

Protein-Energy Malnutrition in Beef Cows

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Lack of feed in sufficient quantity and quality is a common nutritional problem of livestock.^{1 2} The term protein-energy malnutrition (PEM) has been used to describe this condition and its resulting clinical syndrome.³ Total absence of food (complete starvation) occurs less frequently in livestock than malnutrition (incomplete starvation).⁴ Protein-energy malnutrition is a form of incomplete starvation in which protein and energy are present in the diet but in suboptimal quantities. Deficiencies of protein and energy usually occur simultaneously in under-fed ruminants and often cannot be strictly separated. Energy intake is most severely restricted in overall under-feedings; however, pure energy deficiency is usually complicated by protein deficiency.¹ Similarly, primary protein deficiency (kwashiorkor) may occur under unusual feeding conditions but typically causes appetite depression with secondary energy deficiency.^{1 2} Vitamin and mineral stores are not usually depleted during underfeeding, since most are required in proportion to the energy metabolized.^{5 6}

Protein-energy malnutrition corresponds to nomenclature already established in human⁷ and agricultural⁸ literature. It accurately describes the animal's condition yet does not convey to the owner the negative implications of starvation.³ Other terms to describe underfeeding include unintentional starvation,⁹ inanition,⁴ thin pregnant cow syndrome,¹⁰ emaciation,¹¹ hypoalimentation syndrome, and starvation syndrome.³

PEM may be secondary to any disease condition that decreases appetite. Disease also contributes to PEM by increasing basal metabolic rate during fever, inflammation, tissue destruction, or stress.^{12 13} It may be difficult to distinguish secondary PEM from primary PEM in some cases. The focus of this presentation will be on primary PEM in beef cows rather than the much broader subject of secondary PEM.

Factors Increasing Protein and Energy Demand

Cattlemen may be unaware of protein and energy requirements of their livestock. A detailed description of nutritional requirements for beef cattle¹⁴ is available. The

very high feed intakes required in late pregnancy to prevent undernutrition are often overlooked. The bovine gravid uterus gains approximately .45 kg/day during the last 100 days of gestation and .71 kg/day during the final 20 days before parturition.¹⁵ Fetal demands for maternal protein and energy are listed in Table 1. Energy requirements of cows are significantly higher if they are carrying twins instead of a single calf.¹⁶ Most clinical cases of PEM occur in cows and heifers during the last trimester of pregnancy.

TABLE 1. Supplementary Requirements of Protein and Energy of Pregnant Cows for Growth of Tissues of the Gravid Uterus^a.

Day of Gestation	Extra Available Protein (lb/day)	Extra Metabolized Energy (Mcal/day)	Extra Feed Required (Brome Hay ^b) (lb/day)
100	.015	.260	.3
190	.101	1.880	2.3
220	.176	3.260	4.0
250	.300	5.370	6.6
280	.491	8.340	10.3 ^c

^a Adapted from reference 15.

^b Bromus spp hay (International Feed Number 1-00-888), sun-cured, late bloom, at 89% dry matter, 1.99 Mcal/kg energy, and 10.0% crude protein (both energy and protein are on a dry matter basis). From reference 14.

^c The addition of 10.3 lb hay to the diet of a 1000 lb cow already consuming 17.8 lb hay to meet her energy requirements results in a total diet of 28.1 lb/day. The bulk of this diet (dry matter intake of 2.5% of body weight) may limit intake (reference 17).

Pregnant heifers are particularly susceptible to PEM. National Research Council (NRC) standards show that pregnant heifers, because of both growth and maintenance requirements, need considerably more energy and protein than mature pregnant cows (see Table II). If not fed accordingly, first calf heifers may be the first animals in a beef herd to exhibit signs of PEM.⁹

Outbreaks of PEM are more frequent in cattle housed outdoors than cattle housed indoors during cold winter months.⁴ NRC requirements are calculated for animals at

TABLE 2. Examples of Nutrient Requirements of Beef Breeding Cattle^a.

