Cow/Calf Session I

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Moderator: **Donald B. Hudson**

Reproductive Efficiency in Beef Cattle: Nutritional and Medical Considerations

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Cow-calf efficiency can be defined both in terns of biological efficiency and economic efficiency. Measures of biological efficiency include pregnancy rate, percentage calf crop weaned and calf weight weaned per cow exposed. Economic efficiency may be measured by net return per cow/calf unit or net return to the beef cattle enterprise. Biological and economic efficiency are often closely related, but in some situations only a limited relationship exists. For example, if biological efficiency defined as calf weight weaned divided by cow exposed is high, economic efficiency may or may not be high, depending on cow costs and the price of calves. Economic efficiency is of most importance to producers and is dependent on: 1) percent calf crop weaned, 2) weaning weight, 3) sale price of calves, and 4) annual cow costs (Ritchie, 1984). Maximizing production may not always be consistent with maximizing net profits over the long term. Identifying optimum levels of production (those consistent with maximum continuing net profit) should be the goal. The optimum levels for reproductive measures such as pregnancy rate and percentage calf crop weaned are in fact high and quite close to maximum in most cases. Focusing on high reproductive efficiency at minimal cost is essential in moving cow-calf producers closer to optimum levels of production.

Where do reductions in reproductive efficiency occur? Bellows (1984) summarized losses in potentially weanable calves and reported that most losses occur either because cows fail to become pregnant or lose calves at or near calving. Nutrition is a major factor contributing to these losses. The purpose of this paper is to discuss factors, primarily nutritional, contributing to these losses.

Nutrient Requirements of Beef Cows

Beef females, once they have reached puberty, are expected to conceive and wean a calf every year. Within the year, energy and protein requirements vary according to stage of production. Demands are highest following parturition when the cow is lactating heavily and must recover from calving in order to cycle and rebreed. From breeding through weaning, the cow is pregnant and lactating, however nutrient requirements are not as high since milk production is reduced from earlier levels. After weaning, nutrient requirements are lowest as the cow must only maintain herself. This changes several weeks before calving as a pregnant female must receive enough nutrition to maintain herself and a rapidly growing fetus. Effects of stage of production on nutrient requirements of beef cows have been reported (Corah, 1987; Table 1).

Table 1. NRC Requirements - 1100 LB BEEF COW MILK PRODUCTION - 15 LBS/DAY (AVERAGE)[a]

	Periods			
	1 (80 days postcalving)	2 (125 days pregnant & lactating)	3 (110 days mid-gestation)	4 (50 days precalving)
TDN (lbs/day)	13.3	11.5	9.5	11.2
Protein (lbs/day)	2.3	1.9	1.4	1.6
Calcium (grams/day)	33	27	17	25
Phosphorus (grams/day)	25	22	17	20
Vitamin A (IU/day)	39,000	36,000	25,000	27,000

[a] Corah, 1987.

This pattern of changing requirements according to stage of production throughout the annual cycle holds for all females entering into and remaining in production. Specific requirements for energy and protein in each stage depend on factors such as age, body condition, body size and level of milk production.

NRC nutrient requirement equations divide maintenance energy (NEm) requirements into energy required strictly for maintenance, energy required for pregnancy and energy required for lactation. For heifers, young growing cows and thin mature cows, energy required for gain must be added to maintenance energy requirements

(NRC, 1984).

Energy required strictly for maintenance is a function of metabolic body size ($Wt^{.75}$). Changes in body size will change energy requirements, though the change in requirements will not be proportional to the change in weight. Energy required for pregnancy is a function of calf birth weight and time before calving. As calf birth weight increases and calving approaches, energy for pregnancy increases. Energy required for lactation is directly proportional to the amount of milk produced, and has a relatively large impact on energy requirements.

Body weight, calf birth weight and level of milk production affect NEm and crude protein (CP) requirements to varying degrees. Annual NEm and CP requirements of mature cows with relatively low and high production were compared (Table 2). The high producing cows showed much higher energy and protein requirements than low producing cows. With much of the difference in these requirements due to an increase in milk production.

Table 2. ANNUAL NET ENERGY AND CRUDE PROTEIN REQUIREMENTS FOR MAINTENANCE, LACTATION AND PREGNANCY OF HIGH AND LOW PRODUCTION BEEF COWS.

	Low[a]	High[b]	Difference (%)[c]
Net Energy (Mcal NEm)			
Maintenance	2762	3363	22
Lactation	597	1791	200
Pregnancy	211	268	27
Total	3570	5421	52
Crude Protein (kg)			
Maintenance[d]	216	261	21
Lactation	52	155	198
Pregnancy	280	428	53
Total	280	428	53

[a] Low production cow - 1000 lb, 10 lb milk/d, 75 lb calf
[b] High production cow - 1300 lb, 30 lb milk/d, 95 lb calf
[c] Difference (%) = (High - Low)/Low x 100
[d] Maintenance CP includes metabolic fecal protein loss, endogenous urinary protein loss and scurf protein loss.

