

Effect of Fall Body Condition on Winter Feed Requirements of Wintering Beef Cows

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1. Introduction

The feed energy cost for maintaining cows has a tremendous influence on the costs of beef production. It has been estimated that about 50% of the total energy required in beef production is used for cow maintenance (Montano-Bermudez et al. 1990). Moreover, from 70 to 75% of the of the total annual energy requirements for a beef cow is used for maintenance regardless of cow type (Ferrell and Jenkins 1985). Winter feeding of the beef cow herself is the single most important cost in cow-calf production, averaging 30 and 33% of average Alberta total production costs in 1994 and 1999, respectively, and accounting for \$33.26 and \$34.69 per 100 pounds of calf weaned in these two years (Kaliel et al. 1995; Kaliel 2001). Therefore one of the most promising avenues for improving beef production efficiency is to reduce the cost of winter feeding for the beef cow.

There appears to be considerable variability in maintenance requirements of cows (Van Es 1976; Taylor et al. 1986; Reid et al. 1991; Nielsen 1995). However there are few experimental results concerning the effect of fall cow condition on the economics of feeding a cow during the winter. The NRC (1996) suggests that maintenance requirements are proportional to cow metabolic weight, changes in energy intake have no measurable effect on maintenance requirements for periods up to 60 to 90 days, and maintenance requirements are directly proportional to body condition. In contrast, there are those that suggest the energy cost of maintaining fat in tissue is less than that of maintaining protein in tissue in the winter (Thompson et al. 1983a) so that winter maintenance energy costs are not proportional to metabolic weight of cows of differing body condition. Also, there is evidence that the energy required to maintain metabolic weight of similar tissue increases with increasing energy intake, and that changes in maintenance requirements occur in less than 1 month after changing intake (Schydner et al. 1982; Turner and Taylor 1983; Armstrong and Blaxter 1984; Young et al. 1989). This concept raises doubt concerning the validity of the NRC (1996) in asserting that maintenance energy costs are influenced by body condition but not by prior and current weight

change. These different assumptions can lead to differences of over 30% for estimated energy requirements, and even more for feed costs, of wintering cows. Additional research data is urgently needed to clarify this issue.

2. Literature Review

2.1. Factors influencing energy requirements for maintenance

Numerous factors, including environment and type of feed consumed influence the amount of energy required to maintain beef cows. The following discussion will, however, be limited to: individual animal variation, genotype, age, body condition, and current energy intake.

2.1.1. Individual animal variation

Not all animals of the same type, productivity status, age, and body condition and have exactly the same maintenance energy requirements within the same environment. Van Es (1976) indicated that the coefficient of variation in cow maintenance requirements is in the range of 5-10%. Taylor et al. (1986) estimated the coefficient of phenotypic variation in maintenance energy requirements to be 6.4%. Using data of DiCostanzo et al. (1990) a coefficient of variation in maintenance requirements of 12% can be calculated. Assuming a coefficient of variation of 8% based upon such data, approximately one-third of similar cows within a beef herd will have maintenance requirements outside a range of 92 to 108% of the mean. Further, 5% of the cows will have maintenance requirements differing more than 16% from the mean; i.e. 2.5% of the cows will require at least 38% more feed for winter maintenance than the 2.5% of cows which have the lowest maintenance requirement.

2.1.2. Genotype

2.1.2.1 Experimental differences between genotypes: Significant and large differences in

energy costs for maintenance of cows of different genotypes have been obtained in numerous trials (Jenkins et al. 1994). The NRC (1996) now recognizes genotype differences and suggests that Holstein, Jersey and Simmental cattle have a 20% higher maintenance requirement than 16 other breeds with similar energy requirements whereas cattle with Zebu breeding require less energy for maintenance. Results from four different research institutions in which maintenance energy requirements of different cattle genotypes have been estimated are given below.

At the University of Alberta Hereford, Kinsella beef synthetic and dairy synthetic cows were fed individually over two relatively mild winters during 1974 to 1976 (Berg et al. 1976). It was concluded that on a metabolic weight basis the beef synthetic line had the lowest maintenance requirements. Dairy Synthetics required more energy than Herefords in one year but not in the other. In the following two winters the Dairy synthetic line again had the highest maintenance requirement per unit of metabolic weight (Bolduc et al. 1978). However total energy required daily per cow was similar among all breed groups when no allowance was made for the energy costs associated with losses of backfat which were quite marked in the 1976-77 winter.

Solis et al. (1988) in Texas measured a larger difference in maintenance requirements when dairy breeds were included in measurements; daily metabolizable energy (ME) requirements for maintenance were 98, 100, 118, 119 and 152 kcal/kg^{0.75} for Brahman, Angus, Hereford, Holstein and Jersey cows, respectively. The difference in maintenance energy requirements between the high and low breeds was thus 55%.

Reid et al. (1991) in Reno Nevada measured the daily ME requirements for maintenance at 139, 143, 144, 145, 148, 149, 152 and 169 kcal/kg^{0.75} for Brahman x Hereford, Brahman x Angus, Angus x Hereford, Hereford, Hereford x Red Poll, Red Poll x Hereford, Angus x Charolais, and Red Poll, cows, respectively. This equates to a difference of 22% between the high and low beef breeds.