Body Weight (lb)	Dry Matter (lb)	Metabolizable Energy (Mcal/day)	Crude Protein (lb/day)	Brome Hay ^b (lb/day) Required
Dry Pregnant Mature Cows — Middle Third of Pregnancy ^c				
1000	18.1	14.5	1.3	17.9
Dry Pregnant Mature Cows — Last Third of Pregnancy ^d				
1000	19.6	17.3	1.6	21.3
Pregnant Yearling Heifers — Last Third of Pregnancy ^e				
950	20.0	21.3	1.8	26.3

^a From reference 14. Energy requirements assume a thermoneutral environment without snow or mud conditions.
^b Brome hay diet (International Feed Number 1-00-888), from reference 14.
^c Based on an expected daily gain of 0.0 lb/day.
^d Based on an expected daily gain of 0.9 lb/day.
^e Based on an expected daily gain of 1.9 lb/day.

thermoneutrality and do not take into account profound effects of environment on energy metabolism.¹⁷ Heat loss from animal to environment dramatically increases in cold conditions. When the effective ambient temperature drops below the animal's lower critical temperature (LCT), the animal responds by increasing metabolic rate in order to maintain normal body core temperature.¹⁸ Estimates of LCT for beef cattle are listed in Table III. Young animals, animals with short haircoats, and very thin animals have the highest LCT's and therefore must expend more energy to stay warm.¹⁷ Provision of shelter dramatically lowers the LCT of a beef cow during cold conditions with wind and/or moisture. Table IV depicts the increased energy necessary to maintain a beef cow under winter conditions without shelter.

TABLE 3. Estimates of Lower Critical Temperature for Beef Cattle.

Species	Lower Critical Temperature (LCT) ^a	
	°C	°F
Beef Cattle ^b		
Calf, 1 week old	7.7	45.9
Dry pregnant beef cow — middle third of pregnancy	-25.0	-13.0
Dry pregnant beef cow — middle third of pregnancy wet snow, 10 mph wind	-7.3	18.9

^a Assumes no wind, snow, or mud (unless so indicated), and maintenance level diets.
^b From reference 17.

If sufficient feed is available when temperatures are below the LCT, then a beef cow will increase her voluntary feed intake in order to produce enough body heat to stay warm. This results in an increased rate of gastrointestinal passage and depression of dry matter digestibility.^{19, 20} If sufficient feed is not available, the cow must draw on energy stored as fat and/or muscle in order to maintain core temperature.

Wet or mud-caked hair provides little insulation and will increase the LCT.²¹ Muddy conditions will significantly

TABLE 4. Estimates of the Increase in Energy Requirements to Compensate for Cold Stress in 1100 lb Dry Pregnant Beef cows, Middle Third of Pregnancy^a

Environmental Conditions	Lower Critical Temp. (LCT) ^b		Increased Energy Requirement per °C below LCT (ME, ^c Mcal/day)	Brome Hay ^d Requirement at 0° F (-17.8°C) ^e (lb/day)
	°C	°F		
Dry, low wind (as in a shelter)	-25.0	-13.0	.237	19.1
Wet snow, 10 mph wind (no shelter)	-7.3	18.9	.334	23.2

^a Adapted from reference 17.
^b LCT in terms of effective ambient temperature.
^c ME = Metabolizable Energy.
^d Brome hay diet (International Feed Number 1-00-888), from reference 14.
^e Effective ambient temperature.

depress voluntary feed intake¹⁷ and force cattle to expend more energy to walk to feed and water sources.

Parasitism due to lice²² or gastrointestinal helminths²³ occurs more frequently in malnourished cows than in well-fed cows. Parasites rob the host of energy through blood loss, decreased voluntary feed intake, and impaired intestinal absorption of nutrients. Impairment of the immune system secondary to PEM allows parasitic infections to become more established and initiates a vicious cycle of worsening PEM and more severe parasitism.

Factors Decreasing Protein and Energy Intake

A number of factors may lead to suboptimal dry matter intake in cattle, goats, or sheep. Drought, severe overgrazing, or floods may drastically reduce the amount of feedstuffs available for livestock. Prolonged heavy snowcover may reduce forage intake up to 50% in cattle grazing winter pasture.²⁴ Blind animals are usually unable to eat sufficient forage under grazing conditions. Some producers may be utilizing supplemental feeds or have ample stored forage yet provide insufficient quantity due to ignorance or neglect. Limited stores of harvested forages may be rationed in an attempt to make them last until spring pastures begin producing adequate forage for grazing.