An increase in milk production from 10 to 30 lb/day will increase requirements for lactation by 200%. Additionally, as milk production increases, the proportion of total annual nutrient needs included in the lactation component increases. Lactation represents approximately 17% of the total annual NEm requirement and 19% of the CP requirement of a relatively small, light milking cow. Her larger heavy milking counterpart may use 33% of annual NEm and 36% of annual CP requirements for milk production.

Effects of body weight and calf birth weight on nutrient requirements are much less than milk production. Differences in requirements due to size differences are appreciable and may account for some variation in cow requirements. Differences due to birth weight are relatively small in comparison to differences due to body size and milk production. While birth weight is important in determining requirements, varying requirements for expected differences in birth weight is of little value as calf birth weight is essentially unpredictable.

NRC requirement equations were also used to determine daily NEm and CP requirements in each of the four periods of the cow year for various cow weights and levels of milk production (Table 3). These calcuations show the effects of cow weight and milk production on requirements in each period. In Period 1, postcalving, NEm and CP requirements are highest for all cows, with more variation in requirements due to variation in milk production than variation in weight. There is also more variation due to milk production in Period 2 when cows are pregnant and lactating, however variation is reduced as the milk production drops approaching weaning.

Table 3. DAILY NET ENERGY AND CRUDE PROTEIN REQUIREMENTS OF BEEF FEMALES AT VARIOUS BODY WEIGHTS AND LEVELS OF MILK PRODUCTION IN EACH PERIOD OF THE BEEF COW YEAR.

Cow Weight (lb)	Milk Production[a] (lb/day)	Period 1	2	3	4
NEm (Mcal/day)					
900	10	10.2	9.6	7.7	9.7
	20	13.4	12.2	7.7	9.7
	30	16.6	14.8	7.7	9.7
1100	10	11.3	10.7	8.8	10.8
	20	14.5	13.3	8.8	10.8
	30	17.7	15.9	8.8	10.8
1300	10	12.4	11.8	9.9	11.9
	20	15.6	14.4	9.9	11.9
	30	18.8	17.0	9.9	11.9
CP (lb/day)					
900	10	1.8	1.7	1.4	1.4
	20	2.4	2.2	1.4	1.4
	30	3.1	2.7	1.4	1.4
1100	10	2.0	1.9	1.5	1.6
	20	2.6	2.4	1.5	1.6
	30	3.2	2.9	1.5	1.6
1300	10	2.2	2.1	1.7	1.8
	20	2.8	2.6	1.7	1.8
	30	3.4	3.1	1.7	1.8

[a] Average milk production, adjusted for peak lactation 30 to 60 d postpartum, significant decline 120 d postpartum.

In Periods 3 and 4, mid-gestation and precalving, differences in nutrient requirements of cows are due to differences in body weight, as calves are weaned and cows are no longer lactating. Requirements are lowest in Period 3, after weaning and increase in Period 4 as calving approaches. Requirements in Period 4 are higher than in Period 2 for lighter milking (10 lb/day) cows but Period 2 requirements are higher than Period 4 for heavier milking (20 to 30 lb/day) cows. These requirements are based on calculations using NRC nutrient requirement equations and may not be adequate for all cows in all situations. Differences in cow type and breed may demand some adjustment, additional adjustments in requirements may be needed for level of activity, weather, age and body condition.

First and second calf heifers have higher requirements than their mature counter parts; these females are still growing while maintaining a developing fetus and lactating. This places an additional nutritional stress on these heifers so they must be maintained on a higher plane, especially during the critical pre-and postcalving periods in order to maintain adequate reproductive performance. Aged cows may have a problem getting adequate nutrition. While their requirements may be greatly different than those for younger mature cows, their ability to ingest adequate feed to meet these requirements may be reduced. Thin cows are in a situation similar to young cows, their energy and protein needs may be higher than cows of similar size and productivity in good flesh. Thin Angus X Hereford cows were found to have higher maintenance requirements than similar cows in good condition (Thompson et al., 1983). Nutrition above maintenance requirements is needed if these cows are to gain weight and remain productive.

There is evidence to suggest breed differences in maintenance requirements. High milking beef breeds may have higher maintenance requirements, in addition to increased requirements for lactation. This may magnify the differences in calculated requirements for high and low milking cows (Ferrell and Jenkins, 1988).

