agriculture
& rural development
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PROVINCE OF KWAZULU-NATAL

Beef Production: The Basics

Nutrition

A characteristic of all living organisms is their ingestion of nutrients which are required for maintenance (necessary for the basic functioning of the living body) and production. With livestock, production includes growth, pregnancy, lactation and fibre (wool) production, amongst others. In lower forms of life such as bacteria, once their food is consumed, they die or sporulate, unless another food source becomes available. In the case of plants and animals, they have the ability to store nutrients which can tide them over until food is again obtainable. Plants store energy as carbohydrates and oils, whereas animals store energy as fat. Animals have the additional advantage of being able to move around and forage for their food.

The study of nutrition in animals embraces ingestion, digestion and absorption of nutrients, their transport to the body cells and the removal of waste products of metabolism, including that part of the ingested food that is not absorbed. Although a thorough knowledge of all that is known of nutrition is useful to the practical farmer, only aspects essential to beef production will be discussed.

Nutrients

The nutrients in feeds are grouped as water, protein (which can also be a source of energy), energy sources, and minerals. This division is based on relatively simple laboratory techniques, and although modern technology makes it possible to determine the chemical composition in greater detail, this division satisfies most requirements for feeding farm animals.

Water

Water is the most important nutrient. Without water animals die very quickly. Water shortages often result in reduced feed intakes, leading to poor animal performance. There is evidence that the provision of clean water in adequate quantities leads to improved animal growth. This is understandable because water is the fluid carrier of chemicals in the animal body.

The water content of feeds varies from as much as 85% in some pastures to 10% to 15% in conserved, dried feeds. The water content of feed is determined by weighing a representative sample of the feed, drying it in an oven to constant weight, and assuming that the difference in weight loss before and after drying is the moisture content of the feed. When comparing different feeds, the comparison is simplified when composition is expressed on a dry matter basis.

Protein

Protein can serve as a source of energy, but the main functions of proteins are their role as building blocks of the body, especially muscle, and many hormones and enzymes are proteins. Proteins are made up of amino acids, some of which are considered essential *i.e.* must be provided in a healthy diet, because certain animals do not have the ability to synthesise the relevant amino acids. Because the rumen of ruminants contains many micro-organisms which can produce essential amino acids, ruminants are not as dependant as mono-gastric animals on their diets for the provision of essential amino acids.

As a rule, ruminants should ingest diets containing at least 10% to 15% crude protein. The crude protein content of feeds is determined by measuring the nitrogen content of the feed, assuming that all the nitrogen is contained in proteins, and multiplying the value by 6.25. This is based on the fact that proteins contain 16% nitrogen. For beef cattle, compiling rations using crude protein content as the measure of protein in the diet, provides satisfactory results in most cases.

Excess protein in a diet is not desirable. A crude protein content in a diet of 25% to 30% can be tolerated by cattle adapted to such diets, but higher levels of crude protein should be avoided.

Energy

Energy comprises the bulk of most diets because energy provides the driving force to do work. The main sources of energy are starches and fats. With ruminants crude fibre, which comprises structural carbohydrates in plants, is utilized as an energy source. Although fats are a good source of energy, they usually do not comprise a significant proportion of energy in beef cattle diets. Should fats be included in rations for cattle, the fat should not exceed 5% of the total diet.

With cattle, when a diet contains less than 20% roughage, digestive disturbances are likely, although modern feed additives make it possible to feed rations to cattle containing as little as 15% roughage. The inclusion in a diet of excess amounts of carbohydrate (especially readily fermentable carbohydrate) *e.g.* maize meal, can cause acidosis. When carbohydrates are broken down in the rumen, acids are formed and when present in large amounts, the pH of the rumen drops to levels at which the rumen microflora can not function effectively.

The energy content of feeds can only be determined by more complicated laboratory procedures, including measuring the digestibility of the feed when fed to animals. The energy content of feeds is therefore usually not measured routinely. Previously the energy content of feeds was expressed as total digestible nutrients (TDN), but the present measure of energy content is metabolisable energy (ME), which is measured in mega-joules (MJ).