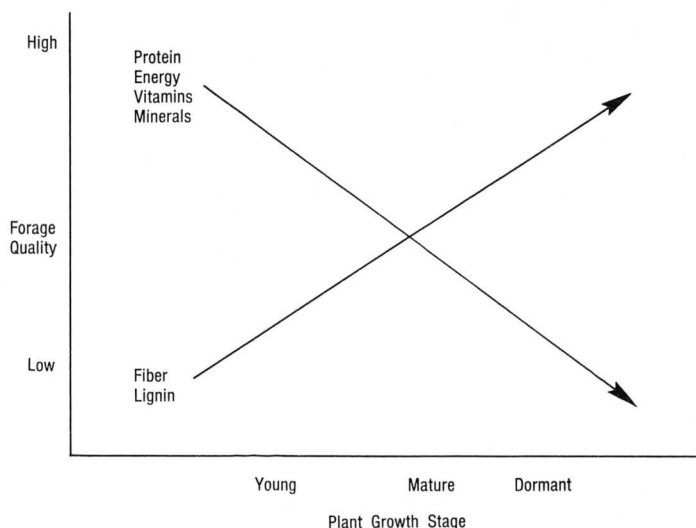
Large hay packages (round bales or compressed stacks) stored outside may lose up to 12.6% of total digestible dry matter due to weather deterioration.²⁵ The potential for underfeeding with large hay packages is further compounded if they are fed without a rack to prevent wastage, which may cause a 23 to 39% loss of dry matter.²⁵ The weight of large round bales is frequently overestimated; such overestimation can result in suboptimal dry matter intake if the bales are fed on a limited basis. Although large hay packages require less labor and storage facilities, more skill is necessary to manage them compared to conventional hay feeding systems.

Poor quality feedstuffs may be available free choice yet be

deficient in crude protein and metabolizable energy. The ability of beef cows to produce calves on relatively poor quality roughages is impressive. However, outbreaks of PEM may occur when roughages with low energy and protein densities are offered to cows during periods of high nutritive requirements, such as late pregnancy.⁴ Relatively undigestible diets cannot be consumed in great enough quantities due to their slow rate of passage through the rumen.²⁶

Several factors may contribute to low nutrient density and poor digestibility of forages. Hay cut when it was too mature or hay that was rained on after cutting may be very low in total digestible nutrients. Protein and energy content of forages declines rapidly as they mature (see Fig 1).²⁶ Early cut hay may have 50% more protein and 33% less fiber than the same species cut after maturity.²⁷ Some lush forages or (rarely) high-moisture silages may contain a high concentration of water, which limits nutrient intake.² If an all corn silage diet is fed to overwintering beef cows at levels based only on energy requirements, then protein will be deficient¹⁴ and a supplemental protein source will be required.²⁸

FIGURE 1. Stages of plant growth related to nutrient quality. As forages mature, they increase in fiber and lignin content and correspondingly decrease in digestible nutrients. Adapted from reference 26.



Cattle grazed year-round, instead of fed harvested forages during winter, may develop PEM because nutritive value of pastures declines through late summer, fall, and winter months.²⁹ Dormant pastures grazed in winter lose nutrient quality as winter progresses; this is primarily due to selective grazing of those plants and/or plant parts that give the highest quality diet first.²⁶ This principle also applies to winter grazing of crop residues, such as corn stubble fields. Animals first consume any unharvested grain, which may be present only in small quantities if modern equipment is used

for harvesting.³ Leaves are consumed next, so that only coarse stalks remain by mid-winter. Corn stalks alone (either in fields or compressed stacks) are not an adequate roughage source for wintering beef cows in late gestation.³⁰

Individual animals within a herd may consume considerably less forage than the average of the group. Poor teeth (more common in older animals) have contributed to clinically evident PEM in cattle.⁹

Social factors may lead to decreased total food intake in submissive cows.⁹ Cattle low on the social order may be unable to obtain sufficient food or be forced to travel farther to obtain it without being molested by more dominant animals.⁵ Insufficient bunk space or feeding of limited numbers of large hay packages to large groups of cows could lead to PEM in some animals in the group.²²

Voluntary feed intake is decreased during late pregnancy due to compression of the rumen by the growing uterus. This decrease in intake unfortunately comes when nutrient requirements are the highest.