Weather conditions have a great impact on nutrient requirements. As the combined effects of temperature, wind and precipitation result in an effective temperature below the lower critical temperature (LCT), additional energy must be ingested to maintain body temperature. Ames (1985) suggested a 1% increase in maintenance energy requirements for each degree F below the LCT. Factors determining the LCT include prior exposure to cold, body insulation, level of intake and type of diet (Adams, 1987). With low intake or a high digestible ration, relatively little heat is produced by digestion. As digestibility decreases and intake increases, more heat is produced through digestion, thereby lowering the LCT.

Body insulation is a major factor determining the LCT. With prolonged exposure to cold, hair coat increases and animals are able to withstand lower effective temperatures (Table 4). The value of hair as insulation is dramatically reduced in wet weather. With a dry winter coat, animals may be exposed to temperatures well below freezing with no need for additional energy to maintain body temperature. At the same temperature with a wet coat, energy requirements may be 30 to 40% higher as the insulative value of the wet hair is similar to that of a summer coat.

Table 4. ESTIMATED LOWER CRITICAL TEMPERATURE OF CATTLE WITH DIFFERENT HAIR COATS.

Hair Coat	Lower Critical Temperature
Summer Coat or Wet	59°F
Fall Coat	45°F
Winter Coat	32°F
Heavy Winter Coat	18°F

Ames, 1985

Monitoring Nutritional Status of Beef Cows

Although it is important to know the nutrient requirements of beef cows and factors influencing these requirements, it is difficult to insure that these requirements are precisely met. This is because most beef cows are maintained in range environments where accurately knowing forage intake is impossible. The appropriate philosophy is to supplement the cow herd when needed to meet nutrient requirements at lowest cost.

An excellent tool for monitoring energy status of beef cows is body condition score. Body condition scores are primarily measures of percentage body fat. Cows are scored from 1 through 9 with 1 being very thin and 9 being very fat (Table 5; Richards et al., 1986). Most research suggests that targeting cows for condition score 5 or 6 at calving results in optimal postpartum reproduction. Cows that are less than condition score 5 at calving usually have longer intervals to first estrus and are less likely to conceive early in the breeding season. Additionally, calves born to thin cows are likely to be less vigorous at birth and have reduced immunoglobulin levels at 24 hours of age, resulting in increased susceptibility to disease (Odde, 1988).

Table 5. SYSTEM OF BODY CONDITION SCORING (BCS) FOR BEEF CATTLE.

Group	BCS	Description
Thin Condition	1	EMACIATED - Cow is extremely emaciated with no palpable fat detectable over spinous processes, tranverse processes, hip bones or ribs. Tail-head and ribs project quite prominently.
	2	POOR - Cow still appears somewhat emaciated but tail-head and ribs are less prominent. Individual spinous processes are still rather sharp to the touch but some tissue cover exists along the spine.
	3	THIN - Ribs are still individually indentifiable but not quite as sharp to the touch. There is obvious palpable fat along spine and over tail-head with some tissue cover over dorsal portion of ribs.
Borderline Condition	4	BORDERLINE - Individual ribs are no longer visually obvious. The spinous processes can be identified individually on palpation but feel rounded rather than sharp. Some fat cover over ribs, transverse processes and hip bones.
Optimum Moderate Condition	5	MODERATE - Cow has generally good overall appearance. Upon palpation, fat cover over ribs feel spongy and areas on either side of tail-head now have palpable fat cover.
	6	HIGH MODERATE - Firm pressure now needs to feel spinous processes. A high degree of fat is palpable over ribs and around tail-head.
	7	GOOD - Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over ribs and around tail-head. In fact "rounds" or "pones" beginning to be obvious. Some fat around vulva and in crotch.
Fat Condition	8	FAT - Cow very fleshy and over-conditioned. Spinous processes almost impossible to palpate. Cow has large fat deposits over ribs, around tail-head and below vulva. "Rounds" or "pones" are obvious.
	9	EXTREMELY FAT - Cow obviously extremely wasty and patchy and looks blocky. Tail-head and hips buried in fatty tissue and "rounds" or "pones" of fat are protruding. Bone structure no longer visible and barely palpable. Animal's motility may even be impaired by large fatty deposits.

Veterinarians can help producers by condition scoring cows at the time of pregnancy examination. They can then design programs that help the producer target cows to a condition score 5 or 6 at calving.

