lactating cows offered diets of less than 9.0 MJ/kg DM of ME are not included in the table because such diets should not be offered to milking cows either at pasture or indoors.

Table 12.2 Maximum intake of forages (kg DM/cow per day) differing in energy content

(Source: Holmes *et al.* 2002)

	Live weight (kg)	Energy content (MJ/kg DM)		
		>10.5	9.0–10.5	7.5–9.0
Heifers	100	2.8	–	–
	200	6.0	4.6	3.5
	300	8.0	6.2	4.5
Dry cows	350	9.0	7.3	5.0
	400	10.0	8.1	5.5
	450	10.9	8.8	6.1
	500	11.9	9.5	6.6
Pregnant cows	350	10.8	9.2	7.9
	400	12.0	10.2	8.8
	450	13.1	11.1	9.6
	500	15.2	12.1	10.4
Lactating cows	350	15.5	12.6	–
	400	16.0	15.0	–
	450	17.6	15.2	–
	500	19.1	16.5	–

Chamberlain and Wilkinson (1996) predicted appetites of milking cows based on their diet quality, live weight and milk yield and these are presented in Table 12.3. These intakes were predicted from the Ministry of Agriculture, Fisheries and Food (1984) and indicate nothing about their adequacy to support milk production. In many cases, intakes are too low for cows to consume sufficient energy and protein, hence they will have to lose weight to achieve the target milk yields.

These feed intakes are predicted for cows more than 12 weeks into their lactation. For cows in their first five weeks of lactation, Chamberlain and Wilkinson (1996) considered their appetites to be only 86%, while from week 6 to 12, appetites will be 95%, of those in Table 12.3.

Table 12.3 Predicted daily intakes (kg DM/cow per day) of different diets in cows of various live weights and milk yields
(Source: Chamberlain and Wilkinson 1996)

Diet [ME] (MJ/kg DM)	Live weight (kg)	Daily milk yield (L/cow)				
		0	5	10	15	20
9.0	400	7.5	8.4	9.2	10.1	10.9
	500	9.4	10.3	11.1	12.0	12.8
	600	11.2	12.0	12.9	13.7	14.6
10.0	400	8.9	9.9	10.9	11.5	12.0
	500	11.1	12.1	13.1	14.0	14.5
	600	13.2	14.2	15.2	16.2	17.0
11.0	400	10.0	10.5	11.0	11.5	12.0
	500	12.5	13.0	13.5	14.0	14.5
	600	15.0	15.5	16.0	16.5	17.0

A simpler predictor of dry matter intake (DMI) uses live weight (LWT) and milk yield (MY) as follows:

$$DMI = 2.5\%\ LWT + 10\%\ MY$$

This equation provides the same predicted intakes as Table 12.3 for diets with 11 MJ/kg DM of Metabolisable Energy (ME), so is less relevant to tropical diets with their lower dietary ME contents.

12.3 Animal production level

Some ration formulation computer programs take into account that high yielding cows are less efficient at using energy than low producing animals. This effect can be quantified by determining the Animal Production Level (APL) which is the total energy requirements divided by the maintenance energy requirements. A correction factor to account for this inefficiency can then be determined (from Table 12.4) and applied to the total energy requirements to calculate the adjusted energy requirements, modified for the higher level of production, be it more milk, increased milk solids, a growing foetus or deposition of body reserves. For every increase in APL above 1.0, the total energy requirements increase by 1.8% (Chamberlain and Wilkinson 1996). This correction factor can be applied to either Total Digestible Nutrients or Metabolisable Energy calculations of energy requirements.

Table 12.4 Relationship between Animal Production Level and Correction Factor to use to adjust total energy requirements
(Source: Chamberlain and Wilkinson 1996)

Animal Production Level	Correction Factor
1.0	1.000
2.0	1.018
3.0	1.036
4.0	1.054
5.0	1.072
1 unit	0.018

To calculate the Animal Production Level (APL), Correction Factor (CFac), and adjusted energy requirements, use the following equations:

$$\text{APL} = \text{Total energy requirements} \div \text{Maintenance energy requirements}$$
$$\text{CFac} = 1 + [(\text{APL} - 1) \times 0.018].$$

Adjusted energy requirements = CFac × Total energy requirements (either kg TDN/d or MJ ME/d).