In a comparative recent summary of data from the US Meat Animal Research Centre in Clay Center, Nebraska, Nielsen (1995) suggests that ME costs for maintenance (kcal/kg^{0.75}/day) of

different beef breeds were: Herefords (108), Angus (109), Brahman (109), Brangus (109), Maine Anjou (110), Pinzgauer (114), Charolais (116), Gelbvieh (116), Brown Swiss (117), Red Poll (117), Limousin (118), Simmental (121) and Chianina (125). This would suggest that there is a 16% difference between the lowest and highest energy requirements of these breeds.

2.1.2.2 Heritability: Since there are breed effects for the energy requirements for maintenance, it is obvious that there must be a strong genetic component to this parameter. DiCostanzo et al. (1990) cited results in which heritability estimates for maintenance energy requirements ranged from 0.31 to 0.71 and concluded that it may be possible to change energy requirements through selection. Hotovy et al. (1991) used identical twins to estimate the heritability of fasting heat production and maintenance requirements. Values obtained were 0.75, 0.52 and 0.34 for fasting heat production, ME required for maintenance and efficiency of use of ME for maintenance, respectively. Shuey et al. (1993) suggest that the maintenance requirements of cattle may vary by 20 to 30% due to genetic differences and that these differences are moderately to highly heritable. In contrast with these results, heritabilities of feed intake and measurements of feed efficiency were estimated to be low to moderate by Fan et al. (1996) based upon results of feed intake measurements 90 days prior to calving in individually fed cows between at the Elora Beef Research Centre, Guelph, Ontario.

Studies from other animal species may provide direction in this area. Nielsen (1995) reported that there was a 53% difference in heat production in mice selected for this trait for over 15 generations. No major difference in body size between the selected animals was apparent and it was concluded that heat loss (and hence maintenance requirements) responds well to selection. However, the researcher concluded that the most likely reason for differences in heat production was because of differences in activity of the animals.

2.1.3. *Body condition score*

2.1.3.1. Theory

The NRC (1996) assumes that there is an effect of previous nutrition and compensatory gain on energy requirements. On the basis of results of Thorbeck and Henckel (1976); Crabtree et al. (1976); Frisch and Vercoe (1977); Andersen (1980); Baldwin et al. (1980); Thomson et al. (1980); Vermorel et al. (1982); Schnyder et al. (1982); Webster et al. (1982); Koong et al. (1982, 1985); Koong and Nienaber (1987); Wurgler and Bickel (1985); Ferrel et al. (1986); Birkelo et al. (1989); Burrin et al. (1989) and Carstens et al. (1989) they suggest that maintenance requirements in growing animals will be reduced by an average of 20% during a recovery period of 60 to 90 days following a low dietary intake. On the basis of this information the NRC (1996) suggests that energy requirements for maintenance change 5% per condition score when the nine-point condition scoring system is used. Their adjustment for previous nutrition is thus: Compensating factor = $0.8 + (\text{condition score} - 1) * 0.05$ which gives a range of -20 to +20% of normal energy requirements for the energy requirements of very thin to very fat animals.

Maintenance requirements are increased when cattle are lactating, with the NRC (1996) assuming that maintenance requirements of lactating cows are about 20% higher than that of dry cows. Although not considered in the NRC (1996), there is good evidence that maintenance energy requirements increase when animals are gaining weight. Data of Young et al. (1989) have been used to suggest that the metabolic rate of animals is highest during times of greatest relative growth. Similarly, Armstrong and Blaxter (1984) reported that the level of feed intake influences the amount of feed energy required for maintenance. Ortigues et al. (1993) estimated ME requirements for maintenance to be reduced by 12% in animals losing weight in comparison to those given 50% more feed. There are several reasons why maintenance requirements change with the level of productivity. Changes in the energy costs associated with ion pumping and metabolic cycling have been related to level of production (Milligan and Summers 1986; Harris et al. 1989; McBride and Kelly 1990;

Lobley et al. 1992). Also the size and heat production of visceral organs, which have relatively high energy requirements, are proportional to the level of productivity of the animal (Koong et al 1982, 1985; Burrin et al. 1989).

On the basis of the above information, the NRC (1996) approach, in which maintenance requirements are adjusted only for body condition score, appears to be overly simplistic for cows changing in body condition. Rather, it appears as if the metabolic rate of cows previously increasing in condition score will be higher than that of cows recently decreasing in condition score due to the effect of level of intake on requirements. At some time over the wintering period, then, a thin cow gaining in body condition would be expected to have a higher energy requirement per unit of metabolic weight than a fat cow losing condition. This concept is exactly opposite to that arising from the NRC (1996) approach of adjusting energy requirements directly with body condition score without consideration of previous weight change.