The digestibility of a feed is the proportion of feed not excreted in faeces and is assumed to have been absorbed into the animal's body.

Minerals

Minerals are divided into major- (required in larger amounts) and trace minerals (needed in only small amounts). Calcium, potassium, magnesium, sulphur, phosphorus and chlorine are the essential major minerals, and iron, manganese, copper, cobalt, iodine, zinc, molybdenum and selenium the essential trace minerals. Fluorine, bromine, barium and strontium could be essential. Chromium, nickel, tin, aluminum, vanadium, boron, lead and titanium are usually present in feeds, but are considered non-essential.

Table 8 reflects the mineral requirements of cattle and in Table 9, symptoms of mineral deficiencies are listed.

Vitamins

With monogastric animals, many vitamins are essential and must be provided in the diet. With ruminants, vitamin deficiencies are rare. The only vitamin that plays a significant role in cattle feeding is Vitamin A. Green grazing contains large amounts of Vitamin A precursors so that only when cattle have not had access to greenfeed for 2 to 3 months or more, is the supplementation of Vitamin A necessary.

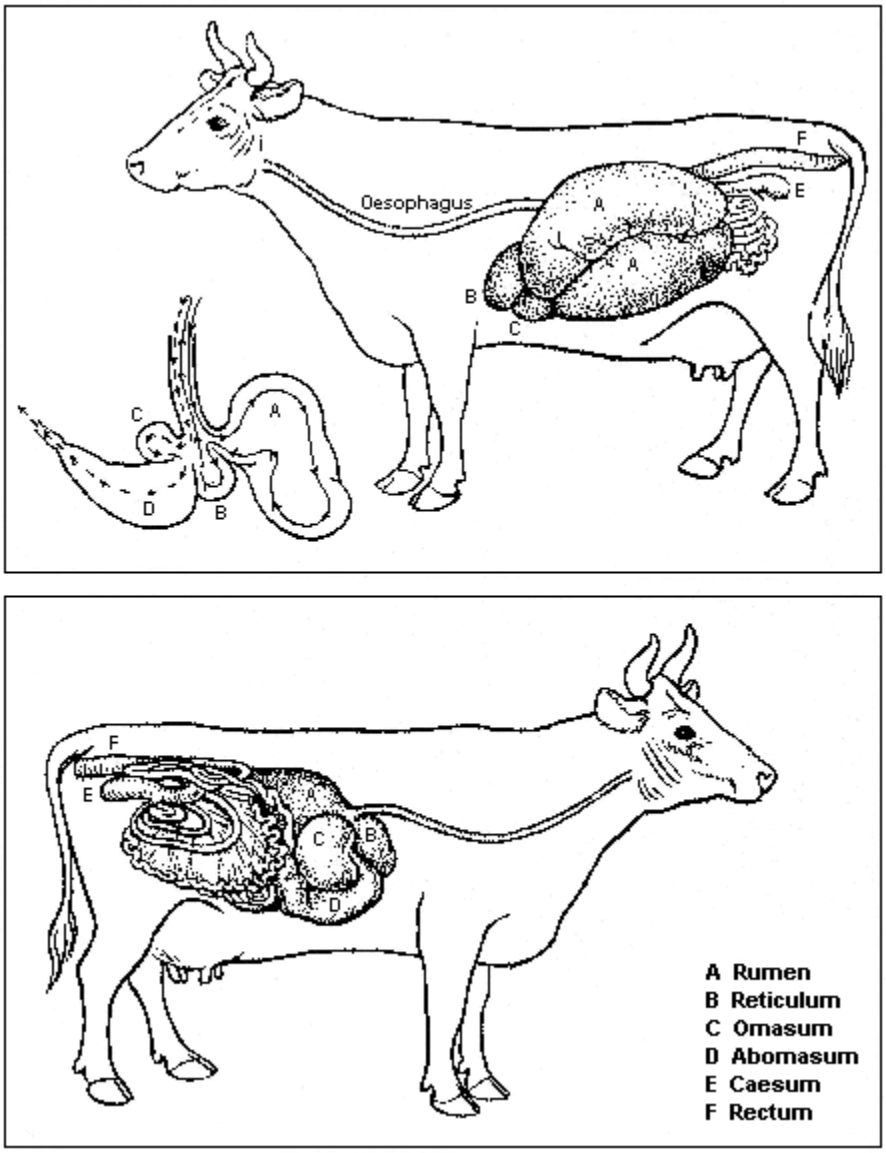

Figure 9. Anatomy of the digestive tract of a cow.

