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Feedlot finishing of cattle

Canada

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Cover illustration
Feedlot comprises eight pie-shaped pens arranged in an octagon with a central core for sorting and treating animals

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Contents

Preface

This revised bulletin includes new information on practical feeding recommendations based on research data from feeding trials at the Lethbridge Research Station of Agriculture Canada and on published data from other research centres. All sections on the feeding and management of beef cattle have been updated. Information from feeding experiments on efficiency of gain and carcass grades, which are major factors influencing financial outcome of the feeding operation, are discussed to help the feedlot operator make management decisions. Much of the information has been put into practice by feedlot operators and has been proven to be beneficial.

The economics section on modeling has been expanded and is based to a great extent on biological data obtained from experiments with feedlot cattle at the Lethbridge Research Station. Past prices are used to forecast future trends. Alternative marketing strategies to reduce risk are discussed.

Although no feeding program or economic strategy ensures a profit, this bulletin gives alternatives that the feedlot operator can use or modify to enhance opportunities for success.

Introduction

Feedlot finishing of cattle is an important industry in Canada. The industry converts grains, forages, and by-products of specialty crops into marketable beef and is a major enterprise on many farms. Large feedlots that annually feed thousands of cattle are common.

Feedlot finishing of cattle is a high-risk business. Large amounts of short-term capital are required to buy feeder cattle, feed, and other inputs. Prices for feeders, finished cattle, and feed are unpredictable. Diseases, physiological disorders such as bloat and acidosis, and weather are always a threat. However, financial gains may be substantial when the price of finished cattle is high relative to input costs.

Successful management of feedlots requires careful consideration of markets, feeds, health of animals, and feed preparation. This publication provides information for feedlot operators on nutrient requirements, feed preparation, financial planning, and managing their business.

Nutrient requirements of feedlot cattle

Water

A constant supply of clean, fresh water is important. Inadequate water intake limits the amount of feed that is eaten, resulting in reduced weight gains. Water intake averages about 4.1 L for every kilogram of feed dry matter consumed. A 200-kg calf that consumes 6 kg of air-dry feed drinks about 22 L of water a day. At market weight of 475 kg, cattle drink about 40 L per day. Cattle consume about 25% less water in winter than they do in summer.

Use heaters in winter to keep the water temperature just above freezing. A light over the water bowl at night increases water intake. Clean the bowl or tank regularly, especially in summer.

Water high in salts is unsuited for cattle. Cattle will tolerate about 9000 ppm of salts, but, above that level, they reduce their water intake and may develop scours, resulting in emaciation and weight loss. A practical maximum salt level is about 5000 ppm. The sulfate level that is tolerated in the water may be influenced by the level of salt in the feed. Forage grown on soil high in sodium sulfate may have a high sulfate content. If a high level of such a forage is fed, a practical upper limit of salts in the water may be only about 2000 ppm. Physiological disorders such as runny eyes, swollen joints, depressed appetite, general lassitude, and, in extreme cases, nutritional polio may occur when forage high in sulfates is fed and the water is also high in sulfates. If the water has a high mineral content, fewer mineral supplements need be added to the diet.

Energy

Available energy from feed consumed daily is a major determinant of rate and efficiency of gain as well as carcass composition of feedlot cattle. The available energy from a feedstuff, called digestible energy (DE), varies with the composition of the feedstuff. Grains, which have a high starch content, are digested to a high degree and have a high level of DE. Roughages, which have high cellulose, hemicellulose, and lignin contents, are digested to a lesser extent than grain and thus have a lower DE content. Table 1 lists the DE content of 1 kg of some common feed ingredients. A portion of the available energy is lost in urine and combustible gases; what remains is called the metabolizable energy (ME), part of which is lost as a heat increment. The remainder, called net energy (NE), is used for activity, maintaining vital body functions and body temperature, and weight gain. Fig. 1 illustrates these definitions schematically.

Although weight gain depends on the amount of net energy available after meeting all other energy needs, DE is the most practical description of energy requirements and is most readily available and easily understood. Therefore, DE values are used in this publication to express the relative energy values of feeds and the energy requirements of cattle. Total DE intake depends on the DE content of the feed and the rate at which the feed is digested. Grains that have a high DE content and are readily digested are the major component of feedlot diets. Lower DE contents and slower digestion of roughages compared with grains limit the use of roughages in feedlot diets.

The DE required by feeder cattle in comfortable surroundings depends on the size of the animal, its breed type, age, sex, and rate of gain. Tables 2 and 3 give the DE required for animals of different weights gaining at different rates.

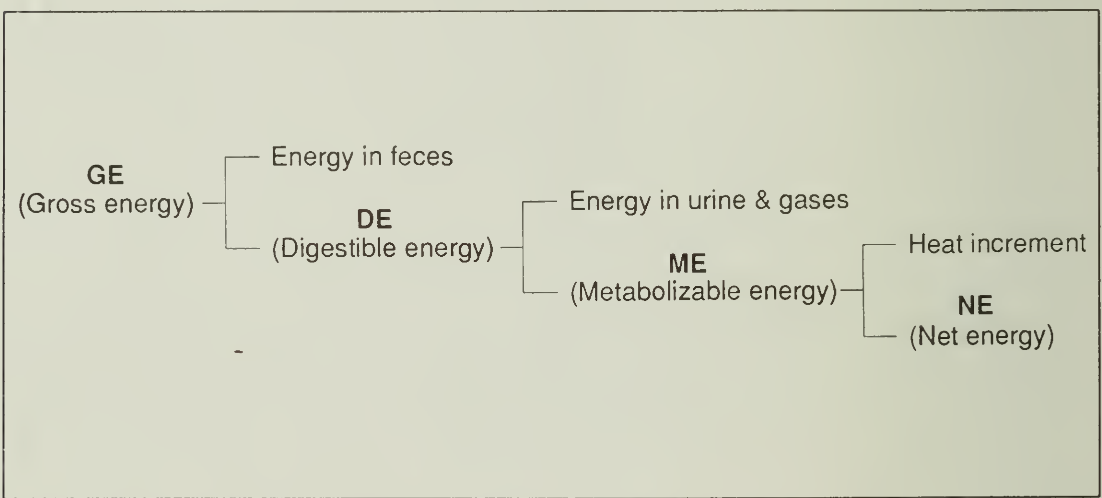

Fig. 1 How cattle use the gross energy contained in feed.

Table 1 Composition of common feeds

Feeds	DM[1] (%)	Protein (%)	ADF[2] (%)	DE[3] (kcal/kg)	Ca (g/kg)	P (g/kg)
Grains						
Barley	90	11	6	3420	0.7	4.0
Wheat	90	14	7	3440	0.4	4.0
Oats	90	10	14	3130	0.9	3.3
Rye	90	12	3	3170	0.7	3.7
Triticale	90	14	NA	3310	0.5	3.0
Corn	87	9	3	3470	0.4	2.7
Oil meals						
Linseed	91	38	17	3150	4.4	8.4
Canola	92	38	16	2830	6.8	11.7
Soybean	91	46	9	3440	2.6	6.4
Hays						
Alfalfa, early bloom	90	16	28	2360	14.8	2.2
Alfalfa, late bloom	90	12	35	2030	13.4	2.4
Barley	90	12	24	2200	1.8	2.7
Oats	88	10	32	2640	2.2	2.0
Sainfoin, early bloom	90	14	32	2710	6.4	3.1
Sainfoin, late bloom	90	10	NA	2350	7.6	1.6
Bromegrass	89	8	36	2200	4.2	2.0
Timothy	88	8	38	2380	3.6	4.1
Cicer milk vetch	91	14	24	2680	1.8	0.2
Silages (dry-matter basis)						
Barley	100	11	33	2780	4.6	3.5
Oats	100	10	36	2640	4.7	3.3
Corn	100	8	31	2890	3.7	2.2
Faba bean	100	20	36	2490	9.0	2.8
Pea vine	100	13	49	2490	1.3	0.2
Straws						
Barley	91	4	47	1750	3.3	0.9
Oats	91	4	47	1870	3.0	0.9
Wheat	91	3	49	1700	1.5	0.7
Miscellaneous						
Beet pulp (dried molasses)	92	9	31	3220	5.5	0.9
Beet pulp, pressed	22	2	7	760	0.1	0.0
Beet tops (dry-matter basis)	100	14	14	2690	9.9	2.2
Bran	89	16	14	2750	1.4	11.7
Brewers' grain (dried)	92	26	22	2690	2.6	5.1
Distillers' corn grain (dried)	92	27	18	3370	0.9	3.7
Flax	92	24	7	4760	2.6	5.5
Meat meal	94	53	NA	2910	79.1	40.3
Molasses (beet)	80	8	0	2650	0.4	0.2
Peas (seed)	91	22	7	3170	1.7	5.0
Potatoes	22	2	1	790	0.1	0.5
Minerals						
Bone meal	95	12	0	0	290.1	136.0
Rock phosphate (30-18)	96	0	0	0	300.0	180.8
Dicalcium phosphate (16-21)	95	0	0	0	160.0	210.0
Limestone	95	0	0	0	401.2	0

[1] Dry matter.
[2] Acid-detergent fiber.
[3] Digestible energy.
NA - not available.

Table 2 Daily DE required for various ADG for medium-frame steers (e.g., Hereford)

Animal weight (kg)	DE in diet (Mcal/kg)	Daily gain (kg) 0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
		Daily DE (Mcal)								
200	2.2	8.7	9.8	10.3	10.9	11.4				
	2.6	8.5	9.6	10.2	10.7	11.2	11.8			
	3.0	8.4	9.5	10.0	10.5	11.1	11.6	12.2		
	3.4	8.2	9.3	9.8	10.4	10.9	11.4	12.0		
250	2.2	10.7	12.5	13.4	14.4	15.3				
	2.6	10.5	12.3	13.2	14.1	15.0	15.9			
	3.0	10.4	12.1	13.0	13.9	14.8	15.7	16.5		
	3.4	10.2	11.9	12.8	13.7	14.5	15.4	16.3		
300	2.2	12.8	15.3	16.6	17.8	19.1				
	2.6	12.6	15.0	16.3	17.5	18.8	20.0			
	3.0	12.4	14.8	16.0	17.2	18.5	19.7	20.9		
	3.4	12.2	14.6	15.8	17.0	18.2	19.4	20.6		
350	2.2	14.8	18.1	19.7	21.3	22.9	24.6	26.2		
	2.6	14.6	17.8	19.4	21.0	22.6	24.1	25.7	27.3	
	3.0	14.3	17.5	19.0	20.6	22.2	23.8	25.3	26.9	28.4
	3.4	14.1	17.2	18.7	20.3	21.8	23.4	24.9	26.5	28.0
400	2.2	16.9	20.8	22.8	24.8	26.8	28.7	30.7		
	2.6	16.6	20.5	22.4	24.4	26.3	28.3	30.2	32.1	
	3.0	16.3	20.2	22.1	24.0	25.9	27.8	29.7	31.6	33.5
	3.4	16.1	19.8	21.7	23.6	25.5	27.4	29.2	31.1	33.0
450	2.2	18.9	23.6	25.9	28.2	30.6	32.9	35.2		
	2.6	18.6	23.2	25.5	27.8	30.1	32.4	34.7	37.0	
	3.0	18.3	22.8	25.1	27.3	29.6	31.8	34.1	36.4	38.6
	3.4	18.0	22.5	24.7	26.9	29.1	31.3	33.6	35.8	38.0
500	2.2	21.0	26.4	29.0	31.7	34.4	37.1	39.8		
	2.6	20.6	25.9	28.6	31.2	33.8	36.5	39.1	41.8	
	3.0	20.3	25.5	28.1	30.7	33.3	35.9	38.5	41.1	43.7
	3.4	20.0	25.1	27.6	30.2	32.8	35.3	37.9	40.4	43.0

Table 3 Daily DE required for various ADG for large-frame steers (e.g., Charolais × Hereford)

Animal weight (kg)	DE in diet (Mcal/kg)	Daily gain (kg) 0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
		Daily DE (Mcal)								
250	2.2	13.4	13.5	13.5	13.6	13.6				
	2.6	13.2	13.3	13.3	13.3	13.4	13.5			
	3.0	13.0	13.0	13.1	13.1	13.2	13.2	13.2		
	3.4	12.8	12.8	12.9	12.9	12.9	13.0	13.0		
300	2.2	16.2	17.1	17.5	18.0	18.4				
	2.6	16.0	16.8	17.2	17.7	18.1	18.5			
	3.0	15.7	16.6	17.0	17.4	17.8	18.2	18.7		
	3.4	15.5	16.3	16.7	17.1	17.5	18.0	18.4		
350	2.2	19.1	20.7	21.6	22.4	23.2	24.1	24.9		
	2.6	18.8	20.4	21.2	22.0	22.9	23.7	24.5	25.3	
	3.0	18.4	20.1	20.9	21.7	22.5	23.3	24.1	24.9	25.7
	3.4	18.2	19.7	20.5	21.3	22.1	22.9	23.7	24.5	25.3
400	2.2	21.9	24.4	25.6	26.8	28.1	29.3	30.5		
	2.6	21.5	24.0	25.2	26.4	27.6	28.8	30.0	31.2	
	3.0	21.2	23.6	24.8	26.0	27.2	28.4	29.5	30.7	31.9
	3.4	20.8	23.2	24.4	25.5	26.7	27.9	29.1	30.2	31.4
450	2.2	24.7	28.0	29.6	31.3	32.9	34.5	36.2		
	2.6	24.3	27.5	29.1	30.7	32.4	34.0	35.6	37.2	
	3.0	23.9	27.1	28.7	30.2	31.8	33.4	35.0	36.6	38.2
	3.4	23.5	26.6	28.2	29.8	31.3	32.9	34.4	36.0	37.5
500	2.2	27.5	31.6	33.6	35.7	37.7	39.8	41.8		
	2.6	27.1	31.1	33.1	35.1	37.1	39.1	41.1	43.1	
	3.0	26.6	30.6	32.6	34.5	36.5	38.5	40.4	42.4	44.4
	3.4	26.2	30.1	32.0	34.0	35.9	37.8	39.8	41.7	43.6
550	2.2	30.4	35.2	37.7	40.1	42.5	45.0	47.4		
	2.6	29.9	34.6	37.0	39.4	41.8	44.2	46.6	49.0	
	3.0	29.4	34.1	36.4	38.8	41.2	43.5	45.9	48.2	50.6
	3.4	28.9	33.6	35.9	38.2	40.5	42.8	45.1	47.4	49.8