The Total Digestible Nutrient requirements of seven different cows is calculated in Table 17.3. For each cow, the APL, hence the correction factor, can be applied, as in Table 12.5. In each case, the level of animal production has only increased the total energy requirements by 2% to 3%. Because this adjustment is relatively small, it is rarely used in ration formulation. However, it does quantify the effect of higher feed intake and shorter rumen retention time on reducing feed efficiency.

Table 12.5 Daily energy requirements of cows at different stages of lactation and pregnancy, adjusted for the correction factor for Animal Production Level (see also Table 17.3)
Total Digestible Nutrients (TDN).

Cow details	Cow 1	Cow 2	Cow 3	Cow 4	Cow 5	Cow 6	Cow 7
Description							
Live weight (kg)	550	550	550	550	500	500	500
Month of pregnancy	0	0	0	3rd	6th	7th	9th
Milk production (L/d)	20	17	13	10	8	5	0
Fat test (%)	3.6	3.6	3.6	3.6	4.0	4.0	0
Protein test (%)	3.2	3.2	3.2	3.2	3.8	3.8	0
LW gain/loss (kg/d)	-0.5	0	0	0	0	+0.5	+1.0
Energy requirements							
Maintenance (kg TDN/d)	4.1	4.1	4.1	4.1	3.8	3.8	3.8
Total energy requirements (kg TDN/d)	11.1	10.9	9.3	8.1	7.6	8.0	9.1
Animal Production Level	2.7	2.7	2.3	2.0	2.0	2.1	2.4
Correction factor	1.03	1.03	1.02	1.02	1.02	1.02	1.03
Adjusted energy requirements (kg TDN/d)	11.4	11.2	9.5	8.3	7.8	8.2	9.4

12.4 Formulating a ration

12.4.1 Using the worksheets

To balance a diet, you need to know which nutrients are limiting. These limitations can then be overcome by selecting supplements rich in these nutrients. This is very much trial and error.

1. Use Work sheet 1 to calculate the theoretical ration to satisfy nutrient requirements for a desired level of production.
2. Use Work sheet 2 to determine the nutrients supplied by a particular combination of feeds (basal forage and supplements).
3. Once the limiting nutrients are known, select the most appropriate supplement to balance the diet.
4. The Neutral Detergent Fibre content of the total diet provides a guide to the likelihood of the entire diet being consumed.

12.4.2 Deciding on supplements

Choosing the most economical supplement depends on the deficiency being corrected: whether energy, protein or fibre. For example, if energy is deficient, then choose the feed that provides the most energy at the cheapest price per MJ of ME (or per kg of TDN).

Price per tonne of dry matter can be deceptive. Look at the composition of the dry matter. Prices for wet or as-fed feed are even more deceptive: who wants to pay for water?

To calculate the cost of energy, protein or fibre, the following information is required:

1. nutrient content: dry matter, energy, protein, fibre
2. cost of feed on a fresh weight basis.

Work sheet 3 allows the calculation of the cost per unit of nutrient (ie MJ of ME or kg of Crude Protein, CP). Local Currency Units (LCU) must be used to calculate nutrient costs and these are presented in Appendix 3.

Decisions on what supplements to feed depend on more than just the cost of the feed itself. Increased capital requirements, extra labour and other costs need to be considered when deciding on the supplement to best balance a diet.

Once farmers have invested in equipment to handle by-products, the range of supplements that can be fed increases. The best and most economical feed will vary from farm to farm given the farmer's situation and equipment.

12.5 Computer aids to ration formulation

There is a wide variety of computer models used for ration formulation. Some are relatively simple, requiring the sort of data input described in this manual. Others are more complex, either requiring a more sophisticated data input, or using similar input but deriving additional parameters with which to formulate the diet to achieve target levels of performance.

When using computers, the validity of the formulated ration is only as good as the data available to describe the ration constituents, or as computer specialists say, 'GIGO –

garbage in = garbage out'. For example, if the feed analyses data are derived only from tables, such as those in Chapter 10, and not from actual analyses of feed samples of the ration to be fed, complex computer models may not necessarily improve the ability to predict animal performance accurately from such a formulated ration.