Anatomy of the digestive tract

The anatomy of the digestive tract of a cow is illustrated in Figure 9. At birth cattle function as monogastrics because the fore-stomachs (reticulum, rumen and omasum) have not yet fully developed. By the time cattle are 3 to 4 months old, their intestinal channel has

developed to include the reticulum, rumen, omasum and abomasum (also called the true stomach) *i.e.* it is a fully developed ruminant with three chambers before its stomach.

The main characteristic of the anatomy of the ruminant digestive tract is the rumen, the very large (volume of 125 R in mature cows) sack where food is kept until digested to the extent that digestion can take place lower down in the gut. The rumen contains many millions of micro-organisms which break down fibre (roughages) and make it possible for the ruminant to utilize the products of this digestion as well as the bodies of the surplus microflora to satisfy its own nutritional needs.

When the diet of a ruminant is changed, it must be adapted to the new diet. The reason for this adaptation is that the intestinal microflora must adapt to the new feed. This adaptation process takes 2 to 3 weeks.

Nutritive value of feeds

Various terms are used to describe the nutritive value of feeds, including feeding value and quality feed. Often these terms are used without a clear definition of what is meant. The fact that people like the smell of hay or silage does not necessarily mean that livestock are of the same opinion. Ultimately, the best criterion of feed quality is the performance of the animal consuming the feed. The two most important factors known to affect the quality of feed as reflected in animal performance are intake and the digestibility of the feed.

In feedlots, concentrates formulated to achieve the most economic animal performance, are used. With concentrate feeding *i.e.* where feeds with a digestibility above 70% is fed, intake is limited by rumen capacity and the digestibility of the feed is the major determinant of animal performance. For feeds where the digestibility is below 70%, it has been shown that voluntary intake by the animal is the major factor limiting animal performance. A trial at Glen showed that approximately 80% of the difference in quality between roughages could be ascribed to voluntary intake and 20% to digestibility. With very poor quality roughages, cattle cannot ingest enough feed for maintenance requirements. In the case of beef cattle, the main source of nutrients is the grass they graze. Farmers are therefore well-advised to evaluate quality of grazing with care and ensure that cattle not only have enough feed, but that they grow well, indicating that the quality of their feed is good. Experience has shown that when grass is grazed at a relatively early stage of growth *i.e.* has not matured to the extent that its lignin content is still relatively low, animals perform well.

Different animals require different types of food and amounts of nutrients to satisfy their nutritional needs. The National Research Council (NRC) of the United States of America and the Agricultural Research Council (ARC) of Britain compiled tables listing the requirements for different classes of livestock. A summary of the NRC tables for beef cattle are reflected Tables 6, 7 and 8. Experienced nutritionists know which feeds can be included in diets and what limits must be placed on the presence of certain feeds in a diet. Farmers are well advised to seek advise from nutritionists about feeds they do not know.

The values reflected in the nutrition tables are average values containing a safety margin and must therefore be applied with caution when estimating the nutritional needs of an animal. Factors that can affect the nutrient requirements of cattle includes:

- Variations within groups of animals.
- Weather conditions *e.g.* in cold conditions livestock require more feed and when it is very hot, food intake declines.
- The desired production level.
- Genetic factors could create the potential for higher growth rates which would require higher nutritional levels.
- Growth enhancers and growth promoters will affect nutritional requirements.

With the nutrition tables, tables reflecting the chemical composition of feeds are available and, where the analysis of a feed is not available, these tables provide usable data.