The following equations may be useful to operators who use computer programs to formulate diets. These equations can predict DE required per day (E in Mcal), given average daily gain (G in kg), and weight of cattle (W in kg):

$$E_{HR} = [433.9 - 4124 \cdot G + 39.18 \cdot W + 33.87 \cdot G \cdot W]/1000$$
$$E_{HH} = [-6381 + 14332 \cdot G + 62.41 \cdot W - 16.90 \cdot G \cdot W]/1000$$
$$E_{CR} = [-693.1 - 9355 \cdot G + 53.95 \cdot W + 38.13 \cdot G \cdot W]/1000$$
$$E_{CH} = [6069 + 1183 \cdot G + 26.27 \cdot W + 21.67 \cdot G \cdot W]/1000$$
$$E_{HAY} = [-11.98 + 3954 \cdot G + 50.78 \cdot W + 7.522 \cdot G \cdot W]/1000$$

where HR = Hereford restricted in feed to gain about 0.5 kg daily until they reach a weight of about 350 kg, then full-fed;

HH = Hereford full-fed high concentrate diet from weaning to market;

CR = Charolais restricted in feed to gain about 0.5 kg daily until they reach a weight of about 400 kg, then full-fed;

CH = Charolais full-fed high concentrate diet from weaning to market; and

HHAY = Hereford fed a diet of about 50% Hay.

To estimate average daily gain (G in kg) for the same five diets, given DE intake (E in Mcal) and weight of cattle (W in kg):

$$G_{HR} = -0.3631 + 0.06586 \cdot E + 0.002302 \cdot W + 0.00007937 \cdot E \cdot W - 0.0009205 \cdot E^2 - 0.000008234 \cdot W^2$$
$$G_{HH} = -1.526 + 0.08973 \cdot E + 0.007719 \cdot W + 0.0001836 \cdot E \cdot W - 0.002106 \cdot E^2 - 0.00002001 \cdot W^2$$
$$G_{CR} = -2.8442 - 0.0527 \cdot E + 0.02220 \cdot W + 0.0006081 \cdot E \cdot W - 0.002656 \cdot E^2 - 0.00005045 \cdot W^2$$
$$G_{CH} = -0.2094 + 0.09898 \cdot E - 0.001153 \cdot W + 0.0002059 \cdot E \cdot W - 0.002334 \cdot E^2 - 0.000008546 \cdot W^2$$
$$G_{HHAY} = -1.700 + 0.004385 \cdot E + 0.01452 \cdot W + 0.0005834 \cdot E \cdot W - 0.003406 \cdot E^2 - 0.00004395 \cdot W^2$$

Energy requirements increase with stress from cold, wind, humidity, precipitation, mud, and a wet surface in the feedlot. For methods of reducing stress, see “Designing and equipping a feedlot.”

Protein

Protein requirement, expressed as a percentage of the air-dry diet, varies primarily with the weight of the animal and to a lesser extent with the rate of gain (Table 4). Cattle can use preformed protein, urea, or rumen microbial protein to meet their requirements. Rumen microorganisms require protein, which is called rumen-degradable protein. Above this requirement, part of the protein intake may not be broken down by rumen microorganisms and is called rumen-undegraded protein or simply

Table 4 Protein required in diet for cattle of various weights gaining at various rates

Animal weight (kg)	DE in diet (Mcal/kg)	Daily gain (kg) 0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
		Protein (%)								
200	2.2	7.8	10.1	11.1	11.9	12.8				
	2.6	7.2	9.7	10.8	11.8	12.6	11.8			
	3.0	8.3	9.3	10.5	11.6	12.6	13.4	14.2		
	3.4	9.4	9.4	10.3	11.5	12.6	13.5	14.4	15.2	
250	2.2	7.6	9.2	9.8	10.3	10.8				
	2.6	7.2	8.6	9.3	9.9	10.5	10.9			
	3.0	8.3	8.3	9.0	9.6	10.2	10.7	11.2		
	3.4	9.4	9.4	9.4	9.4	10.0	10.6	11.0	11.5	
300	2.2	7.5	8.6	9.0	9.3	9.6	9.9			
	2.6	7.2	8.0	8.4	8.8	9.2	9.4	9.7		
	3.0	8.3	8.3	8.3	8.4	8.8	9.1	9.4	9.6	
	3.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	
350	2.2	7.4	8.1	8.4	8.6	8.8	9.0	9.2		
	2.6	7.2	7.5	7.8	8.0	8.3	8.5	8.6	8.8	
	3.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.4	8.5
	3.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
400	2.2	7.3	7.8	8.0	8.2	8.3	8.4	8.5		
	2.6	7.2	7.2	7.3	7.5	7.6	7.8	7.9	8.0	
	3.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
	3.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
450	2.2	7.2	7.6	7.7	7.8	7.8	7.9	8.0		
	2.6	7.2	7.2	7.2	7.2	7.2	7.2	7.3	7.4	
	3.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
	3.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
500	2.2	7.2	7.4	7.4	7.5	7.5	7.5	7.6		
	2.6	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	
	3.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
	3.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4

bypass protein. Bypass protein is used for gain more efficiently than protein that has been converted into microbial protein. Most dietary protein is degraded in the rumen and reformed as microbial protein. Commonly used protein supplements have limited undegradable protein content so that the efficiency of use for gain is similar among protein sources. Although protein supplements with relatively high contents of bypass protein are available, they generally cost more per unit of total protein supplied than many commonly used supplements. There is insufficient information available on the influence of bypass protein on rate and efficiency of gain to permit an economic evaluation of their use in feedlot diets.

The protein content is generally about 9–14% in grains, 10–16% in legume hays, and 5–8% in grass hays. However, because protein content varies highly, have feed and forage samples analyzed so that you can supplement the diet if necessary. The protein content of forages varies with the maturity of the plant when it is cut, the amount of leaf saved during harvest, and the fertility of the soil. Leaves have a higher protein and energy content than stems.

Protein supplements are usually made by combining canola meal, flour-mill by-products, urea, and grains. Protein-rich feeds such as peas, beans, and alfalfa, which also are moderate to high in DE content, often can provide the required protein more economically than purchased protein supplements.

Rumen microorganisms convert nonprotein nitrogen, such as urea, to a protein that the animal can use. Because high levels of urea are toxic, do not provide more than one-third of the dietary protein as urea. If you do use a high-urea protein supplement, limit the amount that the animal consumes at one time or mix it thoroughly with the feed to avoid toxicity.

Rumen microorganisms convert feed protein as well as urea to microbial protein; therefore protein quality is of little concern unless it has been treated with formaldehyde, volatile fatty acids, or heat to increase the amount of bypass protein.

Minerals

When salt is provided free-choice, feedlot cattle normally consume an amount equaling about 0.5% of their intake of air-dry feed. Calcium (Ca), phosphorus (P), and other minerals are often mixed with the salt. Add 2% cooking oil to the mixture to reduce caking or hardening.

Cattle that are deprived of salt have poor appetites, low rates of gain, and poor feed efficiency. Salt-deprived cattle consume large amounts of supplementary salt for a few weeks when it becomes available. The amount of minerals that an animal ingests in its feed and water influences the amount of supplementary salt it will consume. Some forages grown on saline soils contain a high level of salts so that the intake of salt provided free-choice may be very low. In these circumstances, intake of a salt–mineral mix provided free-choice may be too low to supply the animal's mineral requirements (see "Water" for more information on salts in water and forage). Cattle that are on a high-concentrate diet require little supplementary salt. However, if salt is fed free-choice, cattle fed an all-concentrate diet may consume daily about 0.2 kg.

The amounts of Ca and P in the diet and the ratio of these two minerals influence the rate and efficiency of gain and the health of cattle. The Ca and P requirements vary with the size and class of cattle (Table 5).

Table 5 Calcium and phosphorus requirements

Class of cattle	Body weight (kg)	Daily needs (g) Ca	P
Finishing calves	150	21	15
	200	24	17
	300	27	19
Finishing yearlings	250	25	18
	300	28	20
	400	35	25
Wintering calves	150	7	5
	200	11	8

Grains contain little Ca and moderate levels of P (Table 1). Legume forages contain fairly high levels of Ca and moderate levels of P. Grasses have intermediate levels of Ca and P. The ratio of Ca to P in the diet should be between 1:1 and 6:1. A low-Ca, high-P diet can cause stiffness in the legs and digestive upsets. This difficulty is encountered with high-concentrate diets but can be corrected by adding 1.0–1.4% limestone (calcium carbonate, $CaCO_3$) so that the ratio of Ca to P is at least 1:1. If necessary add silage or about 2% molasses to prevent the limestone supplement separating from the grain, especially if the grain is coarse. Adding 1.8% limestone to a diet reduces feed intake, rate of gain, and feed use efficiency. A mineral supplement with about 30% Ca and 18% P is usually needed when the diet is mainly forage.

Trace minerals required by cattle in very small quantities include iodine, cobalt, copper, zinc, manganese, and selenium. Each diet has a different need for supplements of trace minerals, depending on the amounts in the feed ingredients, which, in turn, are influenced by the soil and growing conditions of the crop. Feed ingredients throughout western Canada are usually deficient in iodine (I) and possibly cobalt (Co). A mild deficiency may be difficult to detect. When it is consumed in sufficient quantity, cobalt–iodized salt meets the animal's requirement for Co and I. However, if you provide block salt or if the water is hard, cattle may not eat enough of the fortified salt to supply the necessary amount of trace minerals. You may need to add ground grain or other feed to raise the free-choice salt intake to a level sufficient for the animals' Co and I requirements.

Selenium (Se) deficiency is common in the foothills region of the Rockies. Crops grown in acid soils are notably deficient in Se. The minimum requirement is about 0.2 ppm, but 0.3 ppm may be a more practical level. An excess of Se, especially the organic form that is found in plant material, is very toxic. Supplementing diets at recommended levels is generally safe, even though the basal diet may meet the animal's needs.

Copper (Cu), zinc (Zn), and manganese (Mn) deficiencies are difficult to detect in feedlot animals. A Cu deficiency may be caused by high molybdenum (Mo) and sulfate contents in feed, water, or both. Early signs of Cu deficiency are fading of hair color and failure to shed the winter coat in spring. With more prolonged deficiency, cattle will become anemic, will chew wood, and their rate of gain will decline. With advanced deficiency, sudden cardiac failure, ataxia of the hind quarters, and bone deformities and fractures occur. Copper levels in dry feed of 6–12 mg/kg and Mo levels of 0.2–1.0 mg/kg, which are found in most Canadian grains, meet the animal's needs. The Zn requirement is about 20 mg/kg of dry feed equivalent. Zinc deficiency first causes rough dry skin, especially around the muzzle of light-colored animals; the coat is dry. One function of Zn is in an enzyme system involved in vitamin A metabolism. Therefore the symptoms of a Zn deficiency may be mistaken for a vitamin A deficiency. A high Ca intake increases Zn excretion and thereby increases the dietary requirement. Weight-gain response to supplementary Zn varies from no response to a modest increase in the rate of gain; some feedlot operators add Zn to the diet to control foot rot. Although Mn deficiency influences bone growth and reproduction, feedlot diets supply sufficient amounts to meet the needs for normal weight gain and feed use.

Indiscriminate use of mineral supplements may create problems. High levels of minerals can be toxic. Metabolism and mineral needs of the animal are interrelated. Large mineral imbalances can cause deficiencies of other minerals. Follow the advice of qualified personnel when supplementing minerals, especially the trace minerals. Laboratory analysis of your feeds or of feeds grown in your area may be needed to assess the kinds and amounts of supplements required.

Vitamins

Vitamin A is required in the diet of beef cattle. Feedlot cattle need about 20 000 international units (IU) of vitamin A at a liveweight of 200 kg and about 30 000 IU at 400 kg. Although each animal requires this amount daily, up to a 1-month supply can be fed in one dose. Vitamin A may be given orally or by injection, or it can be dissolved in the drinking water. If vitamin A is to be injected intramuscularly, use a clean, sterile needle for each animal. Vitamin A is often sold combined with vitamins D and E.

Hay and silage contain carotene, which cattle convert to vitamin A in their bodies. However, cattle do not use carotene very efficiently; they convert only about 25% of the vitamin A equivalents of the carotene in the forage to vitamin A. Vitamin A deficiency has been found in cattle fed silage diets even though chemical analysis indicated enough carotene in the diet to meet the vitamin A needs of the animal.

Vitamin A deficiency symptoms include watery eyes, rough coat, high incidence of respiratory disease, loss of appetite, reduced rate of gain, and susceptibility to ringworm. In cases of severe deficiency, cattle become blind and may even lose weight.