Table V summarizes the effects of late pregnancy, growth requirements of heifers, cold conditions without shelter, and cold-induced depression of forage digestibility on energy requirements of overwintering beef cattle. A growing heifer in the last third of pregnancy, without shelter in the winter, requires 37.6% more metabolizable energy than a mature cow in the middle third of pregnancy with adequate shelter. A diet of good quality brome hay (International Feed Number 1-00-888¹⁴) may be too bulky to meet the heifer's energy requirement.¹⁷

Pathophysiology of Ruminant Protein-Energy Malnutrition

During periods of PEM, nutrients are distributed within the animal such that maintenance needs receive highest priority. Basal metabolic rate is lowered through decreased thyroid hormone concentrations^{31 32} to minimize maintenance requirements. Decreasing organ size further reduces basal metabolic needs.¹³ Growth and reproduction are curtailed in order to increase the likelihood of survival. Once an animal has conceived, however, products of conception have first priority for nutrients. Pregnant females will attempt to mobilize maternal nutrients in order to meet fetal requirements.³³

Whenever maintenance requirements exceed nutrient intake, body stores of protein and energy must be mobilized. Carbohydrate stored as glycogen is first catabolized in response to negative energy balance.^{5 34} Glycogen is rapidly depleted and stores of lipid and protein must then be catabolized.⁴ Lipolysis is triggered by a fall in insulin concentration relative to glucagon.³⁵ Non-esterified fatty acids are mobilized from depot fat and release large amounts of energy when oxidized in the tricarboxylic acid cycle.¹³ If the energy deficiency is sudden and the cow is pregnant or lactating, then ketosis may result.² Gradual onset of energy deficiency, as seen in most cases of PEM,

TABLE 5. Summary of Factors Increasing Energy Requirements of Overwintering Beef Cattle^a.

Management Situation	Additional Energy Requirement (ME, Mcal/day)	Additional Brome Hay ^b (lb/day)	Cumulative Total of Brome Hay Required (lb/day)
Baseline Energy Needs:			
Mature cow, 1100 lb middle third of pregnancy	15.6	—	19.2
Additional Energy Demands:			
Mature cow, 1100 lb. last third of pregnancy	2.7	3.3	22.5
Growing heifer, ^c 950 lb last third of pregnancy	3.0	3.7	26.2 ^g
Growing heifer, ^c 950 lb last third of pregnancy cold conditions (0°F) ^d with shelter	0.0	0.0	26.2 ^g
Growing heifer, ^c 950 lb last third of pregnancy cold conditions (0°F) ^e no shelter ^f	3.7 ^h	4.5	30.7 ^g

^a Based on data from references 14 and 17.

^b Brome hay diet (1-00-888), from reference 14.

^c 950 lb heifer gaining 1.9 lb/day.

^d Effective ambient temperature, which in this case is above the lower critical temperature.

^e Effective ambient temperature, which due to lack of shelter is below the lower critical temperature (LCT), thus increasing energy needs. Assumes that LCT and additional energy requirements for a 950 lb heifer, last third of pregnancy, are the same as those for a 1100 lb pregnant mature cow, middle third of pregnancy.

^f Assumes wet snow and 10 mph wind, which raises the LCT to 18.9°F.

^g Bulk of the diet may limit intake of brome hay (reference 17).

^h This value also takes into account loss of dry matter digestibility with effective ambient temperature below the LCT (reference 19).

causes a slower mobilization of depot fat and does not usually result in ketosis. Low insulin concentrations facilitate protein catabolism.³⁶ Blood glucose is maintained by hepatic gluconeogenesis. Glycerol from hydrolysis of lipid and alanine from muscle breakdown are the major substrates for glucose synthesis.³⁷ Increased secretion of glucocorticoids maintains gluconeogenesis.³⁵

Physical and functional changes are most pronounced in the liver of undernourished cattle.³⁸ Hepatic proteins are very labile and are catabolized quickly during negative nitrogen balance.¹³ During prolonged undernutrition, the liver loses weight faster than other organs.¹³ Fatty infiltration of the liver is evident in acutely starved

animals,³⁸ but may not be observed in ruminants suffering from chronic PEM.³ Functional disturbances of hepatic enzymes may help explain the tendency of malnourished animals to be more susceptible to the effects of toxins than well-fed animals.^{4 38} Malnourished animals are more inclined to eat toxic plants than animals fed an adequate diet.