Supplementation

Where cattle are on veld grazing, it is common practice to provide them with supplements. The objective is to add to deficiencies that may exist in the feed available to them and thus prevent losses. It can happen that severe deficiencies exist on a specific farm and farmers should always monitor their livestock to determine the presence of specific problems on their farms. On the other hand supplements can be used to enhance animal performance. Enhanced animal performance is only advisable when gains provide greater financial returns than the associated input costs.

Summer supplementation

In many parts of KwaZulu-Natal, shortages of iodine, zinc and magnesium limit the growth of livestock. In addition, on almost all farms in the region, phosphorus and salt should be provided, although in many areas close to the sea, salt inhibits lick intake when added to the licks in even small amounts.

A mature cow requires about 30 g of salt and 10 g of phosphorus per day.

Many commercial summer licks are available, but the most commonly used is to mix dicalcium phosphate or P12 with salt. The salt usually comprises 50% of the lick, but must be reduced where lick intakes are too low. Intakes of 170 g per cow per day can be expected.

Winter supplementation

With winter feeding of beef animals the objective is to maintain adequate body condition for cows so that they can calve down during the subsequent summer and reconceive as well. The main deficiency in winter veld, more specifically in the sourveld, is a protein deficiency. The general recommendation is to provide 200 g of crude protein per adult dry cow per day. This could be achieved by the provision of winter licks or the feeding of oil cakes. Many licks are available and advisors should be consulted. Whichever lick is used, it must be remembered that enough roughage must be fed with the lick because licks are additives and the bulk of an animal's diet must be provided by relatively cheaper feed. Some examples follow:

Winter lick 1:
Feed 2 kg poultry litter per cow per day.
Caution: Livestock being fed poultry litter must be vaccinated for botulism and the litter must be free of maduramycin.

Winter lick 2, for sourveld:
Maize meal 20.2%
Salt 46.2%
Feedlime 16.8%
Urea 16.8%
Intake should be 0.4 kg per cow per day.
Caution: This lick contains a non-protein nitrogen (urea) and the necessary precautions must be taken, including that livestock must be adapted to the lick and the lick must be kept dry. This lick does not contain phosphorus and is suitable for mature animals, whereas growing animals should still be fed phosphorus.

Winter lick 3, for sweetveld:
Maize meal 35.8%
Salt 30.0%

Feedlime 17.1%
Urea 17.1%
Intake should be 0.385 kg per cow per day.
Caution: This lick contains a non-protein nitrogen (urea) and the necessary precautions must be taken, including that livestock must be adapted to the lick and the lick must be kept dry. This lick does not contain phosphorus and is suitable for mature animals, whereas growing animals should still be fed phosphorus.

Terminology

Feeding stuffs
In general, this term is synonymous with feed, food or fodder, but it is a broader term in that it includes all materials included in the diet for their nutritional properties. It includes plant or animal products and by-products as well as chemically synthesised pure nutrients or mixtures of nutrients added to animal feeds. Thus, maize meal is a stock or human food, but the vitamin thiamine-HCl is a pure nutrient that can be chemically synthesised. The vitamin is not food, but is a foodstuff.

Ration: Diet
A ration is a 24-hour allowance of a feed or of a mixture of feedstuffs. The term implies nothing with respect to the suitability or adequacy of the allowance but merely refers to the amount of the provisions permitted. We commonly refer to the daily allowances for animals as rations but speak of human diets. Soldiers are provided rations and rats eat diets. For all practical purposes these terms are synonymous.

Balanced ration
This refers to a feed mixture just sufficient to provide for all the requirements of a specified animal for one day. The term "balanced" originally referred to the proportions of fat, carbohydrate and protein in the ration. In the feed trade a balanced ration refers to a mixture of feedstuffs nutritionally adequate for the feeding of specified animals when used as recommended by the manufacturer.

Nutrient
A nutrient is any food constituent or chemical substance that aids in the support of animal life. Thus, carbohydrates, fats, proteins, individual amino acids and the various vitamins and minerals are all nutrients.

Toxicity
This term should be distinguished from "poisonous". A nutrient may be essential to an animal in small amounts, but when taken in excess it may result in toxicity, mild or acute. Fluorine is desirable in small amounts (about 1 mg/kg in the DM of the ration), but it is harmful in large amounts (about 30mg/kg) and it may actually poison the animal.