Although cattle require other vitamins, supplements are rarely needed because either feeds contain enough of these vitamins, or rumen bacteria or the animal itself can manufacture required amounts. Vitamin D, which is present in sun-cured hay but not in silage, forms in the animal's body when it is exposed to the sun. Vitamin E is present in most feeds in quantities sufficient to meet the needs of cattle. Vitamin C is formed by biochemical reactions in the animal's body, and therefore a dietary source is not required. The B vitamins are usually formed by rumen microflora in amounts that meet the animal's needs. However, nutritional polio, which appears to be caused by feeding diets with a high level of readily available carbohydrates, or high sulfate level in feed or water, responds to an injection of thiamin (vitamin B_1). Stressed, low-appetite calves may respond to thiamin therapy.

Kinds of feed

Nutritional needs of feedlot cattle can be satisfied by combining feeds and feed supplements. Besides being nutritious, a diet also should be appetizing, nontoxic, and economical. Taste, texture, and amount and kind of fiber (such as cellulose, hemicellulose, and lignin) influence consumption and the extent and rate of digestion, thereby affecting the rate and efficiency of gain.

Grain

Grains have a high concentration of DE and moderate protein levels. They are generally a good source of P but are low in Ca. The low ratio of Ca to P necessitates Ca supplementation (see "Minerals"). Grains contain neither carotene nor vitamin A and therefore high-grain diets require supplementation with vitamin A (see "Vitamins"). Grains must be properly processed to be used efficiently and to avoid digestive problems (see "Processing feeds"). Slowly increase the amount of grain offered over 10–14 days to avoid digestive upsets.

Wheat has the highest DE and protein content of commonly fed grains in western Canada. Although barley is lower in DE and protein than wheat, it is the most commonly fed grain in the feedlot. Barley is preferred because the price is generally less per unit of energy than wheat or oats. Wheat has a reputation of causing more digestive problems than barley when fed at high levels, but coarsely processed wheat may be fed successfully. Oats has more hull than barley and about 10% less DE. Corn grain has a DE content similar to that of wheat but contains less protein. Rye, which is lower in energy content and less palatable than barley, should constitute no more than 25% of the concentrates in the diet. Rye often contains ergot, a fungus that reduces palatability and may cause restriction of blood flow to the extremities, resulting in loss of the tail and hooves (see Agriculture Canada Publication 1701 *Problem feeds for livestock and poultry in Canada*). More than 0.1% ergot in the total diet is potentially toxic. Triticale is similar to barley in DE content and a little higher in protein content. New varieties of triticale are relatively ergot-free. Coarsely rolled triticale provides a rate and efficiency of gain similar to that of coarsely rolled barley.

Newly harvested grain may cause digestive upsets and even mortality in cattle. The cause is unknown and the frequency is not predictable. To avoid the problem, store grain for at least 6 weeks after harvest before it is fed.

Most frozen grains can be fed to cattle without ill effects; however, avoid feeding them frozen flax because it can be toxic. Slightly frozen grain and unfrozen grain have a similar nutritional value. Severely frozen grain has a higher fiber content and lower nutritional value than unfrozen grain. Digestible energy decreases roughly in proportion to the increase in fiber content. Grains infected with smut, rust, and ergot have a higher fiber content and consequently a lower nutritional value than grain free of these diseases.

Although energy appears to be lost as heat and carbon dioxide from sprouting grain, diets containing up to at least 36% sprouted grain do not influence the rate of gain or feed efficiency. No differences were found in the DE content of wheat with 20 and 7% sprouted kernels.

Roughage

Dry matter of hay contains about two-thirds as much DE as that in grain. The relatively low content of DE results in lower rate of gain and requires more feed per unit gain than when a high-concentrate diet is fed. Therefore, it is common practice to limit the amount of hay fed. High-hay diets are generally limited to the first few weeks that cattle are in the feedlot and to cattle that are being "backgrounded" (that is, being fed to increase frame size, not to finish).

Protein contents of roughages vary from about 3% in straw to about 18% in legume hays. Legume hays usually have a high content of protein and Ca and a moderate content of P. Grass hays contain only moderate levels of protein, Ca, and P. When diets contain high levels of hay, the kind and amount of Ca and P supplement required depend on the type of hay. Because straw is high in lignin, which is digested slowly, limit the amount of straw in a feedlot diet so that cattle can eat enough feed to gain weight. Grinding low-quality hay increases consumption and rate of gain and reduces the amount of feed required per unit gain, but cost of processing generally does not give an economic gain (see "Processing feeds").

Silage and haylage

Silages can be made from various crops that differ widely in nutrient content with about 22–40% dry matter or even higher dry matter in oxygen-limiting silos. Because the water content of silage varies greatly, ensure adequate intake of dry matter. Silages that contain 35% dry matter require 2.6 t of silage to produce the nutritional equivalent of 1 t of hay;

for silages that contain 22% dry matter, the ratio is 4:1. The ensiling process itself does not alter the digestibility of the feed unless the silage reaches an abnormally high temperature, which lowers digestibility. Protein and DE yields are often higher when a crop is ensiled than when it is made into hay, because leaf losses are usually less; spoilage losses also may be reduced, especially in areas where rainfall is high during the haying season. Bloat is rarely a problem when silage forms a large part of the diet. Handling silage requires considerable mechanization for efficient use of labor.

Corn silage is a valuable feed in areas where corn can be grown successfully. Protein constitutes about 8% of the dry matter in corn silage made from the whole plant. The protein level of the silage can be increased to 12% by adding 0.5% urea, based on the weight of wet forage at ensiling, or by adding anhydrous ammonia. Corn silage that contains about 35% dry matter is best, but some contains as little as 22%. If silage containing such a low percentage of dry matter forms a large part of the diet, cattle may not eat enough to meet their energy needs for rapid gain. Cereal silage contains slightly less DE and more protein than corn silage, on a dry-matter basis (Table 1). Adding 0.5% limestone to cereal silages will help achieve an acceptable ratio of Ca to P. Adding ground grain at about 75 kg/t of alfalfa when ensiling may improve that process by providing a readily fermentable carbohydrate for the silage bacteria. However, spoilage organisms in the silage may increase. Losses of 5–10% of the available energy of added grain during the fermentation process reduce the benefit of adding grain when making silage.

When feeding any silage, pay special attention to the vitamin A status of the cattle. Some silages appear to increase the vitamin A requirement to a level above that usually recommended.

Haylage is forage stored with about 50% moisture. Storage of this material requires an airtight facility or a preservative added to control the growth of mold. Haylage has a lower moisture content than silage, and 2 t of haylage provide about the same nutrients as 1 t of dry hay. Haylage and silage have similar nutritional values, on a dry-matter basis.

Before choosing either silage or haylage instead of dry feed, consider the cost of handling and storing them compared with the gains in nutritional value of the crop. To determine if silage should be part of the feeding program, consider several factors such as the nutrient yield, cost of production per hectare, and the use of labor and equipment, as well as performance of the cattle. Programs are available through extension services to assess the economics of silage production and feeding under different situations. For further information on making and feeding silage, we refer the reader to manuals devoted to the subject.

Miscellaneous feeds and by-products

Beet tops are moderately rich in protein and DE, and cattle eat them readily either fresh, dried, or ensiled. An average crop of beet tops has a dry-matter content that equals 10% of the yield of roots. Because beet tops are a laxative, limit the daily amount to about 3 kg for calves and 12 kg for older cattle. Although beet tops contain moderate levels of Ca, they also contain oxalic acid, which combines with the Ca making it unavailable to the animal. Add 1% limestone to the wet beet tops to provide enough free Ca to prevent a deficiency. Beet tops may be toxic because of a high nitrate content. Cattle may choke on beet roots, especially when they are first offered.

Dried molasses beet pulp is very palatable but low in protein and P (Table 1). It is especially valuable when the diet contains high levels of concentrate or when cattle that are accustomed to a high-roughage diet are being introduced to a high-concentrate diet. Pressed beet pulp is high in moisture content but on a dry-matter basis contains about 10% less DE than barley. Pressed beet pulp may be ensiled or kept fresh during the colder months.

Beet molasses is a good source of energy but, because of cost, is used mainly to increase the palatability of a diet. When it is added at a level of about 2% of the concentrate or 5% of the roughage in a diet, it helps to reduce the dustiness of a feed and the separation of fine-particle vitamin and mineral supplements. Because molasses is a laxative, restrict the daily amount to about 1 kg for each animal. Canola oil mixed with molasses reduces feed sticking to the feed-processing equipment. Canola oil may be used alone to reduce dustiness of the feed.

Liquid molasses supplements with urea and other supplements may be fed free-choice using a wheel mechanism to limit the rate of intake to prevent urea toxicity. Liquid molasses with urea may be added to feed to reduce dustiness and as a source of protein.

Pea vines contain levels of protein and DE similar to those of alfalfa. Cattle eat them readily.

Potatoes contain about 22% dry matter and 2% protein. The dry matter in potatoes contains about 9% protein and the same amount of DE as barley. Large amounts of potatoes can be included in the diet of cattle if the feed is supplemented adequately with protein, minerals, and vitamins. Potatoes are low in Ca and contain moderate amounts of P. Cattle can choke on whole potatoes, so watch for gagging or feed the cattle small chopped pieces. Wastes from potato processing are high in energy but they, too, require protein, mineral, and vitamin supplements when they form a large part of the diet (see Agriculture Canada Publication 1527 *Guidelines for feeding potato processing wastes and culls to cattle*).

Cooked and dried paunch residue from cattle that were fed high-concentrate diets has about the same nutritional value as alfalfa hay. When it is combined with 25% hay, paunch residue can be fed to growing cattle. Paunch residue that contains many fine particles is not usable because cattle will not eat it. Add molasses or some other palatable feed to induce cattle to eat it until they have become accustomed to it.

Dried or wet brewers' grains are highly palatable; the dry matter contains about 26% protein. Dried brewers' grains are especially valuable as a component in starter diets and for cattle that have gone off their feed.

Dry matter in dried distillers' grains contain about 27% protein. Introduce these grains gradually to the diet.

Feed additives

Additives are not nutrients. They are used to increase the rate of gain, or feed efficiency. Although many additives have been tried, only a few, such as ionophores, are beneficial. Be sure to mix additives thoroughly in the diet to avoid giving cattle too much at once.

Ionophores, such as Rumensin and Bovatec, increase feed efficiency by about 5–10%. They must be introduced gradually to cattle and must be mixed thoroughly into the diet. Even a single feeding that contains a high level may be toxic or may cause cattle to go off their feed. Because some species of animals (for example, horses, dogs, and pigs) are sensitive to even low levels of some ionophores, do not use feedlot diets that contain ionophores for other species.

Antibiotics may benefit cattle during their first 2 weeks in a feedlot. They help to reduce respiratory ailments during this period of stress when cattle are most susceptible to disease. Administering low levels of antibiotics during the entire feeding period gives inconsistent results.

Tranquilizers are inconsistent in promoting rate of gain or improving feed efficiency. Use them only under a veterinarian's supervision to calm an excited animal.

Enzymes added to the diet produce no measurable effect. Rumen microorganisms apparently produce enough enzymes to digest the feed.

Implants of various growth stimulants increase rate of gain by about 10% and gain-to-feed ratio by about 5%. Responses to implants vary with several factors such as level of feeding, type of diet, sex of cattle, and management practices. Cattle on full feed benefit most from these stimulants. For best results, be sure to follow the directions on the label.

Processing feeds

Feeds are processed to increase digestibility, feed intake, rate of gain, and gain-to-feed ratio and to reduce feed wastage. Consider equipment and labor costs, power requirements, kinds of feed to be processed, and the potential advantage from processing before selecting equipment. Feed-handling equipment should include a scale for measuring the proper feed mixture, to control feed intake, and to record consumption.

Processing operations generate a lot of dust. Tallow, canola oil, or a fine spray of water added just before cutting or grinding reduces dust. Operations such as steam generating and forage grinding pose a fire hazard. If a piece of metal were accidentally to go through a forage grinder, it could become hot enough to start a fire that might not be noticed for hours. Perform such operations at a safe distance from other buildings.

Hay

Cutting, cubing, grinding, and pelleting hay not only generally increases intake and rate of gain but also increases the cost of the feed. The extra costs generally make the cost of DE from roughage higher than that from grain. The increase in intake of processed hay is greater for low- than for high-quality hay. Processing hay facilitates mixing of hay and grain, mechanical feeding, and generally reduces feed wastage. Weigh the advantages of processing against the extra cost of labor, energy, and equipment as well as dustiness from processing hay.

Cubing Hay compressed into cubes that are about 3 cm^2 is easier to handle than baled or loose hay. Feed losses from cattle pulling cubes out of the manger are reduced. However, fine particles formed in the cubing process may increase the incidence of bloat.

Cutting Hay that is cut into lengths of 5–10 cm can constitute up to 40% of the finishing diet without reducing the rate of gain that is achieved when cattle are fed a high-concentrate diet. However, the risk of bloat is increased.

Grinding and pelleting Rates of gain and feed efficiencies are improved by pelleting when low-quality hay constitutes more than about 50% of the diet. Pelleting high-quality hay has little effect on rate or efficiency of gain. As the level of hay is increased, DE concentration declines and the feed required per unit of gain increases. More hay may be fed without a reduction in rate of gain when hay is ground and pelleted but there is little improvement in the efficiency of feed usage. The extra gain seldom warrants the extra cost of grinding and pelleting. Pelleting is used to bind fine-particle materials such as protein supplements and additives to reduce separation from coarsely rolled grain.