Loss of muscle mass and muscular power accompanies PEM.³⁹ This is clinically evident as lethargy and weakness. In cases of protracted starvation, greater than 60% of the total body protein lost is from muscle and skin.¹³

Large alimentary tract capacity of cattle acts as a cushion to absorb the effects of short-term malnutrition.^{4 38} However, long-term malnutrition eventually exhausts digestible nutrients stored in the rumen. Rumen microorganism numbers decline as feed is depleted, since they are being deprived of substrates for metabolism along with their host.⁵ Protozoa are particularly sensitive to underfeeding and may be absent in animals suffering from PEM.²⁹ Digestive and absorptive capacity of the rest of the alimentary tract is also adversely affected by protracted malnutrition.¹³ Onset of PEM-induced maldigestion and malabsorption results in decreased efficiency of feed utilization and contributes to rapid clinical deterioration of animals suffered from PEM. These factors also help explain the slow recovery of ruminants after refeeding; affected animals remain maldigestive while rumen microbial populations become re-established and also remain malabsorptive while function of the lower intestinal tract is restored. Diarrhea is common during refeeding due to osmotic activity of unabsorbed nutrients in the large intestine.²⁹

Effects of PEM on the reproductive system of beef cattle have been extensively reviewed.^{40 41} These effects can only be summarized in this presentation. Malnutrition of developing animals delays sexual maturity⁴² and decreases libido after puberty.⁴ Prolonged malnutrition results in cessation of the estrous cycle.⁴³ Fetal development is adversely affected only by extreme PEM.⁴⁴ Most pregnant cows with fatal PEM do not abort before they die. Severely emaciated animals will occasionally abort or deliver prematurely, but only shortly before their own death.⁴⁵

Malnutrition during the last trimester of pregnancy in beef cows will significantly decrease calf birth weights, decrease milk production, increase calf mortality, decrease calf weaning weights, and increase age at puberty.^{2 41 46} Parturition nutrition did not significantly affect the incidence of dystocia in beef cows;^{46 47} however, malnutrition was not severe in these trials. Increased mortality of calves born to malnourished dams has been attributed to calf weakness at birth and poor maternal colostrum and milk production. Low maternal protein intake during the last trimester has been directly associated with weak calf syndrome of beef cattle.^{48 49} Inadequate parturition nutrition has been shown to increase the interval from parturition to first estrus in beef cows^{41 50} and has been linked to failure to

conceive when estrus commences.⁵⁰

Effects of malnutrition on the immune system has been reviewed.⁵¹ Malnutrition generally increases host susceptibility to bacterial infection.^{4 52 53} Cell-mediated immune response,⁵¹ antibody production,⁵² and complement concentration⁸ are reduced by malnutrition. Resistance to parasitic infection is also decreased. It is interesting to note that poorly nourished animals are generally more resistant to viral infections than their well-nourished counterparts.⁵⁴ This phenomenon has been related to impairment of host metabolic functions necessary for viral replication in the malnourished host.^{54 55}

Historical and Clinical Findings of Affected Cows

An accurate history is essential if a tentative diagnosis of PEM is to be made in the field. A good history should reveal factors that could increase demands for protein and energy or decrease protein and energy intake below required levels. A complete ration evaluation² with accurate feed consumption data may be necessary in some instances, since owners tend to overestimate nutritional quality of their forages and dry matter intakes of their cattle. Time of year and climatic conditions should be taken into consideration as well. For example, a high incidence of emaciated or downer cows in a herd without shelter in the middle of a harsh winter is suggestive of PEM. Spring calving herds have a much higher incidence of PEM than fall calving herds, because the cold winter months coincide with late gestation (the time of the greatest and most obligatory fetal nutritional requirements).

The veterinarian is often called to a malnourished herd when one or more cows have already become recumbent. Downer cows frequently appear normal to the owner one day, then rapidly deteriorate and go down the next. The alert mental state of PEM-affected cows helps differentiate PEM from chronic, debilitating diseases. Cows with PEM also often have normal or avid appetites, which is not characteristic of most chronic diseases. Digital palpation over the backbone and ribs may reveal marked loss of body condition; this may not be evident by visual observation alone if the haircoat is long. Rectal temperature may be normal or decreased (hypothermia occurs as basal metabolic rate is lowered and body insulation is lost). Heart and lung sounds are typically normal. The rumen often has normal to poor motility and may be full of firm ingesta. Diarrhea due to maldigestion and malabsorption is occasionally present in advanced cases, particularly if high concentrate feeds have been offered by the owner. Evaluation for blindness, trauma, chronic degenerative joint disease, foot problems, and musculoskeletal injuries should be included in the physical examination.