Feeding standard
A general term for tabulations of the amounts of the various nutrients required by specified animals.

Feed allowance
The amount of feed actually given to an animal daily. It is usually greater than the "requirements" by a safety margin to allow for variations in requirements between individuals.

Nutrient requirement
A statement of what an animal on average requires for a particular function.

Digestibility
This term is usually taken to mean that nutrients which are consumed are broken down in the digestive tract and absorbed. In common language both processes, digestive attack as well as uptake of the resulting nutrients, are understood by the term "digestion".

Composition and concentration
Composition may be expressed as a percentage (%) or as mass/unit mass *e.g.* g/kg.
Concentration may be percentage or mass/unit volume *e.g.* ml/litre.
Very low concentrations are usually expressed as mg/kg (ppm - parts per million)
Vitamin units are usually expressed in terms of mass of active compound and called i.u.

Antioxidants
Natural fats possess a certain degree of resistance to oxidation, owing to the presence of compounds termed antioxidants. These prevent the oxidation of unsaturated fats until they themselves have been transformed into inert products.

Metabolic body size
This is the mass of an animal (kg) raised to the power 0.75 ($Wkg^{0.75}$)

Energy
The international unit of work and energy is the joule. One joule is the work done by a force of 1 newton exerted through a distance of 1m. One newton is the force that will give a mass of 1kg an acceleration of $1m/sec^2$.

1kcal = 4.184 kJ or 1 kJ = 0.239 kcal

Previously energy content of feeds was expressed as TDN (total digestible nutrients), whereas ME (metabolisable energy)is the modern unit used.

To convert TDN to MJ of ME, multiply the TDN value with 0.15%.

Procedures for feed mixing

Practical considerations
Very expensive modern machinery is available to mill and mix feeds. Unless very large quantities of feed must be mixed, hand mixing is quite effective if certain principles are adhered to.

- The equipment required must include a scale, shovels or spades and a floor large enough to do the mixing on. Although a well-packed earth floor can serve, a cement or concrete mixing floor is better.
- Even mixing is very important. This is best achieved by the following procedure:

The major constituent of the mixture is spread on the floor. The other constituents are then spread in layers over this first layer until all the components have been added. Shovels or spades are then used to mix the ingredients, much as concrete mixing is done. The people doing the mixing start at the edge of the layered ingredients and, using spades or shovels, turn the feed over with a mixing motion and move the mixed feed to one side, while at the same time heaping it. The mound of feed is then moved while continuing the mixing motion. Moving the mound back and forth is repeated two or three times, after which the feeds are usually well mixed.

- Where very small quantities of an ingredient must be evenly distributed in a feed *e.g.* ionophores, making a premix has been shown to make it possible to distribute the relevant ingredient very evenly throughout the mix. Making a premix involves taking a small amount, say a bucket full, of one of the ingredients of the diet (maize meal is usually taken, even if it is not one of the ingredients of the mixture) and the additive mixed well into this bucket full of meal. When all the other ingredients have been spread in layers on the mixing floor, the premix is carefully sprinkled over the top, while taking care that all the feed is covered with the premix (almost like spreading salt over a plate of food). Mixing proceeds as described above.
- Ingredients must always be weighed out on a scale that has been checked for accuracy. Mistakes with feed mixing are usually caused by the addition of incorrect quantities of one or more ingredients. Care must be taken to ensure that all the ingredients are added and that they are added once only.
- Ideally, when a new batch of an ingredient is obtained, it should be chemically analysed and checked for toxins. This is often not feasible in the farm situation, especially where small quantities are involved. However, farmers should examine feeds carefully. Often contaminants can be seen. Where feed has become wet, it must be examined for the presence of fungal growth. Mycotoxins are produced by fungi which inhibit animal growth and can cause animal deaths.
- Some modern feed additives are dangerous to use because they are poisonous or toxic. Farmers are well advised to read the instructions provided with additives. It can happen that a company revises the chemical composition of an additive. Unless instructions are read, farmers will not be aware of changes in the product and should the additive be made more concentrated, adding the same quantity could cause major losses.