Grain

The gain-to-feed ratio (G/F), which is a result of digestibility and intake, is lower on thin- than on medium-rolled barley. Digestibility of steam-rolled barley increases as the thickness of the roll decreases from coarse to thin. However, consumption increases as the thickness of the roll increases and fewer digestive problems occur when grain is rolled coarse (1.8 mm) rather than thin (1.5 mm) or medium (1.6 mm), especially during the first few weeks that cattle are fed the high-concentrate diet. With thin and medium steam-rolled grain, digestive upsets increase, especially during the first 4–6 weeks until the cattle become accustomed to rolled grain. During this crucial period of getting the cattle on a high-concentrate diet, roll the grain coarse. Although whole grain may appear in the manure, the loss in digestibility of the whole grain is only about 14–22%, which may be more than compensated for by the reduction in digestive upset. Fine particles in overprocessed grain reduce rate of gain and feed efficiency and may lead to digestive disturbances such as bloat and rumen acidosis.

Cooking Cooked grain requires a protein supplement because the protein and organic matter in cooked grain are less digestible. Cattle fed steam-flaked grain and a protein supplement gain 0–15% slower than those fed dry-rolled barley.

High-moisture grain A major advantage to high-moisture grain is that less loss during harvesting increases the dry-matter yield. Barley that contains 30–40% moisture is physiologically mature. Harvesting barley at this stage of maturity, about 12 days earlier than normal, may increase crop yield by 16% (dry matter), mainly by reducing harvest losses. Grain can be harvested when weather conditions do not permit harvest of dry grain. Grain with a high moisture content may be preserved as silage. It is too heavy for normal augering and requires belt conveyors, front-end loaders, or other moving equipment. Conventional rollers are not satisfactory for rolling high-moisture grain. Roller mills are available with grooved rollers of different sizes that rotate at slightly different speeds to break the hull of high-moisture grain. Breaks in the hull permit cattle to digest grain as efficiently as dry-rolled grain. Hammer mills break the hull of kernels but usually part of the kernels escape, especially if the screen of the hammer mill is removed to increase the mill's capacity. When comparing high-moisture and dry-rolled barley, we need to know the proportion of kernels with broken hulls. The thickness of rolled grain may account for most of the wide variations in rate of gain (from −15% to +20%) of high-moisture versus dry-rolled grain. Use a four-wheel drive or a tracked tractor for packing the grain in horizontal silos. Before you decide to harvest your crop as high-moisture grain, calculate the extra cost of storing the increased yield and compare it with the potential advantage in rate and efficiency of gain and increased dry-matter yield. Grain that contains 30–40% moisture is suitable only for feed and cannot be sold on other markets.

Rates of gain and feed efficiencies are variable for cattle fed grain that has had water added to it and is partly fermented before rolling. Evidence suggests that any advantage from feeding high-moisture grain can be attributed to it having fewer fine particles than the dry-rolled grain. A similar effect can be achieved by tempering, without the use of airtight silos or preservatives.

Popping or expanding Popping requires special equipment and care in its operation, which adds to the cost of this feed. Feed efficiencies and rates of gain are lower for popped grain than for cracked grain because cattle eat less of it.

Tempering Grain kept coarse by tempering it with water before processing (Figs. 2–5) reduces bloat, increases feed intake, reduces wind loss and irritation from dust, and increases the rate of processing (see “Processing feeds”). To temper the grain, attach a garden hose on the top side of the auger about 2 m from the top end (Fig. 4). Add water as the grain is augered (Fig. 5) to raise the moisture content of the grain to about 15%, which is near the limit of cold water that grain will hold as it passes

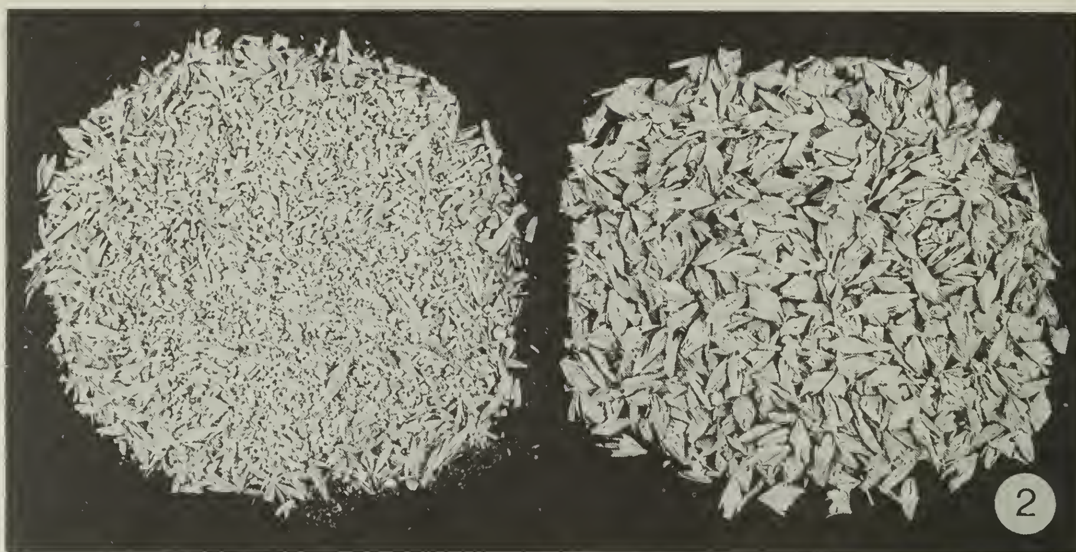

Fig. 2 Dry-rolled grain (*left*) is too fine and can cause bloat and digestive upsets. Tempered and rolled grain (*right*) is coarse and dust-free.

Fig. 3 Foam in rumen contents from cow that was fed fine-ground grain (*left*) indicates potential bloat. Rumen contains no foam (*right*) when animal is fed coarse-ground grain that is dust-free.

through the auger. Under warm conditions, allow the moistened grain to stand for 1–4 h before processing it. Under cold conditions, add the water as the grain is augered from the storage bin and allow it to stand overnight. Experienced operators have found that down to about −10°C, tempering grain with unheated water is practical. Under extremely cold conditions or if grain has been handled before tempering, add hot water and hold it in insulated tempering bins. Commercial equipment to monitor grain moisture content and to add predetermined amounts of water is available.

If cattle must be fed feed that contains too many fine particles, add 2–3% fat, molasses, or canola oil, or 10–20% silage to keep the fines from separating from the coarse particles. However, if there is a high proportion of fines, feed intake may be low and digestive problems may still occur. For a short-term measure to prevent digestive upsets from fine feed, add 4% salt to the feed. However, salt reduces feed intake and results in reduced gains. Over long periods, rumen microorganisms adapt to the high concentration of salt, and it becomes an ineffective remedy for fine-particle size feed.

Fig. 4 Hose attached to the top side of the auger.

Fig. 5 Water is added as grain is augered from bin to temper it before rolling; tempered and rolled grain is dust-free.

Feed-related disorders

Bloat

Bloat may be a major problem in feedlots. Gas, naturally produced by microflora in the rumen as the feed is digested, is normally expelled by belching. Bloat is the condition when the gas becomes trapped, causing the rumen to extend and push against the diaphragm until the animal is no longer able to breathe. When gas is trapped by viscous rumen fluids, it is termed frothy bloat. Bloat develops rapidly; often in less than 30 min from the time an animal is observed to be normal, its condition can become critical. Frothy bloat is the most common type of feedlot bloat. When gas accumulates at the top of the rumen as a free gas, it is termed free-gas bloat. This type of bloat usually develops slower than frothy bloat.

Major causes of feedlot bloat are too many fine particles in the feed and alfalfa in the diet. To prevent bloat caused by fine-particle feed, process it so that the particles are coarse. Feeds that contain more than 20% fine particles, passing through a 0.85 mm screen, can cause bloat (Fig. 3) and other metabolic disorders. Diets high in grain or legumes often contain an abundance of fine particles as well as readily available energy, which are believed to cause frothy bloat. High viscosity of rumen fluid develops over about 2 weeks on diets with fine-particle size feed and readily available energy. Rumen bacteria and protozoa respond to fine-particle feed by producing a viscous secretion that traps gas produced by normal metabolism of these microorganisms, thus causing bloat. Sometimes, a change in the source of alfalfa eliminates the problem.

Numerous treatments have been suggested for afflicted animals, including drenching the rumen with compounds such as mineral oils, adding detergent at 0.05% of the diet (500 g/t) or anti-foaming agents, releasing the gas with a garden hose (for free-gas bloat), and cannulating or surgically fistulating the rumen. Because a major cause of feedlot bloat is fine-particle size feed, prevention rather than treatment is recommended (see "Processing feeds"). Process grain to avoid fine particles. Changing either diet ingredients or their proportions to reduce the amount of fine particles and readily available energy may eliminate the problem. Grass hay or even some legumes that are digested more slowly than alfalfa reduce the amount of fine particles and the rate at which energy is made available to the rumen microflora.

Many feedlot operators blame high-energy diets for causing bloat and they cut and mix straw or coarse hay with rolled grain to reduce the incidence of bloat. However, all-concentrate diets have been fed that resulted in a very low incidence of bloat. Although adding cut hay or straw may reduce the incidence of bloat, the rate of gain is also reduced and the cost of the gain generally increases. Therefore, use the procedure only temporarily until a more permanent solution to increase feed-particle size is developed.

Calculi

Urinary calculi (water belly, urolithiasis) are stones formed in the kidney or bladder, which block the ureter and prevent normal urination. Symptoms of urinary calculi include dribbling of urine or complete lack of urination, an uneasiness in cattle, twitching of the tail, kicking at the belly, and standing with their hind legs extended. If the condition is not corrected the bladder will burst and spill the urine into the abdominal cavity, resulting in death from uremia. The usual treatments are surgical removal of the stones from the urethra or injection of a muscle relaxant to relax the urethra so that the stone may be passed. There are several types of stones, but, in feedlot cattle, most stones are formed of phosphates or silicates. The latter are believed to form from silica in grass and are in cattle before they arrive at the feedlot. Although several hypotheses have been raised about the etiology of phosphate stones, their major cause seems to be a low Ca-to-P ratio such as is found in many high-concentrate diets that are not adequately supplemented with a high-Ca supplement such as limestone.

Common ailments

Common nutrition-related ailments and ways to prevent or treat them are listed in Table 6.

Table 6 Guide to common nutrition-related ailments

Symptom	Common or predisposing factor	Nutritional treatment or preventive measures
Dull coat	Vitamin A deficiency	Provide vitamin A supplement (see "Vitamins")
Failure to shed hair	Vitamin A or Cu deficiency	Provide vitamin A supplement; provide Cu or trace mineral supplement
Night blindness	Vitamin A deficiency	Provide vitamin A supplement
Erratic appetite	Vitamin A deficiency	Provide vitamin A supplement
	Fine particles in feed	Temper or steam-roll grain to maintain coarse particle size
Frequent respiratory problems	Vitamin A deficiency	Provide vitamin A supplement
Ringworm	Vitamin A deficiency associated with infected premises	Provide vitamin A supplement
Shipping fever	Physical stress, especially of nutritionally stressed cattle	Precondition before transporting; provide good-quality hay, vitamin A, and clean, dry quarters on arrival at feedlot; provide K supplement in feed or water; permit animals to settle down before vaccinating (see "Bringing cattle into the feedlot")
Sudden nervousness	Shortage of Ca caused by feed that is high in oxalic acid, e.g., beet tops	Feed daily 0.1 kg limestone/head mixed with grain or silage
Bleeding	Sweetclover poisoning	Alternate sweetclover and other forage at 2-week intervals

(continued)

Table 6 (*concluded*)

Symptom	Common or predisposing factor	Nutritional treatment or preventive measures
Stiff legs	Ca:P imbalance	Add 1% limestone to concentrate
Impaction	Shortage of protein or high-straw diets	Provide protein supplement to supply protein requirement (see Table 4); replace part of straw with hay
Chewing wood	P deficiency; Ca:P imbalance; Co deficiency; Cu deficiency	Provide a P supplement; provide 1% limestone in grain; provide loose cobalt-iodized or trace-mineralized salt
White muscle disease	Se deficiency	Provide Se supplement or trace-mineralized salt
Bloat	Fine-particle feed	Temper or steam-roll grain (see "Processing feeds"); adjust roller to reduce excessive fines
	Legumes in diets	Replace legume with grass hay; feed straw with legume hay
Acidosis	Fine-particle feed	Temper or steam-roll grain (see "Processing feeds")
	Increasing grain too rapidly	Use a starter diet; increase grain allowance slowly (see "Starting cattle on high-concentrate feeds")
Gangrene of extremities (ears, tail, and feet), rough coat, reduced appetite, tenderness of feet	Ergot	Dilute feed that contains ergot to a safe level or screen out ergot bodies
Nutritional polio	Unknown, possibly related to type of carbohydrate in diet	Inject thiamin (vitamin B_1)
	High sulfates in water and feed	Change source of water and/or reduce amount of high-sulfate feed

Cattle management

Bringing cattle into the feedlot

Cattle entering a feedlot are commonly under stress and have lost weight from handling, weaning, and shipping and from changes in feed and water. Stress increases the susceptibility of cattle to disease. Observe new arrivals carefully; attend to and medicate those that show symptoms of stress. Minimize stress by immediately providing newcomers with adequate clean dry bedding, fresh water, and a palatable feed such as loose hay.