References

Adams, D.C. 1987. Effects of winter weather on beef cattle on rangelands. Proc. The Range Beef Cow Symposium X. Cheyenne, Wyoming. Ames, D.R. 1985. Managing cows during winter. Proc. The Range Beef Cow Symposium IX. Chadron, Nebraska. Bellows, R.A. 1984. Calving management. Proceedings, Annual Meeting of Society for Theriogenology, p. 145. Corah, L.R. 1987. Planning a nutrition program for today's productive beef cow. Kansas State Univ. Ext. Rep. C-680. Ferrell, C.L. and T.G. Jenkins. 1988. Influence of biological types on energy requirements. Beef Research Progress Report No. 3. NRC. 1984. Nutrient Requirements of Beef Cattle. Sixth Revised Ed. National Academy of Sciences. National Research Council. Washington, D.C. Odde, K.G. 1988. Survival of the Neonatal Calf. Veterinary Clinics of North America: Food Animal Practice, p. 501. Ritchie, H.D. 1984. Overview of factors affecting beef cow efficiency. Proceedings, Beef Cow Efficiency Forum, CSU, p. 1. Rush, I.G. 1987. Selecting and pricing of supplementary energy and protein for range beef cows. Proc. The Range Beef Cow Symposium X. Cheyenne, Wyoming. Thompson, W.R., J.C. Meiske, R.D. Goodrich, J.R. Rust and F.M. Byers. 1983. Influence of body composition on energy requirements of beef cows during winter. J. Anim. Sci. 56:1241.

Abstracts

Surgical repair of peripheral detachment of the medical meniscus in 34 cattle

D. R. Nelson, J. C. Huhn, S. K. Kneller

Veterinary Record (1990) **127,** 571-573

A detachment of the periphery of the medial meniscus from the joint capsule and medial collateral ligament in 34 cattle was repaired by securing the meniscus to the joint capsule with vertical mattress sutures during arthrotomy. Of 28 cattle with follow-up reports, 20 had recovered satisfactorily by their owners' evaluations; 17 were either not lame or slightly lame after the operation and three were moderately lame. Three of four cattle without follow-up reports were either not lame or slightly lame when discharged from the hospital.

Reproduction of mucosal disease with cytopathogenic bovine viral diarrhoea virus selected in vitro

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Veterinary Record (1990) **127,** 200-203

Isolates of non-cytopathogenic bovine viral diarrhoea (BVD) virus from 18 persistently infected calves from one herd were compared by using monoclonal antibodies directed against the major viral glycoprotein gp53. All the isolates displayed an almost identical reaction pattern. Based on this antigenic analysis three cytopathogenic BVD and three non-cytopathogenic BVD viruses closely related to the non-cytopathogenic BVD herd isolate were selected. Six of the persistently infected calves were inoculated with a pool of the three closely related cytopathogenic BVD viruses and two with a pool of the three non-cytopathogenic BVD viruses. In addition three animals were infected with one closely related cytopathogenic BVD strain (Indiana) and two animals with the antigenetically different cytopathogenic BVD viral strain A1138/69. Regardless of the inoculation route all the animals superinfected with closely related cytopathogenic BVD viruses developed the characteristic lesions of mucosal disease within 14 days of infection. Animals which were inoculated with non-cytopathogenic BVD viruses which closely resembled the herd isolate, or with cytopathogenic BVD viruses which did not resemble the herd isolate did not develop any signs of disease. However, the latter group produced antibodies to the superinfecting virus.

Evaluation of real time B-mode ultrasound scanning for detecting early pregnancy in cows

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Veterinary Record (1990) **127,** 350-352

A real time B-mode ultrasound scanner with a 7•5 MHz rectal linear transducer was used in two trials to detect whether dairy cows, less than 25 days after insemination at standing oestrus, were pregnant. In the first trial 17 cows were inseminated on the same day, and their reproductive tracts were examined 14, 15, 16 and 17 days after insemination. All the cows were diagnosed accurately as either pregnant or not pregnant. In the second trial 22 cows were inseminated on the day of observed oestrus while 14 were observed at oestrus but not inseminated. The animals were kept as a mixed group and an experienced operator scanned the uterus of each cow on one occasion, without knowing either the dates of observed oestrus or which cows had been inseminated. The rate of correct diagnosis was only 33 per cent in cows up to 16 days after oestrus, but increased markedly after 17 days and was 100 per cent by day 20.

Juvenile bovine angiomatosis: A syndrome of young cattle

T. D. G. Watson, H. Thompson

Veterinary Record (1990) **127,** 279-282

This report describes the clinical and pathological features associated with angiomatous lesions in two calves. In the first case, a single mass located in the atrioventricular ring of the heart was responsible for congestive cardiac failure. The mass was composed of numerous vascular cavities filled with blood and lined by a single layer of well differentiated endothelial cells. The second case had multiple blood-filled cutaneous masses which were confirmed as benign vascular tumours by histological examination of a biopsy specimen. The calf was later euthanased after profuse and uncontrollable haemorrhage from one of the lesions. At necropsy, additional tumours were found in the liver, spleen, kidneys, spinal canal and attached to the pleura, omentum and mesentery. It is proposed that these two cases are representatives of solitary and multiple forms of a syndrome which should be called juvenile bovine angiomatosis.