Pearson square

Farmers are advised to make use of an experienced nutritionist to formulate rations for their own mixing programmes. Should a farmer want to mix two or even three ingredients, making use of the Pearson square method or by iteration, a reasonably effective ration can be formulated. Usually standard tables reflecting the composition of the different ingredients are used, although the chemical analysis of the same type of feed can differ significantly from batch to batch.

The method is as follows:

Given maize meal with a 10% crude protein (CP) content and an oil cake with 50% CP, formulate a mixture containing 17% CP.

10		Maize	33 = 50 - 17
	7	9	
		17	
	9	7	
50		Oil cake	7 = 17 - 10

The answer is to mix 33 parts maize with 7 parts oil cake.

Check:

33 kg maize @ 10% CP =	3.3 kg CP
7 kg oil cake @ 50% CP =	3.5 kg CP
40 kg mix	6.8 kg CP
100 kg mix	17 kg CP *i.e.* 17% CP

Note:
The content of the mix cannot be above the content of the ingredient with the higher nutrient level or below the content of the ingredient with the lower nutrient level, but must be between the levels of the ingredients.

Table 6. Daily Nutrient Requirements for Maintenance, Growth and Fattening of Steers.

Live mass	ADG (kg/day)	Energy requirements in MJ ME: Energy concentration in MJ ME/kg DM of ration fed						CP (g)	DP (g)	Ca (g)	P (g)	Vit A '000 IU
		8	9	10	11	12	13					
150	0.00	22	22	22	22	22	22	230	130	5	5	6
	0.25	29	29	28	27	27	27	460	270	13	11	8
								515	320	14	12	9
	0.50	38	36	35	34	33	32	560	365	19	15	9
	0.75			43	41	40	38	600	410	25	18	9
	1.00				50	48	46	640	455	31	21	9
	1.25					58	56					
175	0.00	24	24	24	24	24	24	260	150	5	5	7
	0.25	32	31	30	30	29	29	485	285	12	11	8
								525	325	14	13	10
	0.50	41	39	38	37	36	35	570	370	19	16	10
	0.75		49	47	45	43	41	610	415	24	18	10
	1.00			56	54	52	50	650	460	29	21	10
	1.25				66	63	60					
200	0.00	27	27	27	27	27	27	300	170	6	6	8
								510	300	10	10	12
								555	345	14	13	12

	0.25	35	35	34	34	33	33	610	395	19	16	13
	0.50	44	42	41	39	38	37	655	445	23	18	13
								700	495	27	20	13
	0.75		53	50	48	46	45	750	545	31	22	13
	1.00			61	58	55	53					
	1.25				70	67	64					
	1.50					81	77					
225	0.00	29	29	29	29	29	29	325	185	7	7	8
	0.25	37	37	36	35	35	34	525	310	11	11	13
								580	360	14	13	13
	0.50	47	45	44	42	41	40	645	420	18	16	13
	0.75		56	53	51	49	48	700	475	24	19	13
								745	530	28	22	13
	1.00			65	62	59	57	810	590	32	23	13
	1.25				75	71	68					
	1.50					86	82					
250	0.00	31	31	31	31	31	31	350	200	8	8	9
	0.25	40	39	38	38	37	36	570	330	12	12	14
								635	375	13	13	14
	0.50	51	49	47	45	44	43	715	430	18	16	14
	0.75		60	57	54	52	51	790	485	24	20	14
								855	540	30	23	14
	1.00			69	65	63	60	915	595	34	25	14
	1.25				79	75	72					
	1.50					91	87					
300	0.00	36	36	36	36	36	36	405	230	9	9	10
	0.25	46	45	44	44	43	43	595	345	13	13	16
								660	390	16	16	16
	0.50	57	55	53	51	50	49	735	440	19	18	16
	0.75	72	66	64	61	59	57	805	495	24	21	16
								875	550	28	23	16
	1.00		81	77	73	70	67	925	600	33	27	16
	1.25			93	88	83	80	965	655	37	30	16
	1.50				107	101	96					