Cattle coming into the feedlot may lack several nutrients. A deficiency of vitamin A is especially common and may lead to respiratory ailments and death. To combat these problems, it is usual to inject 2–3 million IU of vitamin A into all cattle entering a feedlot (see "Vitamins"). Alternatively vitamin A may be mixed with water and sprayed on hay just before it is consumed, to provide about 500 000 IU per head for about 4 consecutive days, which will ensure that incoming cattle have adequate vitamin A. This procedure reduces the stress of putting cattle through a chute to inject vitamin A.

This crucial period in the life of the animal requires special dietary treatment to avoid morbidity and death losses. Although water loss is a major part of weight loss, sodium (Na), potassium (K), and tissue losses from the body may be more harmful to the health of the animal. If cattle take in less feed, higher nutrient composition of the diet may be necessary to meet their dietary needs. Appetite or willingness to consume feed and possibly water is usually depressed during the first 1–3 weeks after arrival at a feedlot (Table 7).

Healthy calves may require up to 4 days to begin eating and morbid calves even longer. Add 1–3% KCl to the diet of incoming cattle for the first 2 weeks to assist cattle in overcoming stress and to reduce morbidity and mortality.

Incidence of clostridial diseases, infectious bovine rhinotraceitis (IBR), and *Hemophilus somnus* (sleeper syndrome) have been greatly reduced by vaccination. Consult a veterinarian about vaccinating and administering antibiotics for therapeutic purposes.

Table 7 Depression of appetite after arrival at feedlot

Time after arrival at feedlot (days)	Dry-matter intake (% of body wt)
1–7	0.5–1.5
8–14	1.5–2.5
15–28	2.5–3.5

Starting cattle on high-concentrate feeds

When cattle have been accustomed to a high-roughage diet, introduce them to high-concentrate diets gradually to avoid digestive upsets and even death. There are many ways to gradually increase the amount of concentrate intake until cattle are on a full, high-concentrate diet.

Starter diets (Table 8) can help you put cattle on a full, high-concentrate diet safely and quickly. Feed loose hay free-choice with starter diet 1, but not with starter diet 2, which already contains sufficient hay. A feeding schedule using starter diets for introducing cattle to a full, high-concentrate diet is outlined in Table 9. Be sure to provide plenty of good-quality, fresh water.

Cattle can be introduced to a high-concentrate diet with an allowance equal to 0.8% of the body weight of each animal, provided in two equal feedings per day, and increased at the rate of 0.08% of body weight daily until cattle are on a full feed of the concentrate diet.

Starting with a ratio of 30% grain to 70% hay, the proportion of concentrate can be increased by 10% and the proportion of hay decreased by 10% every 2nd day until cattle are eating the level of concentrate desired.

Table 8 Starter diets for feedlot cattle

	Composition (%)	
Ingredient	Starter 1[1]	Starter 2[2]
DMBP, DBG, or both[3]	25	17.5
Alfalfa, grass hay, or both	20.05	50
Oats	25	25
Barley	21.5	0
Molasses	5.0	4.65
Rock phosphate (30–18)	2.5	2.25
Salt (Co–I)	0.5	0.4
Vitamin A–10[4]	0.1	0.05
Antibiotic[5]	0.35	0.15
	100.00	100.00

[1] Provide hay free-choice.
[2] Complete diet.
[3] Dried molasses beet pulp (DMBP) and dried brewers' grain (DBG).
[4] 10 000 IU/g.
[5] Aureomycin at 24 g/kg.

Table 9 Schedules for starting feedlot cattle on feed

Day	Hay	Schedule 1 (%)		Schedule 2 (%)	
		Starter 1[1]	Finisher[2]	Starter 2[1]	Finisher[2]
1, 2	FC[3]			100	
3, 4	FC	100		75	25
5, 6	FC	75	25	50	50
7, 8	FC	50	50	25	75
9, 10	FC	25	75		100
11 on[4]			100		100

[1] From Table 8.
[2] Formulate diet from available feeds to provide all required nutrients (see Tables 2–5).
[3] FC = Free-choice.
[4] Gradually reduce hay to desired level.

Compensatory gain

Cattle fed a high-energy diet after a period of DE restriction will gain weight abnormally quickly. This rapid increase in weight is called compensatory gain. Sometimes weight gain is reduced unintentionally by grazing cattle on sparse pastures or by giving them low-quality feed, or intentionally by restricting feed.

Cattle that are allowed to eat as much high-energy feed as they want, from the time they are weaned until they reach a selected market weight, consume about the same total amount of DE as cattle that are fed at a medium or low rate for part of this time. The total DE required for cattle of specific initial weights to reach a higher weight is given in tables 10 and 11. Carcasses of full-fed, medium-frame steers (e.g., Hereford) are fatter (as reflected by an increase in grade A3 and A4 carcasses) than those of restricted steers. Dressing percentage of cattle fed a restricted diet is usually about 2% lower than that of full-fed cattle marketed at the same weight (Table 12). For large-frame steers (e.g., Charolais × Hereford) feeding programs have less influence on carcass grade and dressing percent (Table 13).

Table 10 Total DE required to bring medium-frame cattle (e.g., Hereford) to market weight

Initial weight (kg)	Market weight (kg)									
	400		450		500		550		600	
	Conc.[1]	Hay	Conc.	Hay	Conc.	Hay	Conc.	Hay	Conc.	Hay
	Digestible energy (Mcal)									
150	4100	4990	5470	6430	7020	8010	8750	9740	10 670	11 610
200	3640	4290	5010	5720	6560	7300	8300	9030	10 210	10 900
250	3010	3430	4380	4870	5940	6450	7660	8180	9 580	10 050
300	2190	2430	3560	3870	5110	5450	6840	7180	8 760	9 050
350	1190	1290	2550	2730	4100	4310	5840	6040	7 750	7 910
400			1370	1440	2920	3020	4650	4740	6 570	6 620

[1] Diet type: Conc. = all or nearly all concentrate; Hay = about 50% roughage.

Table 11 Total DE required to bring large-frame cattle (e.g., Charolais × Hereford) to market weight

Initial weight (kg)	Market weight (kg)									
	400		450		500		550		600	
	Conc.[1]	Hay	Conc.	Hay	Conc.	Hay	Conc.	Hay	Conc.	Hay
	Digestible energy (Mcal)									
150	3820	4650	5270	6200	6960	7940	8870	9870	11 020	11 990
200	3520	4130	4970	5670	6650	7400	8570	9330	10 710	11 440
250	2980	3400	4440	4940	6120	6660	8030	8580	10 180	10 690
300	2220	2470	3670	3780	5360	5720	7270	7630	9 420	9 740
350	1220	1330	2680	2860	4360	4580	6280	6490	8 420	8 590
400			1450	1530	3140	3240	5050	5150	7 200	7 250

[1] Diet type: Conc. = all or nearly all concentrate; Hay = about 50% roughage.

Table 12 Effect of feeding rate on carcass quality of Hereford steers and time required to reach market weight

Feeding rate[1]	Distribution of carcass grades (%)				Dressing (%)	Days to market weight[2]
	A1	A2	A3	A4		
LLH	13.3	46.7	33.3	6.7	56.7	315
LMH	16.1	32.2	32.2	19.4	57.4	300
LHH	0	0	64.0	36.0	58.6	270
MMM	20.0	53.3	26.7	0	56.8	300
MMH	0	6.7	40.0	53.3	58.4	285
MHH	0	7.1	57.1	35.7	59.3	250
HML	21.4	42.8	35.7	0	56.8	285
HHH1	25.0	56.3	0	18.7	56.0	167
HHH2	25.0	37.5	31.3	6.2	55.8	190
HHH3	3.1	6.2	34.9	55.8	59.0	235

[1] Steers of 210 kg initial weight were fed at low (L), medium (M), or high (H) rates over the three stages of growth.

[2] Market weights were 386 kg for HHH1, 432 kg for HHH2, and 475 kg for all other feeding schedules.

Table 13 Effect of feeding rate on carcass quality of Charolais × Hereford steers and time required to reach market weight

Feeding rate[1]	Distribution of carcass grades (%)				Dressing (%)	Days to market weight[2]
	A1	A2	A3	A4		
LLH	62.5	37.5	0	0	57.3	288
LMH	62.5	37.5	0	0	58.0	275
MMM	88.5	12.5	0	0	56.7	282
HML	81.2	18.8	0	0	56.9	290
HHH1	18.8	56.2	25.0	0	57.6	248
HHH2	26.7	40.0	33.3	0	59.6	294
HHH3	21.4	28.6	28.6	21.4	60.4	346

[1] Steers of 250 kg initial weight were fed at low (L), medium (M), or high (H) rates over the three stages of growth.

[2] Market weights were 568 kg for HHH2, 614 kg for HHH3, and 525 kg for all other feeding schedules.

Voluntary feed intake

The amount of feed consumed is the single greatest factor influencing DE intake and thus the rate of gain and gain-to-feed ratio. Feed intake is influenced by DE concentration and form of hay in the diet. Maximum intake of long hay is an amount equal to about 2.8% of body weight of the animal. When feeding long hay, as the proportion of concentrate increases to about 40% of total feed, DE intake increases to about 0.29 Mcal/kg of metabolic weight ($W^{0.75}$). Above this level of concentrate there is no further increase in feed intake per $W^{0.75}$. When feeding cubed hay, DE intake is higher than with a long-hay diet when hay forms more than about 65% of the diet. Below about 40% hay, DE intake is greater with cubed-hay diets than with long-hay diets. With an all-concentrate diet of coarsely rolled grain, DE intake per $W^{0.75}$ is about 0.33 Mcal/kg. When DE concentration is higher than 2.8 Mcal/kg of diet, internal chemical reactions apparently give the animal a full feeling, thereby limiting feed intake. Maximum feed intake is possible only if an adequate supply of water is readily available.

Cattle that are fed several times daily are more likely to eat to capacity and to use their intake more efficiently than cattle restricted to the amount of feed consumed in 20–30 min fed once or twice daily. For example, cattle fed 6 or 10 times a day consumed 17% more feed and gained 0.14 kg/day more than cattle fed an amount of feed consumed in 30 min twice a day. Self-fed cattle generally have feed available most of the day and will gain at the same rate as those fed six times a day.

Allow self-feeding of a high-concentrate diet only after cattle are fully accustomed to it. Use of starter diets (Table 8) greatly reduces the risk of sickness caused by grain overload. Check self-feeding equipment daily for blockages that prevent feed from flowing freely to cattle. If cattle have been without feed for more than a few hours, gradually reaccustom them to grain. When cattle are self-feeding, provide them with at least 10 cm of feeding space per head. Remove fine-particle feed that accumulates, especially at the ends of self-feeders.

About 60 cm of lineal bunk space per head ensures that all cattle eat at once and allows controlled feed intake to obtain the desired rate of gain. Sick animals are easy to spot because they do not come to the bunk when fresh feed is added. All cattle can be medicated at one time by mixing drugs with the daily allotment of feed.

Feed ingredients influence the total voluntary intake. Cattle fed high-silage diets consume less dry matter than cattle fed diets with an equivalent portion of roughage as hay. A shortage of protein also reduces feed intake. Because digestion is slowed markedly when protein is deficient, the rate of feed passage is reduced and voluntary intake of dry matter is below capacity. With low-protein diets, provide protein supplement, legume hay, or other high-protein feed to meet the protein requirement (Table 4). Grinding and cubing hay, especially low-quality hay, increases its voluntary intake. If grain or hay is ground too fine, intake is reduced. Although ground feed can be pelleted to eliminate dustiness, its intake is reduced, and grinding and pelleting are added expenses that are seldom warranted. In addition, when the pellets break down in the rumen, fine particles may lead to bloat and other digestive disturbances. For further information, see “Processing feeds.”

Concentrate-to-forage ratios

The mix of forage and concentrate must contain enough DE and nutrients in acceptable ratios to meet an animal’s needs so that cattle will be finished when net returns are maximized. Dietary needs change as cattle mature. Satisfactory rates of gain, feed efficiency, and grades of carcass can be achieved with many combinations of a variety of feeds. Because feed prices are highly variable, it is difficult to formulate by conventional methods a nutritious, low-cost diet for each stage of growth. Computerized diet-formulation services are available from provincial departments of agriculture and some commercial feed mills. Computer printouts list the ingredients of the diet and how much of each ingredient is required to ensure feeding at minimum cost given the specified starting and finishing weights and time on feed. They also state the price changes that would warrant reformulation of the diet. To make effective use of computer services, the following procedures are recommended:

- Maintain feed-processing and feeding facilities that are flexible enough to handle diets of widely varying composition.
- List all feed ingredients available in your area.
- Obtain current prices in your area for all possible feed ingredients.
- Determine the nutrient requirements for the specific class of cattle you wish to feed. List minimum and maximum levels for each essential nutrient and, where applicable, for specific feeds.
- Analyze the feed ingredients for protein and other nutrients so that the computer has accurate data with which to formulate a good diet. The protein content of hay, in particular, varies highly, and average figures for nutrient composition may not apply to your farm.

Feeding schedules

The least expensive nutritionally adequate diet formulated specifically for your needs, or the diet producing the fastest rate of gain, do not necessarily ensure the highest possible net return from your investment. Quality and carcass weight of the beef produced and the time needed to produce it greatly influence the financial outcome. The feeding rates and duration of the diet fed over various stages of growth affect carcass weight and grade and thus affect financial returns from the sale of cattle. Change the composition of the diet and feeding rates according to a specific feeding schedule as cattle mature. Profitability is influenced by the interaction of finished cattle prices, days on feed, carcass weight, grade price differentials, and feed and feeder prices. Each class of cattle responds differently to changes in the feeding schedule and prices and price differentials. The distribution of grades of carcass and finished weights varied with the rate and duration of feeding over the growth period, as determined from feeding trials conducted at the Lethbridge Research Station, for Hereford steers (Table 12) and for Charolais × Hereford steers (Table 13). The cattle were fed at different rates for each of three stages of growth. Stages 1 and 2 were each 12 weeks. Stage 3 varied in length until calves reached designated slaughter weight. Carcass grades, dressing percentage, and time required to reach market weight differed among groups on the various feeding schedules.