Downer cows usually die 7 to 14 days after becoming recumbent, even though they may eat normally up to the time of death. Abomasal impaction may complicate primary PEM in cows consuming very high roughage diets.⁴

Mild hypocalcemia has been documented in overwintering beef cows and may be related to decreased feed intake and reduced intestinal absorption of calcium.⁵⁶ Other causes of recumbency in overwintering beef cows include Johne's disease, bovine lymphosarcoma, chronic peritonitis, parasitism (internal or external), chronic pulmonary disease, vitamin E or selenium deficiencies, locomotor difficulties, dental disorders, behavioral problems, pregnancy ketosis, non-parturient hypocalcemia, and toxicoses.

Inability to produce sufficient colostrum and milk is common in PEM-affected cows that survive through parturition. This problem is most severe in first calf heifers. Calves born to these heifers may die of PEM. Clinical signs in malnourished beef calves include nursing persistently and vigorously, attempting to eat dry feed, drinking surface water or urine, and bawling for several hours at a time.⁴ Affected calves eventually become recumbent and die. Absence of diarrhea or fever helps differentiate PEM in beef calves due to hypogalactia from neonatal diarrheas or septicemia.

Diagnostic Aids

Careful evaluation of the cow's history, ration, and physical examination are usually sufficient to make a tentative clinical diagnosis of PEM. Substantiating this diagnosis is of great value, since few livestock owners readily accept a diagnosis of PEM. Most owners feel that their cattle are not being starved but rather are suffering from an unusual infectious disease, toxicoses, or exotic nutritional deficiency. Rapid clinical deterioration of individual animals makes the diagnosis of a chronic condition such as PEM even more difficult to accept. Efforts may need to be made to rule out chronic diseases that could cause emaciation or lead to secondary PEM.

Clinico-pathologic procedures are of limited value in supporting a diagnosis of PEM in live cattle. Malnourished cattle are known to have significantly lower packed cell volumes,⁵⁷ lower insulin concentrations,⁵⁸ and lower thyroid hormone values⁵⁸ than well-fed animals. However, such changes in blood parameters are usually either clinically minor, within accepted normal limits, or could be attributed to conditions that resemble PEM clinically. Some studies have shown that serum glucose, urea nitrogen, free fatty acid, and creatine concentrations may differ significantly between malnourished and well-fed cattle.^{57 58 59} However, results within these and other studies have been conflicting.^{10 60} Differences in feeding levels, duration of underfeeding, and environmental conditions may account for discrepancies between studies. Accuracy of blood tests for malnutrition in clinically normal animals may be increased by taking samples from a representative group within a herd. However, no metabolic profile tests have been developed for accurate prediction of nutritional status in apparently healthy cattle.

It may be concluded that ante-mortem diagnostic tests can support but not confirm a diagnosis of PEM. Neither can they distinguish between primary and secondary PEM. The most useful function of ante-mortem diagnostic tests is in ruling out other possible diagnoses.

Pathologic Findings

Necropsy is necessary to confirm a final diagnosis of PEM. Beef cows that die from PEM have decreased muscle mass and body fat as compared to normal ruminants.^{9 11} Serous (brown) atrophy of fat that remains is characteristic of death by starvation.^{11 16} Serous atrophy results from replacement of triglycerides in lipid vacuoles with proteinaceous fluid.⁶¹ It is often most evident in fat in the coronary grooves^{3 61} and bone marrow cavity.⁹

Treatment

Cows that are recumbent due to PEM are already in an advanced catabolic state that is extremely difficult to reverse by treatment.² Owners of downer cows should be informed that treatment could be expensive and the recovery period prolonged if the cow does survive.³

Intravenous fluid therapy may be initiated to correct dehydration or electrolyte imbalances that may be present in PEM-affected cattle. Addition of glucose or amino acids to intravenous solutions does provide needed energy and protein; however, very large (and likely cost-prohibitive) quantities are necessary to return large animals to positive energy and nitrogen balance.