	1.75					124	112					
350	0.00	40	40	40	40	40	40	455	260	10	10	12
	0.25	51	49	48	48	47	47	690	400	15	15	18
								745	440	17	16	18
	0.50	63	60	58	56	55	54	800	480	19	17	18
	0.75	78	73	70	67	65	63	855	525	22	19	18
								905	570	25	21	18
	1.00		89	84	80	77	74	945	615	30	26	18
	1.25			103	97	92	88					
	1.50				117	110	105	985	670	34	30	18
	1.75					135	128					
400	0.00	45	45	45	45	45	45	510	290	11	11	13
	0.25	56	55	54	53	53	52	715	415	15	15	19
								770	455	17	17	19
	0.50	70	67	65	63	61	60	850	510	19	18	19
	0.75	85	80	77	74	72	69	900	555	21	20	19
								950	600	24	22	19
	1.00		99	93	89	85	82	990	645	27	24	19
	1.25			112	105	100	96					
	1.50				127	120	115	1030	700	30	26	19
	1.75					147	139					
450	0.00	49	49	49	49	49	49	545	310	12	12	14
	0.25	61	60	59	58	57	56	765	445	16	16	20
								840	495	18	18	20
	0.50	75	72	70	68	67	66	900	540	19	19	20
	0.75	91	87	83	80	78	76	950	585	20	20	20
								1000	630	24	23	20
	1.00		106	100	95	91	88	1040	675	26	24	20
	1.25			120	114	108	104					
	1.50				137	130	124	1075	730	28	25	20
	1.75					158	150					
500	0.00	54	54	54	54	54	54	595	340	13	13	15
								810	470	17	17	23
								890	525	18	18	23

	0.25	67	65	64	63	62	62	940	565	19	19	23
	0.50	82	79	76	74	73	72	990	610	20	20	23
	0.75	100	94	90	87	84	82	1030	650	22	22	23
	1.00		114	108	103	99	95	1060	690	24	24	23
	1.25			129	123	117	112	1105	750	26	26	23
	1.50				147	140	133					
	1.75					170	161					

Table 7. Daily Nutrient Requirements of Breeding Stock in a Beef Herd.

Live mass (kg)	Daily gain (kg/day)	Min DM consumption (kg/day)	Roughage (%)	ME (MJ)	CP (g)	DP (g)	Ca (g)	P (g)	Vit A `000 IU
Pregnant yearling heifers - last 3 to 4 months of pregnancy									
325	0.4	6.6	100	53	580	340	15	15	19
	0.6	8.5	100	68	750	420	18	18	23
	0.8	9.4	85-100	84	850	500	22	20	26
350	0.4	6.9	100	55	610	350	15	15	19
	0.6	8.9	100	71	780	450	19	19	25
	0.8	10	85-100	88	880	510	22	21	28
375	0.4	7.2	100	57	630	360	15	15	20
	0.6	9.3	100	74	810	460	19	19	26
	0.8	11	85-100	92	960	550	22	22	31
400	0.4	7.5	100	59	650	380	16	16	21
	0.6	9.7	100	77	840	480	19	19	27
	0.8	11.6	85-100	96	1010	500	22	22	33
425	0.4	7.8	100	62	690	400	16	16	22
	0.6	10.1	100	80	880	500	19	19	28
	0.8	12.1	85-100	100	1050	600	22	22	34
Dry, pregnant mature cows - middle third of pregnancy									
350		5.5	100	45	320	150	10	10	15
400		6.1	100	50	360	170	11	11	17
450		6.7	100	54	390	190	12	12	19
500		7.2	100	59	420	200	13	13	20
550		7.7	100	63	450	220	14	14	22
600		8.3	100	67	490	230	15	15	23