Using this information, a microcomputer program was developed that selects maximum-profit feeding schedules for particular classes and breeds of cattle. Each feeding schedule specifies the rate and duration of feeding and the amounts of nutrients and dietary energy needed to produce specific grades and weights of carcass that will maximize profit. The program formulates three diets for each schedule, one for each stage of growth.

Table 14 shows sample computer-formulated diets for two situations that differ only in price differentials between carcass grades. In situation 1, the price differential is large, ranging from $3.13/kg for Canada A1 to $2.74/kg for Canada A4. In situation 2, the price differential is small, ranging from $3.11 to $3.05/kg. Feeder calf price ($2.46/kg) and feed price are identical in both instances. When price differentials are large, feeding schedules that produce large proportions of Canada A1 and A2 carcasses are the most profitable. Thus, in situation 1, the computer selected the CHHH2 schedule (designed to produce a 568-kg crossbred steer), which produces a high proportion of carcasses graded Canada A1 and A2. When price differentials are small, profits are better if dressing percentages are high, feeding periods are short, and feed conversion is efficient. Therefore, the HHH3 feeding program (designed to produce a 475-kg British breed steer) was selected in situation 2. The computer program formulated the most economical diets available that would satisfy the changing nutrient requirements during the three stages of growth. This example demonstrates the use of computer technology for diet formulation and selection of feeding programs. Consult your local extension services about availability of computer services and software in your area.

Forage–grain substitution

Although cattle can be finished on diets varying widely in proportions of grain and roughage, feedlot finishing diets typically contain only minimal amounts of roughage. Industry interest in feeding higher forage diets has occurred in periods of high grain prices relative to forage. Feeding experiments support the practice of feeding high-concentrate diets. Diets containing intermediate amounts of concentrate and forage are less efficient in producing gain than either high-concentrate or high-forage diets (Tables 10 and 11). Thus, in a range of diets with different forage-to-concentrate ratios, the diet giving most profit will be either that having the highest proportion of concentrate or that having the highest proportion of forage. Over most price ranges of forage and concentrate, the high-concentrate diets have been shown to be most economical. Economic studies generally support the practice of feeding high-concentrate diets to maximize profit over a wide range of hay and grain prices.

Table 14 Sample computer-formulated diets for two differentials of carcass price

	Amount of diet (kg/head)						
	Situation 1 (large price differential)[1]			Situation 2 (small price differential)[2]			
Diet ingredient[3]	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Price ($/t)
Barley	277	381	581	270	369	271	132
Alfalfa hay	39	–	–	23	–	–	79
Cereal hay	199	434	656	228	420	259	74
Urea	3	–	1	3	–	3	300
Minerals	2	5	8	3	4	3	4
Total	550	820	1246	527	793	536	
Feed costs ($)							
Individual diets	60.32	91.54	139.22	60.61	88.58	62.41	
Total cost		291.08			211.60		
Feeding schedule		CHHH2			HHH3		

1 Grades A1, $3.13; A2, $3.07/kg; A3, $3.02/kg; A4, $2.74/kg.

2 Grades A1, $3.11; A2, $3.10/kg; A3, $3.08/kg; A4, $3.05/kg.

3 Only partial list of ingredients in the model. Wheat ($158/t), oats ($180/t), and straw ($37/t) were not used because of their high cost.

4 Dicalcium phosphate $578/t, limestone $80/t, salt $198/t.

Financial management

Management is a key factor in determining the economic success of feeding cattle. Market conditions, economic trends, and forecasts must be monitored to determine when and what type of cattle to buy, and when and at what weight to sell to produce the quality and size of carcass demanded by the market for greatest net economic return. Factors affecting profit and risk in cattle feeding and tips for buying and selling cattle are reviewed in this section. A schematic representation of production and marketing alternatives is presented in Fig. 6.

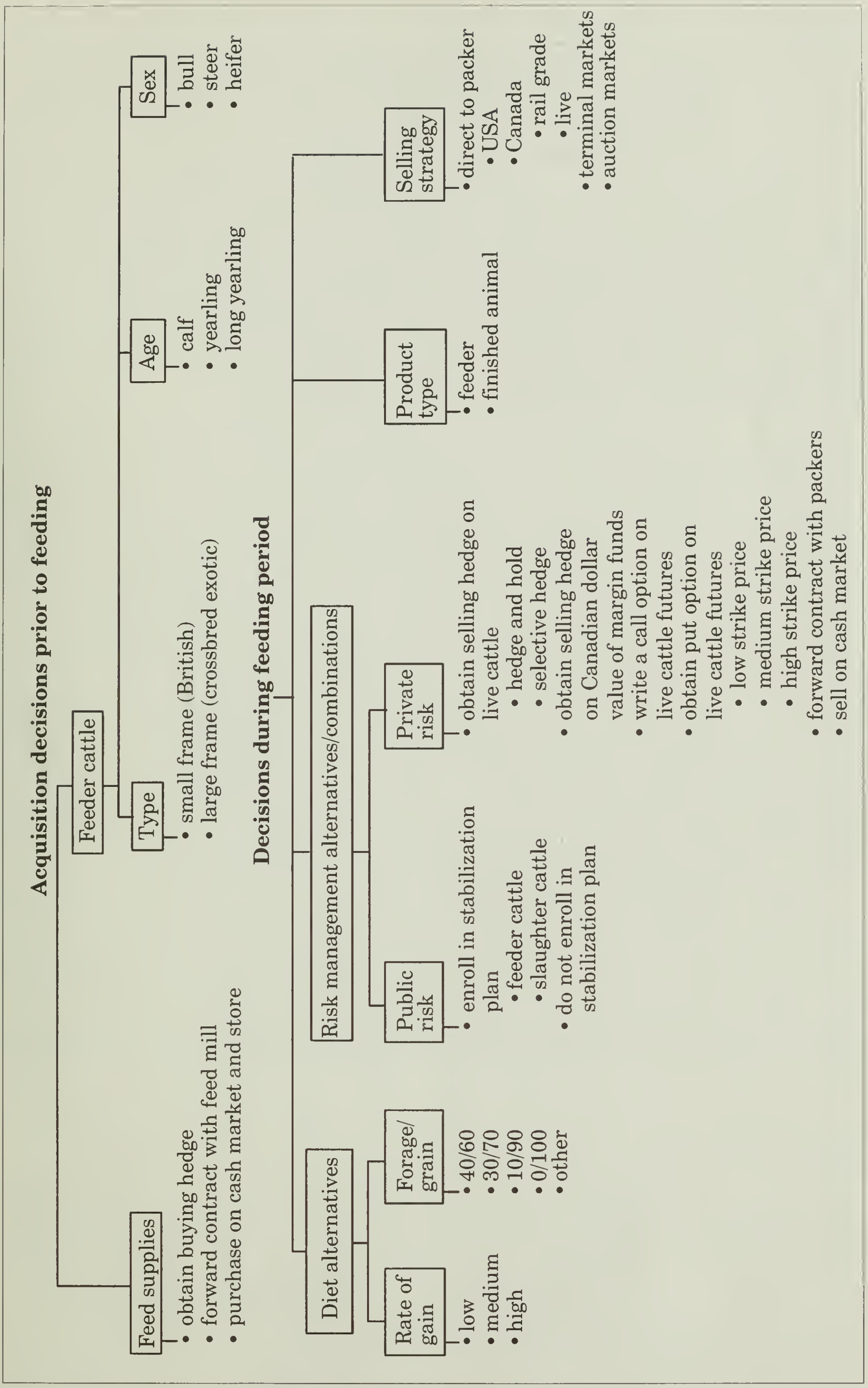

Fig. 6 Beef feedlot production and marketing alternatives.

Margin

Marketing margin is the difference between the buying and selling prices and has a large bearing on the financial outcome of feeding a group of cattle. The margin is positive when the selling price is higher than the buying price, and negative when the selling price is lower than the buying price. Feed margin is the selling price per unit weight of live beef minus the cost of gain per unit weight. When the feed margin is positive and other costs are low, a profit can be realized even when the marketing margin is negative. Conversely, when the feed margin is negative, a profit can be realized only with substantial positive marketing margins. With older, heavy cattle that require only a brief stay in the feedlot before slaughter, marketing margin is the single most important factor determining the amount of profit you can make.

Buying feeder cattle

The purchase of feeder cattle is a crucial step in determining profit or loss from feeding cattle. Decisions on when to buy, how many to buy, what kind, and at what price are often determined by feeder supply, preferences for weight and type, facilities, and projected selling price.

Calves use energy more efficiently than older cattle but require more protein in the diet. Older cattle can digest coarser feeds better than calves and require a shorter stay and less total feed to reach market weight. Bulls gain faster and use feed more efficiently than steers but sometimes sell at a lower price. All classes of cattle are available throughout the year but calves are in greatest supply in October and November, yearlings from February to July, and long yearlings from August to October. Carefully consider the expected marketing and feed margins and feed costs to select the class of cattle that will be most profitable.

Feeder cattle can be obtained from commission agents, auction markets, or directly from producers. Computerized sales of feeder cattle have developed in recent years and list information on the number of cattle, age, sex, breed, type, and body condition. Joint ventures with cow–calf producers can provide feeder cattle during periods of low supply. Preconditioned calves usually cost more but may reduce disease loss.

Carcass grades

Breed and feeding schedules determine weight and grade of carcass, which in turn influence the price of finished cattle. For any breed, restricting feed to obtain a rate of gain about half the maximum for any 6-month period after weaning produces a leaner carcass than full-feeding for the whole time. Restricting the rate of gain at the beginning or end of the feeding period or limiting the rate of gain to about three-quarters of maximum throughout the entire feeding period also produces leaner carcasses than full-feeding for the same length of time. There is a trade-off between large, lean, and thus high-value carcasses obtained from restricted feeding and the extra costs of time, interest, and feedlot turnover time incurred to obtain these benefits. See the section on "Feeding schedules" to determine the effects of diets and feeding programs on feed and time requirements and carcass grades.

Predicting returns on feeding cattle

Predicting the return from feeding a group of cattle is essential to the decisions of whether or not to buy feeder cattle and what type to buy. Many feedlot managers develop their buying strategy using the current or short-term, predicted, finished cattle price along with their current cost of gain, and to a lesser extent interest cost, to establish a break-even price. Break-even price does not include an allowance for profit. Often, the break-even price becomes the floor price for feeder cattle. The decision-making process includes a projected selling price for finished cattle based on current or projected conditions or futures market prices and costs of finishing as perceived at the time of purchase. To forecast returns, consider the importance of various short-run factors, such as feed costs, interest rates, seasonal price effects, and government programs, against the background of long-run factors such as beef demand and the cattle cycle.

Groups of uniform cattle generally command a higher price than unselected groups. Sorting alleys and pens for holding selected cattle permit working cattle before you offer them for sale. These facilities also save labor when sorting and shipping cattle.

Bulls can produce carcasses that have a less favorable, darker red color if they are stressed before slaughter. To maintain high quality in bull carcasses, reduce stress while marketing them. Keep them away from strange cattle. Minimize the time spent in travel from the feedlot to the slaughterhouse and avoid unnecessary handling during selection, holding, and shipping.

Cattle cycle and beef demand

Prior to the 1970s a dominant factor affecting cattle prices was the beef cycle. The classic beef cycle between 1939 and 1980 was 8–12 years. An increase in the price of finished cattle enhances profit margins in the feeding sector. This profit is reflected in increased demand for feeder calves and a subsequent increase in their price. Higher feeder calf prices prompt cow–calf operators to hold back heifers for breeding, which reduces the number of animals marketed for feeding and intensifies the upward pressure on steer and feeder-calf prices. Feed costs, government policy, interest rates, drought, beef demand, technology, and stabilization alter the amplitude and duration of the classic beef cycle.

Beef demand rather than supply is expected to be the driving force in future cycles. Beef demand may increase as the industry increases promotion and marketing. Branded beef products, precooked beef, and specialized beef products (e.g., “natural beef,” “marbled beef,” and so on) should all help to increase beef consumption. Costs, particularly feeder prices and feed costs, will continue to affect the cycle. Expansion of beef production is influenced by high capital costs and government policy. Cash flow and capital requirements of purchasing cows limit many potential producers from entering the business. Beef cycles are influenced by stabilization policies, which may confuse the interpretation of market prices and impact on culling and marketing decisions.

Seasonality

Beef cattle production follows a generalized seasonal cycle. Most calves are born in March and April and weaned in October and November at about 200–250 kg. About 55% of these “fall run” calves are finished to market the following May, June, and July. These fall calves represent about 75% of feeder cattle marketings from September through December. Lesser volumes of calves are offered during January and February. About 30% of fall calves are retained by producers for winter feeding at home or in custom feedlots and are reared at low daily rates of gain (0.7 kg). Resultant yearling cattle (280–365 kg) are either sold to feedlots in April and May to come to market in August or September, or are returned to pasture for the summer and sold as long yearlings or “short-keep” feeders (at greater than 365 kg) in August to October and marketed in November to January of the following year. Yearling cattle represent 40–50% of feeder cattle marketings from February through June. Short-keep feeders represent 30–40% of feeder cattle marketings from July through August.