Ration formulation programs using computer software are basically just large calculators. They provide theoretical answers, which fortunately because of the rapidity of the production response to changes in feeding management, can be quickly validated on-farm. Most of the ration formulation computer programs that are commercially available were developed for temperate dairy systems where feeds, herd management and cow genotypes are often vastly different to those encountered in tropical small holder systems. However, as they are based on biological responses to increments in nutrient intakes, such predictions should be equally accurate in all situations. However, it is important to validate these models in such systems, as this is the only way to gain confidence in their usefulness in predicting production responses to a range of feeding scenarios in that system.

This section introduces four computer programs to facilitate the formulation in the tropics of rations for milking cows and young dairy stock.

12.5.1 RUMNUT

The Agricultural Research Council of the United Kingdom (Agricultural Research Council 1984, Ministry of Agriculture, Fisheries and Food 1984) provides one of the major international standards for calculating the nutrient requirements of livestock, such as dairy cattle. RUMNUT is a commercial UK software package based on ARC data, which formulates rations from a large database of dietary ingredients. It is based on temperate feeds but new data on nutritive value of tropical forages, concentrates and by-products can be easily incorporated into the database. RUMNUT will run using either the Metabolisable Energy or Total Digestible Nutrients system for describing energy and it calculates profit as financial margins over all feeds.

The program is relatively simple to use and the suppliers provide good after sales service. RUMNUT is available from Dr Tom Chamberlain at tom@rumnut.com, with further information of the program at www.rumnut.com.

12.5.2 NRC

The National Research Council of the United States provides the second major international standard for calculating the nutrient requirements of livestock, such as dairy cattle. The latest edition of the NRC manual, the 7th (National Research Council 2000), includes a ration formulation program, which is available from the Internet at no cost from www.nap.edu/html/dairymodel/.

This program utilises the entire National Research Council (2000) collection of databases for nutrient requirements of dairy stock and nutrient contents of feeds, allowing the formulation of rations of specified feed mixes for any given level of milk production in cows or growth in young stock. The energy requirements are expressed in TDN units.

12.5.3 DRASTIC

One major problem with formulating rations for livestock in the tropics is the lack of reliable information on the nutritive value of available feeds, compounded with their large variability. This makes routine analyses or reliance on 'book values' of the composition of tropical feeds to be of little practical value. DRASTIC was specifically written to overcome this problem. It is the abbreviation for **D**airy **RA**tioning **S**ystem for the **T**rop**IC**s, a program developed by tropical dairy specialists in the United Kingdom.

DRASTIC uses qualitative and visual indicators of forages that can be easily undertaken by farmers, such as leaf: stem ratio, days after defoliation, forage colour, pest or disease damage, odour, moisture content, length of chop and general assessment. These are related directly to actual measures of energy and protein contents for specific forage species of grasses, legumes, silages and hays/crop residues which are then used to calculate nutrient intakes, to predict cow performance. The program even allows for grazing in predicting forage intakes.


Feeding out pasture silage on a large dairy farm in northern Vietnam.

The program predicts performance from existing rations or formulates rations to meet target milk yields. After inputting ration costs and milk returns, it calculates margin over feed costs for any feeding scenario.

DRASTIC then provides a tool to assist rationing dairy cows where access to technical knowledge is limited but practical experiences are considerable. The program is freely available from Dr Peter Stirling at drastic@stirlingthorne.com or www.stirlingthorne.com/about_drastic.html

12.5.4 KYMILK, KYHEIF and the TDN Workbook

KYMILK is an Excel spreadsheet, written by the author of this manual, that calculates the energy requirements of grazing or housed milking cows based on Agricultural Research Council (1984) standards, either on a daily basis or over various stages of the lactation cycle. It formulates rations and calculates total feed costs. KYHEIF is another EXCEL spreadsheet which calculates energy requirements of young stock, milk-fed calves and growing heifers. A third program, the TDN Workbook, calculates Total Digestible Nutrients and Metabolisable Energy contents of feeds directly from their chemical analyses.

All programs are freely available from the author, Dr John Moran at john.moran@dpi.vic.gov.au.