Dry, pregnant mature cows - last third of pregnancy									
350	0.4	6.9	100	55	410	190	12	12	19
400	0.4	7.5	100	60	440	210	14	14	21
450	0.4	8.1	100	64	480	230	15	15	23
500	0.4	8.6	100	69	510	240	15	15	24
550	0.4	9.1	100	73	540	250	16	16	26
600	0.4	9.7	100	77	570	270	17	17	27
Cows nursing calves - average milking ability - first 3 to 4 months post partum									
350		8.2	100	67	750	440	24	24	19
400		8.8	100	71	810	480	25	25	21
450		9.3	100	76	860	500	26	26	23
500		9.8	100	80	900	530	27	27	24
550		10.5	100	85	970	570	28	28	26
600		11	100	89	1010	590	28	28	27
Cows nursing calves - superior milking ability - first 3 to 4 months post partum									
350		10.2	100	88	1110	650	45	40	32
400		10.8	100	92	1170	690	45	41	34
450		11.3	100	97	1230	720	45	42	36
500		11.8	100	102	1290	760	46	43	38
550		12.4	100	106	1350	790	46	44	41
600		12.9	100	110	1410	830	46	44	43
Bulls - growth and maintenance (moderate activity)									
300	1	8.8	70-75	85	900	550	27	23	34
400	0.9	11	70-75	105	1030	620	23	23	43
500	0.7	12.2	80-85	113	1070	620	22	22	48
600	0.5	12	80-85	110	1020	600	22	22	48
700	0.3	12.9	90-100	116	1080	600	23	23	50
800	0	10.5	100	88	890	500	19	19	41
900	0	11.4	100	96	990	550	21	21	44
1000	0	12.4	100	104	1050	600	22	22	48
Minimum DM consumption is based on the general type of diet indicated in the roughage column. Approximately 0.4 kg of weight gain over the last third of pregnancy is accounted for by the products of conception Avg milking ability = 5 kg per day, Superior milking ability = 10 kg per day Roughage = good quality roughage containing at least 8 MJ ME/kg									

Table 8. Mineral requirements and maximum tolerable levels of minerals for beef cattle.

	Mean	Range	Maximum tolerable level
Calcium % Magnesium % Phosphorus % Potassium % Sodium % Sulphur %	Table 3 & 4 0.10 Table 3 & 4 0.65 0.08 0.10	0.18 to 0.53 0.05 to 0.25 0.18 to 0.37 0.5 to 0.7 0.06 to 0.10 0.08 to 0.15	2 0.40 1 3 10 0.4
Cobalt mg/kg Copper mg/kg Iodine mg/kg Iron mg/kg Manganese mg/kg Selenium mg/kg Zinc mg/kg	0.10 8 0.5 50 40 0.1 30	0.07 to 0.11 4 to 10 0.20 to 2.0 50 to 100 20 to 40 0.05 to 0.30 20 to 40	5 115 50 1000 1000 2 500

Table 9. Clinical symptoms of dietary deficiencies in livestock.

	Decreased rate or cessation of	Rough coat, unthriftiness	Reduced appetite, anorexia	Decreased milk production	Emaciation, loss of mass	Dead or weak offspring	Stiff joints, lameness	Pica	Impaired reproduction	Collapse or death	Fragile, weak or fractured bones	Anemia	Diarrhoea	Muscular unco-ordination	Decreased phosphorus in plasma	Staggering gate	Convulsive seizures	Straight pasterns	Craving for salt	Suppression of oestrus	Goitre	Day or night blindness	Decreased Vit A in plasma	Shy breeding	Watery eyes, nasal discharge	Secondary pneumonia	Decreased calcium in plasma	Arching back	Tetany	Oedema	Enlarged joints and bowed legs
Energy	X	X		X	X				X	X																					
Protein	X		X	X	X	X														X											
NaCl	X	X	X	X	X			X		X									X												
Calcium	X	X	X	X		X	X		X		X															X					
Phosphorus	X		X	X		X	X	X	X		X				X																
Iron	X	X	X			X						X		X																	
Copper	X	X	X			X		X				X	X	X				X		X											
Cobalt		X	X	X	X			X				X	X																		
Iodine		X				X															X									X	
Vitamin A	X	X			X	X	X		X	X			X	X		X	X					X	X	X	X	X					X
Vitamin D	X		X		X	X	X				X				X	X	X	X									X	X	X		