Owing to seasonal production flows, slaughter prices are highest in March through May. After May, prices decline to seasonal lows in the summer, picking up during the fall. High prices from March through May can be attributed to a reduction in slaughter supplies occurring as the supply changes from cattle finished from the last of the long yearlings to those produced from calves. Depending on the predicted strength of the March-to-May prices, producers should consider targeting their finishing program to market during this period. Any remaining unfinished animals can be sold as feeders.

Slaughter mix

Total cattle slaughter and the mix of cattle making up the supply are important in determining short-term prices. For example, in the spring, when the amount of slaughter beef available from cull animals is at a minimum, demand for fed beef rises to fulfill the demand for manufacturing and ground beef. Ground beef is normally produced from about 50% cull cow or bull beef and 50% fed beef (front quarters, chucks, and rounds). This increase in spring demand for fed beef provides some increase in March-to-May fed cattle prices and a decrease in the price difference between prime cuts and chucks or 90% lean ground beef in the retail market. Conversely, when cow slaughter peaks in early fall and ground beef production is at a maximum, both cow and fed beef prices become depressed with slaughter cow prices generally declining relatively further.

Imports

Imports of manufacturing beef affect finished cattle prices in the same way as increases in domestic cow slaughter. The Canadian beef market is one of the most open markets in the world. Hence it is subject to periodic increases in beef imports from countries that are either expanding production, have lost traditional markets, or have temporary surpluses of beef supplies. For example, subsidized European Economic Community beef exports to Canada rose from 1.2 million kg in 1981 to 22.7 million kg in 1985 as European producers attempted to reduce dairy production by increasing dairy cow kill and exporting the excess beef. Monitoring of beef trade flows from other countries can help the producer in predicting short-term fed cattle prices.

Exports

More than 90% of Canada's cattle and beef exports, representing about 14% of our production, are to the United States. Exports to other countries may become important in the future as Canada attempts to increase trade with Pacific rim countries. Japan plans to replace its beef import quotas with tariffs in 1991. Japanese imports should increase significantly, but Canada faces competition in this market with Australia and the United States.

Government policy

Government policies have become important factors in the cattle business and producers should consider their potential impact on slaughter prices and costs. Policies and programs change frequently in the short (less than 1 year) to intermediate term (1–2 years). Initiatives in Canadian grain transportation policy have affected, and will continue to affect, cattle feeding economics. For example, the Alberta feed grain market adjustment program (AGMAP) began in 1985 in response to perceived distortions caused by payment of the Crow rate subsidy to the railways rather than to producers. Stabilization plans implemented by the provinces and federal government since the early 1980s have been modified several times. The federal national tripartite stabilization plan (NTSP) was initiated in January 1986 with a scheduled termination date of 31 December 1995. Keep informed of changes and new policies to accurately forecast cattle feeding profits or losses. Develop a record of past livestock prices and an awareness of the political climate to help in forecasting stabilization payouts and levies.

Regional and local supplies

Regional and local supplies of slaughter cattle and cows vary because of many of the factors discussed above. This variation can affect the magnitude of price differentials between carcass grade categories and the size of packer price penalties applied to light and heavy fed cattle. Heavy and light penalties can change weekly. For 1987, overweight penalties in Alberta averaged $4.40 per 100 kg for carcasses between 330 and 375 kg, and $8.80 per 100 kg for carcasses over 375 kg. Check with individual packers to determine the average penalty levels in your area and use them to determine the effects of selling at lighter or heavier weights as you try to capture seasonal highs in slaughter prices. Regional supplies can be monitored by charting plant kill levels in relation to capacity. In 1989, for example, Alberta had eight major packing plants with a combined kill capacity of 32 000 head per week. Ontario had 19 federally inspected plants with a capacity of 23 000 head per week. Each 10% drop in kill levels below 100% causes an increase of about $2–3 per head in kill costs. Thus, at low kill levels, even if packing margins are slim to negative, packers will bid higher for available supplies. Types of local and regional supplies available also affect carcass grade price differentials and penalties. For example, Alberta packers prefer to kill 55% A1 cattle. Runs of heavier-than-normal cattle resulting from cheap grains result in higher percentages of grade A3 and A4 carcasses, heavy discounts, and large carcass grade price differentials from the wholesale trade through to the feeder.

Weather

Weather trends in the short term are difficult to predict. The most direct effect of weather on beef-feeding returns is on feed production and grain prices. Monitor carry-over stocks of feed grain, winter snowfall, pasture condition, spring soil moisture, and summer rainfall. Drought conditions in the summer force movement of yearlings into feedlots, increase culling of cows and cow slaughter, and increase feed costs. Cool rainy conditions in May and June (the barbecue season) can reduce seasonal beef demand. Rains during late August and September can lower the quality of harvested grain and increase the amount of cheap grain available for feeding. If grain stocks are high, the effect of a drought on feed costs will be minimal. If they are low, drought can result in dramatic increases in feed costs.

Forecasting future prices

Several agencies forecast future beef prices by considering the long- and short-term factors that affect the industry or movements of past prices. Their published forecasts are valuable in making decisions about buying, feeding, and selling, especially in the fall and spring. Another alternative is to use futures market prices to predict future cash market prices, because they generally move together. However, futures market prices are poor predictors of cash market prices for periods longer than 2 months in the future. Futures market prices may respond differently to processes and information (e.g., trader psychology) than do cash market prices. Changes toward formula pricing, more direct buying, and fewer published cash prices may result in cash markets that ignore or fail to respond to all market information. Use caution when employing futures market prices as indicators of cash prices.

Risk in cattle feeding

Feedlot production of finished cattle involves risk, even with good forecasting and planning. Unexpectedly, slaughter prices may fall, interest rates rise, and feed costs increase as grain and forage supplies become depleted. Large financial losses may force insolvency. Ways to manage this financial risk are available but each has its problems and opportunities. This section discusses hedging and options on commodity markets, forward contracting, and stabilization programs in Canada as ways to manage financial risk in cattle feeding.

Commodity futures markets—hedging Commodity futures markets date back to the mid 1800s in Chicago and evolved as a way to forward price the sale of agricultural commodities. Forward price contracts evolved to become "futures," which are legally binding contracts to deliver or to take delivery of a given quantity of a commodity at a specified price during a specified future month and at specified locations. Futures contracts are traded by open outcry on the floor of a commodity exchange. Few deliveries are made on futures contracts because buyers and sellers offset their purchases and sales of contracts by appropriate sales and purchases before the delivery date. The fact that deliveries may be and are made, however, forces local cash and futures market prices to parallel each other. On the contract delivery or expiration date, cash and futures prices differ only by transportation costs between the local cash market and specified futures contract delivery points. Prior to the delivery date, the difference between cash and futures prices, called the basis, differs theoretically by transportation and storage costs (as in the case of storable commodities like grain) or processing costs (as in the case of feeder cattle). This parallel movement of cash and futures prices is important because it facilitates the use of commodity futures markets to manage financial risk through hedging.

Hedging is simply taking opposite positions in the cash and futures markets to lock in a profit (or loss) as seen in the current cash market. For example, a feedlot manager who budgets out a profit on feeding cattle based on current slaughter prices but has concern that prices will decline before the cattle finish, would hedge by selling futures. Around the time the cattle finish, managers would offset their futures position by buying futures. If cash slaughter prices fell, managers would lose money on the cash market sale of his cattle. However, they would gain money on the futures market by having sold futures high at the beginning of the feeding period and bought futures lower at the end of the feeding period. Thus, the budgeted profit would be preserved, based on cash market prices at the beginning of the feeding period.

Although simple in theory, few producers in the United States and Canada participate in futures markets. In contrast, commercial, nonfarm firms, such as feed mills and slaughtering plants, often make active hedging use of futures. This hedging allows such firms to offer forward contracts for, e.g., feed (the feed mill guarantees a price for feed to be supplied in the future) or finished cattle (the packer offers a guaranteed price on finished cattle contracted for delivery in the future). Such contracts are increasingly popular and extend the benefits of hedging indirectly to producers.

Hedging directly is fraught with problems, particularly in Canada. Hedging details can be found in numerous provincial, university, and investment services publications, but here are some of the problems and complications.

- No livestock futures markets exist in Canada. To hedge cattle, Chicago futures must be traded, which introduces more variables into the system. American livestock futures contracts are specified in terms of American grade standards and changes in the Canada–United States exchange rate can affect the success of a hedge.
- Changes in the exchange rate, tariffs, livestock supplies, and the steer–heifer price differential may affect substantially and unpredictably the basis, that is, the spread between the Chicago futures price and local Canadian cash price for feeder or finished cattle. Thus, the basis is generally more variable in Canada than in the United States and must be monitored closely.
- American lenders usually treat hedgers preferentially by offering a line of credit to cover margins on futures. Margin is the cash deposited with brokers to secure them from loss on a contract. Additional margin is required if the futures contract price moves such that the futures lose money. Canadian lenders, however, often discourage hedging by requiring the security of long-term assets to cover margin requirements.

Several studies suggest that financial performance of Canadian beef feedlots could be improved by hedging on American commodity exchanges as long as interested producers devote considerable time and resources to managing a fairly complex hedging strategy. This strategy may not only involve hedging of feed supplies, feeder cattle, and slaughter cattle, but also hedging of the Canadian dollar and Treasury bills (as proxy for hedging the interest rate). Monitoring of the basis, trends in futures, and cash price movements and careful placing and lifting of hedges are necessary for success. To ensure support of the lender for margin requirements, submit a written plan to the commodity broker and lender and send the lender copies of all orders and transactions. Existence of a written plan will assist in maintaining discipline and help the lender ensure that margin loans are not speculative.

Commodity futures market—options An alternative to hedging, called options, was introduced on the Chicago Mercantile Exchange in 1984. An option is the right, but not an obligation, purchased at some cost (premium) to buy (call option) or sell (put option) a futures contract at a set price (called the strike price) any time before the option expires. To protect against falling cattle prices, a put option would be purchased to give the right to sell futures at the strike price at any time before the option expires. If the cattle futures price moves above the strike price, the option is allowed to expire, and a profit is taken on the cash market. There are no margin requirements on options. Various put and call options are offered for the various futures contract months at various strike prices. Generally, the higher the strike price and the farther away the contract month, the higher the premium on a put option. Buying protection for options for the whole time that cattle are on feed usually costs too much in premiums or is difficult to obtain because there is not enough trading volume for contracts 8–12 months into the future.

Although options allow people to participate on the commodity markets with little relative outlay of dollars, the large premiums and numerous hedging strategies facilitated by their presence warrant extra training and experience in their use for success. In Canada, the problems of the exchange rate and cattle grading differences from the United States complicate the use of options for hedging. Various publications available from the commodity exchanges explain the use of options, but few studies have been done, particularly in Canada, to appraise their success.

Forward contracts Another alternative to hedging is the signing of forward-price contracts. Although relatively rare in Canada, such contracts for calves and fed cattle can eliminate price risk and worry over margin requirements and basis changes. Large feedlots and packers handle the hedging needed to be able to offer forward-price contracts. In this way they ensure a steady cattle supply through their facilities, but animals must be delivered as and when specified by the contract.

Stabilization programs Recognizing the problems associated with the use of commodity markets to manage price risk, various federal, provincial, and producer organization programs have been aimed at managing financial risk in cattle feeding. Many federal and provincial programs have retained a market orientation. Prices are determined by market forces and voluntary programs provide a method for transferring funds to producers during times of low returns. Decide whether or not to join a voluntary stabilization program only after recognizing the costs and benefits, plan objectives, and potential problems. Details of current plans are available from provincial agricultural offices.

Going without a risk-reduction plan Some producers argue that they have no need for hedging, options, or stabilization and that the volume of turnover in their feedlots is large enough to protect them against price risk. Their marketing strategy is to rotate continuously the inventory of cattle to average rises and falls in the prices and returns of feeder and finished cattle. Generally they try to maintain their feedlots at near full capacity to minimize fixed costs. This strategy is valid if short periods of large negative cash flows can be accommodated. Insolvencies that arise from rapidly increasing costs, such as occurred with feed prices in the mid 1970s or with interest rates in the early 1980s, demonstrate the wisdom of some type of financial risk management program, whether self-directed or sponsored by government or industry.

Feeding economics

Production and marketing alternatives

There are many ways to produce and sell feedlot cattle. Marketing decisions—whether or not to hedge feed, feeders, or finished cattle; to participate in a stabilization program; to use options; to sell on a live or rail-grade basis—are complex. Some initial decisions may change while the cattle are on feed. For example, you may market cattle sooner or later than planned, because of changing prices. Methods of comparing alternative ways of producing finished cattle range from budgeting to complex mathematical programs that model risk.

Budgeting When the alternatives to be considered are few, they can be compared by budgeting. Provincial departments of agriculture and universities have worksheets and pamphlets that guide you through the process of evaluating cattle-finishing alternatives. Microcomputer spreadsheet budget templates are also available from provincial agencies and universities. These templates provide a budget format and allow you to easily modify input and output variables to accommodate the specifics of your operation. Automatic adjustments for temperature, breed, and sex are available in many spreadsheet models. Some spreadsheet models now allow for risk and permit you to determine the probability of obtaining a particular net return per head given some forecasted variability in prices, weight gain, interest rates, or other variables.

Mathematical programming When the alternatives to be evaluated are many, mathematical programming provides a solution. A linear risk-programming model developed by Agriculture Canada considers a range of feedlot production and marketing alternatives that include combinations of feeder type, slaughter weight, rate of gain, and risk management strategy (hedging, options, and stabilization). The model is used for research and to develop extension recommendations.