Work sheet 1: To calculate the daily energy, protein and fibre needs of a cow

The cow	Her energy needs (MJ of ME)	Her protein needs	Her fibre needs
Cow live weight: A [ ] kg	For maintenance: I [ ] MJ	Early lactation 16–18% Mid-lactation 14–16% Late lactation 12–14% Dry 10–12%	(17% CF or 30% NDF)
Daily activity level: Terrain (1–5) B [ ] MJ/km	For activity: [ ] From B X [ ] km = J [ ] MJ		
Month of pregnancy: D [ ] th month	For pregnancy (Table 6.2): L [ ] MJ		
Daily milk production: Volume E [ ] Litres; Fat test F [ ] %; Protein test G [ ] %	For milk production (Table 6.3): [ ] From E X [ ] MJ/L = M [ ] MJ		
Daily change in body condition: gain + / loss – H [ ] kg/cow /day	For or from condition (Table 6.5): [ ] From H X [ ] MJ/kg = N [ ] MJ		

Total daily needs of this cow: Energy [ ] MJ (I + J + L + M ± N) | Crude protein [ ] % from above | NDF or CF [ ] % from above

Work sheet 2: To calculate the energy, protein and fibre content of a diet

Dry matter	Energy (MJ)	Protein	Fibre
Forage: [ ] X [ ] ÷100 = A [ ] kg/cow/day, Dry matter %	[ ] X [ ] = F [ ] from A, MJ/kg DM, MJ/cow/day	[ ] X [ ] ÷100 = J [ ] from A, Protein %, kg/cow/day	[ ] X [ ] ÷ 100 = O [ ] from A, NDF/CF %, kg/cow/day
Supplement 1: [ ] X [ ] ÷100 = B [ ] kg/cow/day, Dry matter %, kg DM/cow/day	[ ] X [ ] = G [ ] from B, MJ/kg DM, MJ/cow/day	[ ] X [ ] ÷100 = K [ ] from B, Protein %, kg/cow/day	[ ] X [ ] ÷ 100 = P [ ] from B, NDF/CF %, kg/cow/day
Supplement 2 [ ] X [ ] ÷100 = C [ ] kg/cow/day, Dry matter %, kg DM/cow/day	[ ] X [ ] = H [ ] from C, MJ/kg DM, MJ/cow/day	[ ] X [ ] ÷100 = L [ ] from C, Protein %, kg/cow/day	[ ] X [ ] ÷ 100 = Q [ ] from C, NDF/CF %, kg/cow/day
Supplement 3 [ ] X [ ] ÷100 = D [ ] kg/cow/day, Dry matter %, kg DM/cow/day	[ ] X [ ] = I [ ] from D, MJ/kg DM, MJ/cow/day	[ ] X [ ] ÷100 = M [ ] from D, Protein %, kg/cow/day	[ ] X [ ] ÷ 100 = R [ ] from D, NDF/CF %, kg/cow/day
Total daily dry matter intake E [ ] A+B+C+D kg DM/cow Total daily DM intake limit [ ] kg/cow Use T and Table 12.1 or the formula (120÷ T) ÷ 100 X live weight	Total daily energy intake [ ] F+G+H+I MJ /cow	Total daily protein intake N [ ] J+K+L+M kg/cow Protein % of ration [ ] N÷E X 100	Total daily fibre intake S [ ] O+P+Q+R kg/cow NDF/CF % of ration T [ ] S÷E X 100

Cow requirements (from Worksheet 1)	Total daily energy requirement [ ] MJ	Crude protein requirement [ ] %	Fibre requirement [ ] % NDF/CF

Work sheet 3: The cost of nutrients in feeds (local currency units or LCU)

Feed 1:

Cost per kg Dry Matter (DM)

[ ] X [ ] X 100 = A [ ]

kg bought · DM % · kg DM bought

[ ] ÷ [ ] X 100 = B [ ]

Cost (LCU) · kg DM bought · LCU/kg DM

Cost per MJ of Metabolisable Energy (ME)

[ ] ÷ [ ] = C [ ]

LCU/kg DM · MJ /kg DM · LCU/MJ of ME

Cost per kg of Crude Protein (CP)

[ ] ÷ [ ] X 100 = D [ ]

LCU/kg DM · CP % · LCU/kg CP

Feed 2:

Cost per kg DM

[ ] X [ ] ÷ 100 = A [ ]

kg bought · DM % · kg DM bought

[ ] ÷ [ ] X 100 = B [ ]

Cost (LCU) · kg DM bought · LCU/kg DM

Cost per MJ of ME

[ ] X [ ] = C [ ]

LCU/kg DM · MJ /kg DM · LCU/MJ of ME

Cost per kg of CP

[ ] ÷ [ ] X 100 = D [ ]

LCU/kg DM · CP % · LCU/kg CP