PEM-affected cows that are eating should be provided excellent quality legume hay free choice.^{4 40} Concentrate feeds, such as ground corn or soybean oil meal, should be provided in small, frequent feedings; sudden supplementation could result in ruminal acidosis.⁴⁰ Animals that are not eating may require force feeding with a gruel (such as alfalfa pellets mixed with water) pumped through a large diameter rumen tube. Oral electrolyte solutions may be added to the gruel if the animal is dehydrated. Propylene glycol (33 ml per 100 kg body weight given orally twice a day) may provide additional energy to the affected animal. Response to oral supplementation may be poor, however, since impaired digestive function greatly decreases digestion and absorption of nutrients consumed by PEM-affected animals.¹³ Ruminants recover from starvation more slowly than monogastrics; this is in part due to the time required to re-establish rumen microbial populations.⁶² Rumen transfaunation may speed a return to normal ruminal digestion.⁶²

Other therapeutic measures for individual animals suffering from PEM include appropriate anthelmintic treatment if gastrointestinal parasites are present and insecticides if lice or other external parasites are found. Anti-parasitic agents with a wide therapeutic index (such as benzimidazoles, ivermectins, and pyrethrins) should be used in PEM cases. Organophosphate anthelmintics (such as

haloxon) and organophosphate insecticides (such as coumaphos and trichlorfon) are generally poorly tolerated by a compromised host.⁶³ Organophosphates and the tetrahydropyrimidines (pyrantel and morantel) should be used with great caution in debilitated animals. Hormonal therapy to induce parturition⁴⁵ or a cesarean section may save the life of the dam in certain cases. Multiple B vitamin injections may help replace vitamins lost due to digestive disturbances or dehydration. Good nursing care is essential if the downer animal is to survive.³

Prevention

Whenever a case of PEM is diagnosed in a beef herd, the owner's attention should be directed to the rest of the cattle rather than focused on the affected individual.³ Immediate supplemental feeding may be necessary to prevent further losses in the group. High quality legume hay is an excellent source of supplemental protein and energy for malnourished cattle.²⁸ Natural protein supplements (such as soybean or cottonseed meal) are also highly effective. Increased dietary protein levels increase both digestibility and voluntary intake of low quality forages.⁶⁴ High energy, low protein supplements (such as ground corn or milo) may depress voluntary intake of forages.²⁴ Therefore, high energy supplements are not cost-effective when supplies of forage are adequate.

Long-term prevention of PEM requires a good nutritional program and good overall management. Management factors that contribute to PEM must be minimized or eliminated. For example, windbreaks and/or shelters free of mud will decrease effects of cold weather on energy requirements.¹⁷ Adequate bunk or feeding space must be provided so that submissive animals may consume an adequate ration.⁶² Primigravid heifers should not be fed with mature cows, but rather separated in the fall and supplemented according to requirements.²² Cows in thin condition at the end of the grazing season or cows with bad teeth should either be culled or fed separately (usually with the heifers).⁹

Criteria for subjective body condition scoring of beef cattle⁴⁰ have been described. Veterinarians may be able to assist cow-calf producers in using these scoring systems. Condition scores are usually made on the cows at weaning time and before calving season starts.⁴⁰ Body condition scoring at these strategic times allows adjustments to be made before production efficiency is decreased or death losses occur. Cows may also be weighed during the last trimester of pregnancy to allow identification and supplementation of cows losing weight.⁴¹

Nutrient analysis of native forages is the cornerstone of a good nutritional program for enterprises that maintain ruminants primarily on roughages. Variables in forage quality such as variety, fertilization rate, maturity at harvest, and weather make visual appraisal or "book" values for forage composition unreliable.^{22 41} Rations should be formulated according to National Research Council (NRC)

nutritional requirements, using results of nutrient forage analysis. Energy needs will be higher than NRC standards during periods of cold or muddy conditions.¹⁷ Large round bales or compressed hay stacks must be carefully managed to prevent underfeeding due to weather deterioration or wastage.²⁵ Caution should be used in grazing dormant pastures or crop residues past midwinter; supplementation will probably be necessary.^{65 30}

Good management and a scientific nutrition program are sound investments for the livestock producer. They not only prevent the occurrence of deaths due to PEM but also pay additional dividends by increasing reproductive performance, disease resistance, and overall productivity.

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Questions & Answers:

Question: What is the size of the group?

Answer: I don't have any data. The question relates to the size of the cow groups, like if you have a 150 cow herd they seem to do better if you break them into three groups of 50 rather than the whole group. And I don't have any direct research on that. I wonder how much bunk space has to do with it and some of these social factors.