Sources of market information

A number of periodicals and in-depth reports on livestock and feed situations and outlook are prepared by government and industry sources. Agriculture Canada publishes the weekly *Canada livestock and meat trade report* and annual *Livestock market review and agricultural outlook.* Provincial departments of agriculture publish periodicals on the livestock situation, such as Alberta's *Monthly commentary and outlook.* The Canadian Cattlemen's Association publishes "Beefwatch" semi-annually in the *Cattlemen* magazine and provides information to members through its Canfax affiliate. Periodicals such as the *Western producer* and *Grainews* have sections devoted to the cattle industry. Consult the "Suggested reading" list at the end of this publication for references on beef feeding and marketing economics.

Designing and equipping a feedlot

Design feedlots to provide both a dry, wind-free environment for cattle and efficient, safe, and convenient facilities for the operator. Cattle can withstand cold if they are dry and sheltered from wind. On hot summer days, shade and a slight breeze add to the animals' comfort and increase their rate of gain. Contours, mounds, and wind breaks protect cattle and provide dry areas for cattle to rest. Provide about 18 m^2 of well-drained land for each animal. Good drainage requires a 4–6% slope, preferably sunny and away from the feedlot. Take advantage of natural contours to provide drainage and protection for cattle. In icy conditions, steep slopes are hazardous to cattle. Provide adequate straw or wood shavings (average requirement is about 2 kg per head per day) so that cattle have a dry place to rest. In some feedlots, operators choose to grade the surface level so that precipitation is spread uniformly, which avoids areas of extreme wet. Plant trees or build windbreak fences about 10–15 m outside the feedlots so that trapped snow accumulates outside the feedlot and feed alleys. Build drains so that melting snow does not flow into the feedlot. Construct windbreak fences about 2 m high and of boards with gaps between them; make each gap about one-quarter the width of the boards. Place buildings and fences so that wind is not deflected into feeding areas or sheds.

An open-front shed over part of the feedlot protects cattle from winter storms and hot summer sun and reduces the area of pen space required per head. With an open-front shed and a paved lot, cattle require only about 9 m^2 per animal. Each animal requires 1.0–1.5 m^2 of cover. Make the back of the shed at least 2.5 m high and equip the shed with adjustable ventilators to circulate air. Drain precipitation from sheds away from the feedlot. A covered feed bunk protects feed from weather damage and gives cattle added comfort when they are feeding (Fig. 7). Feed remains dry and palatable and is not blown out of the feeder or into the faces of the feeding cattle. Waste is reduced and feed intake is increased.

Manure is excreted mainly alongside the feed bunk. A heavy clay or concrete pavement, about 3 m wide and raised 0.5 m where the cattle stand, helps to drain the area. To prevent the area from becoming a quagmire, remove manure along feed bunks frequently. In the spring, when manure and ice have accumulated, prevent a quagmire in front of the feed bunk by using a bulldozer to push accumulated ice and manure out of the feedlot. Install gates at the end of the feeding area so that manure can be pushed away from the corral. Build a paved step 10 cm high and 40 cm wide along the feed bunk to discourage animals from standing sideways or backing up to it.

Design the layout and equipment for feeding and handling cattle for the comfort and safety of cattle and to save labor wherever possible. If several pens are needed to hold the stock, arrange pie-shaped pens in a circle with a sorting alley at the centre to reduce the amount of walking among them. It is easier to remove an animal to the central working area of a pie-shaped pen (see cover photo) than from a rectangular pen.

Fig. 7 Hinged cover over feeder provides protection from precipitation and wind.

A chute and squeeze for handling animals quickly and safely are necessities (Fig. 8). Slope the sides of the chute so that it is 40 cm wide at ground level and 85 cm wide at a height of 150 cm. Cover the lowest 100 cm with 2-cm plywood. Space the remaining upper planks 8 cm apart so that the cattle can see out. Cattle move more readily when they can see out of the chute than when the sides are solid. In solid-sided chutes, cattle may climb on the back of the animal ahead to try to see out over the sides, which may result in discomfort and injury to cattle. A horizontally sliding solid door at the back end of the chute and at various intervals, as necessary, prevents cattle from backing out (Fig. 9). A gate built with bars at the head end of the chute allows cattle to see through and is helpful in getting them to move to the front of the chute. Build one side of the holding pen as a straight continuation of one side of the chute and the other side at an angle of 35° so that it is easier to get cattle into the chute. Cattle move more readily through a curved chute than through a long, straight one (Fig. 9). The turn in the chute suggests to cattle that they can escape and as they see others disappearing around the corner and they will generally follow.

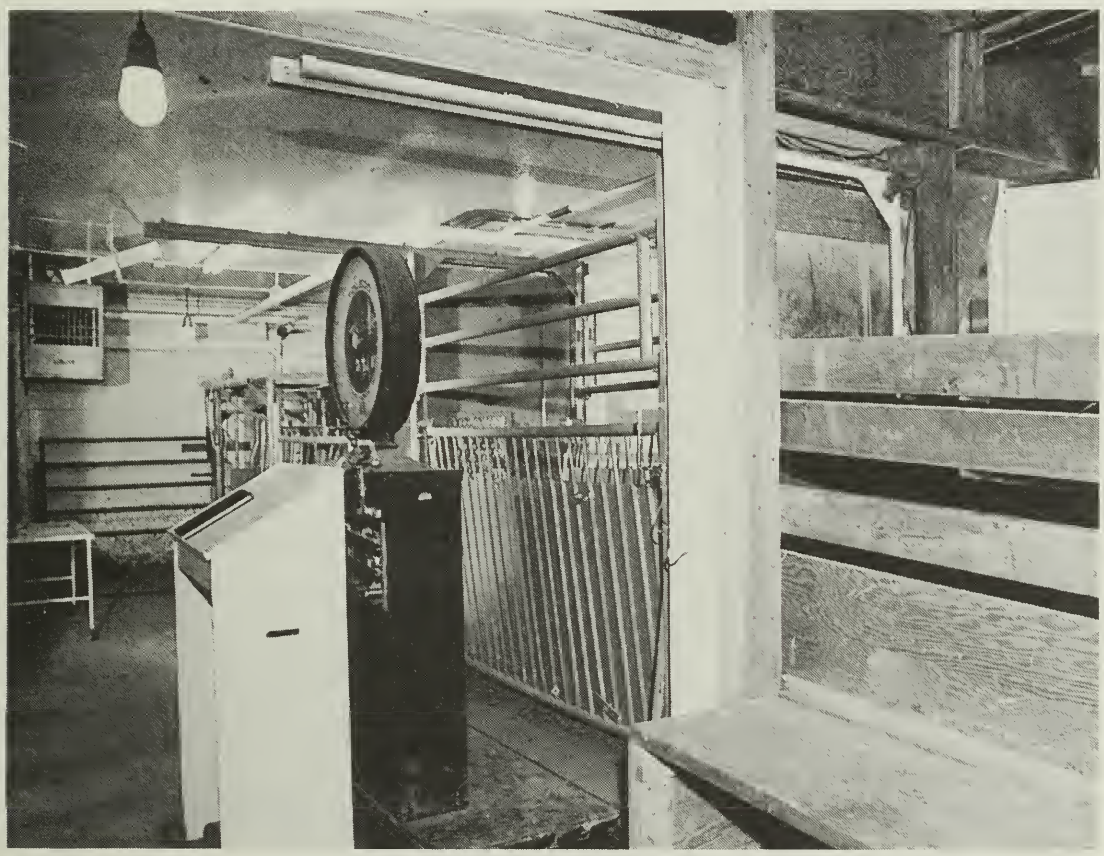

Fig. 8 Feedlot equipment: a scale, a squeeze, and a chute.

Fig. 9 Spaces between the upper boards and the curve of the chute encourage cattle to move along in the chute. Chute is built with sloping sides, using solid plywood on the lower portion, and with a sliding door.

Building the chute and squeeze in a shed (may be open front) permits handling cattle in comfort during inclement weather. Lights over the chute are useful when reading ear tags and working on cattle. Skylights and windows are desirable if the chute is in an enclosed building; cattle do not move readily into a dark area. A catwalk along the chute is helpful when handling or vaccinating cattle. Squeezes and scales of various designs are commercially available and should be part of the feedlot equipment. Select one that meets your needs.

Build a loading chute 1–1.2 m wide and position it so that trucks can easily back up to it. Install a catwalk on the side and slope one fence leading into the loading chute at 35° to facilitate loading cattle. A sliding gate at the back end of the chute prevents cattle from backing out after they have started up the chute. A section about 1 m long at the top end of the loading chute that is horizontal and at an angle of about 35° from the rest of the chute facilitates loading and unloading cattle.

Provide a dry, covered sick pen that is close to the chute and squeeze. Use an enclosed barn for sick cattle. Make sure that the ventilation is adequate, and avoid drafts.

Arrange components of the feedlot to suit the needs of your particular location. A suggested functional layout consists of eight pie-shaped pens, octagonally arranged (see cover illustration). The central core is an area for sorting and treating cattle. One person can easily move an animal to the central core. This arrangement eliminates the need to move sick animals down long alleys for treatment and saves much time and trouble. Cattle are fed on the outside perimeter. An alley provides access from the unloading and scale area to the central sorting area, to the gates of each pen, and to the adjoining octagon. Gates on the outside perimeter allow cleaning of pens without passing through narrow alleys.

Glossary of terms

ADG Average (liveweight) daily gain per head.
air dry Feed that is dried by natural movement of air; air-dry feed is usually about 90% dry matter.

basis The difference between current cash price of a commodity and its futures contract price.
branded beef Beef products marketed under a specific brand or type name, e.g., "Angus beef."
break-even price Cattle selling price (if feeder buying price is known) or feeder buying price (if cattle selling price is known or assumed) at which gross revenue minus expenses involved in feeding cattle is zero.

call option An option that gives the option buyer the right to purchase (go "long") the underlying futures contract at the strike price on or before the expiration date.
calves Weaned cattle ranging from 170 to 230 kg and 5 to 7 months of age and mostly available from October to December (known as **fall run calves**). They may be sold directly into feedlots to be finished on high-grain diets, or retained or sold to be maintained on high-forage diets during the winter (in which case they are often referred to as **stocker calves**). Lesser volumes of calves offered in January to February are sometimes referred to as **winter calves**.

DE Digestible energy; gross energy in feed minus energy in feces.
DM Dry matter; that part of feed that is not water.

fed beef Carcass beef produced from **finished cattle**.
feed margin The difference between the selling price per unit of beef and the cost of gain per unit.
feeder cattle General term applied to steers and heifers sold into the feedlot for finishing on relatively high-grain diets; the cattle may be **calves**, **yearlings**, or **long yearlings**.
finished cattle **Feeder cattle** finished on a high-grain diet to a final slaughter weight ranging from 450 to 600 kg depending on the genetic background and sex. (See **fed beef**.)
fundamental analysis The study of supply and demand of a commodity to forecast price trends and cycles as an aid to selective **hedging**.
futures market price The price of a particular futures contract (such as live cattle) determined by open competition between buyers and sellers on the trading floor of a commodity exchange.

GE Gross energy; total energy of feed released by total oxidation.
G/F Gain-to-feed ratio; a measure of feed use efficiency.

hedging The purchase or sale of offsetting positions in cash, futures, and options markets to achieve protection against an adverse price change.

long yearlings Steers and heifers ranging from 340 to 410 kg and 16 to 20 months of age and mostly available in August to September after removal from pasture; also referred to as **short-keep feeders** when sold into the feedlot.

manufacturing beef Low grade or ungraded carcass beef destined for ground beef (hamburger) production; sources include cull cow or bull slaughter or imported ungraded beef supplies.

margin Money that must be deposited to provide protection to both parties to a futures trade. The stock exchange establishes the minimum margin amount. Brokerage firms often require margin deposits greater than the exchange minimum. Buyers of options do not have to post margins because their risk is limited to the option premium.

margin calls Extra funds that a person with a futures position might be called upon to deposit if there were an adverse price change or if margin requirements increased.

marketing margin The difference between the buying and selling prices of cattle.

ME Metabolizable energy; **digestible energy** (DE) minus energy in urine and combustible gas (methane).

NE Net energy; **metabolizable energy** (ME) minus heat increment (heat produced from the consumption of feed).

non-fed beef Carcass beef produced from cull cows or bulls.

paunch residue The contents of the rumen that is removed at slaughter.

premium The price of an option; the sum of money, arrived at in the competitive market, that the option buyer pays and the option writer receives for the rights granted by the option.

put option An option that gives the option buyer the right to sell (go short) the underlying futures contract at the **strike price** on or before the expiration date.

rumen-degradable protein Dietary protein broken down by rumen microorganisms; most dietary protein is degraded in the rumen and reformed as microbial protein.

rumen-undegraded dietary protein or **bypass protein** Dietary protein that is not broken down in the rumen by microorganisms.

slaughter beef Includes **finished cattle**, cull cows, and bulls.

strike price The price at which holders of options may exercise their right to buy (in the case of a call) or sell (in the case of a put) the underlying futures contract.

technical analysis The study of commodity price movements through the charting of high, low, and close prices to determine trends and buying and selling signals as precipitated by the market psychology.

tempering Addition of water to a feed.

yearlings Steers and heifers ranging from 270 to 340 kg and 12 to 16 months of age and mostly available in late March to the end of June after being fed on relatively high-forage diets to achieve a low, daily rate of gain (0.70–0.80 kg) during the winter months. Also referred to as **pasture yearlings** if sold or retained to go on summer pasture, or **back-grounded cattle** if sold to go into a feedlot.

Suggested reading

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