There is limited information concerning the time period in which previous weight changes become important. The NRC (1996) suggests that cows it will take as long as 60 to 90 for maintenance requirements to return to normal following a period of under-nutrition. Such a long time period would tend add support to their approach of using current cow condition to predict future maintenance energy requirements. However, there is much evidence that the time required for a change in metabolic rate is considerably less than this. Turner and Taylor (1983) suggested that changes in maintenance requirements would be complete within 28 days. Shorter times of 6 to 9 days have been reported in sheep (Wainman et al. 1972) whereas Schynder et al. (1982) found that the maintenance requirement of cattle stabilized within 5 days of making a change in energy intake. The time required for stabilization of maintenance requirement will probably depend upon rate of change in body weight and condition score. In any case, these data suggest that estimated maintenance requirements, both at the time of calculation and for the future feeding period, should normally be adjusted on the basis of present or predicted rate of gain rather than present condition score. The

difference this approach can make relative to the NRC (1996) approach in estimating maintenance energy requirements is shown in the following table where estimates of maintenance energy requirement varied by up to 36% between the two approaches.

Table 2.1. Comparison of NRC (1996) maintenance requirements for a condition score 2 (9 point scale) cow based only on condition score (15% below maintenance, 65 kcal/kg^{0.75}/day) with requirements which increase 15% above maintenance (89 kcal/kg^{0.75}/day) at various times after the diet is changed

Days required for change in maintenance requirement	Mean NRC requirement for a condition score 2 cow (kcal NEm/kg ^{0.75} /day)	Requirements assuming an increase in maintenance requirements with increasing intake	
		Mean maintenance requirement over 30 day period ¹ (kcal NEm /kg ^{0.75} /day)	30-day requirement % of NRC (1996) ¹
0	65	89	136
5	65	85	130
10	65	81	124
15	65	77	118
30	65	65	100

¹ Assumptions are that a cow has an initial body condition score of 2 on the 9 point scale, is gaining in body condition, and that maintenance requirements are 15% lower than normal before maintenance stabilizes and 15% higher than normal after maintenance stabilizes. The NRC (1996) data assumes that the cow has a 15% decrease in maintenance requirements from normal (77 kcal/kg^{0.75}/day) for a 60-90 day period.

2.1.3.2 Selected experimental results

Several experiments have been conducted examining the effects of body condition score and weight changes on the energy required for maintenance.

Klosterman et al. (1968) fed non-pregnant cows fixed rations and concluded that cows with a high degree of finish tended to gain weight those that were in a thin condition lost weight when the amount of energy fed was based on their metabolic size. This occurred in both Hereford and Charolais cows. It can therefore be concluded that energy requirements were not proportional to metabolic weight, the cost of maintaining fat tissue was less than the cost of maintaining lean tissue or that there was some inherent differences in the efficiency of fat and thin cows.

Young and Dietz (1971) established fat, medium and thin groups of cows by feeding a high

concentrate diet or straw-based diet during a pre-experimental period commencing in August. The fat cows had 2 mm greater external fat cover at the start of the experimental period than the thin cows. The 44 cows were individually fed during the winter an amount of a hay-grain diet calculated to maintain their weight for the first 32 days then six of the cows in the fat group were switched to the feeding level of the thin group and six of the cows in the thin group had their feed intake increased to that of the fat group. The groups were fed for another 122 days at these feeding levels. At the end of the wintering period the fat cows which had been switched to the thin group had lost 2 mm backfat but the cows switched from the thin group to the fat group did not exhibit any gain in backfat. The authors concluded that the ME requirements for maintenance were similar between the thin, medium and fat groups on a metabolic weight basis (137, 142 and 146 kcal/kg^{0.75} daily, respectively). The six fat cows which had their diet reduced had numerically the lowest maintenance requirement (136 kcal/kg^{0.75} daily), whereas the cows switched from the low to high feeding level had the highest energy requirements on a metabolic weight basis (160 kcal/kg^{0.75} daily).

Thompson et al. (1983a) fed 40 pregnant cows two different levels of ME daily (12.9 and 18.0 Mcal/day) throughout the winter. Body composition was determined at the beginning and end of the experiment by measuring body water with the deuterium dilution procedure. Metabolizable energy required for maintenance was determined from a linear regression of energy gain on ME intake. Holstein-Angus crossbred cows required 10% more energy for maintenance than Angus-Hereford cows. The ME required for maintenance of thin Angus-Hereford, fat Angus-Hereford, thin Angus-Holstein and fat Angus-Holstein cows were 131, 124, 139 and 142 kcal/kg^{0.75} daily, respectively. The authors concluded that on a metabolic weight basis fatter Angus-Hereford cows required less energy for maintenance than thinner Angus-Hereford cows. In fact the energy required for maintenance of fat was negative, which the authors suggested might have been due to factors such as increased external insulation. However, fatter Angus-Holstein cows required more ME for maintenance of metabolic weight than thinner animals during the wintering period; the difference

between genotypes was attributed to greater deposition of fat internally than externally in the dairy-type animals. Thompson et al. (1983a) calculated that the feed ME required for winter feeding of the Angus-Hereford cows could be reduced by 19% by having cow lose 40 kg of fat over the winter. A reduced energy requirement for the maintenance of fat tissue is also consistent with other research (Pullar and Webster 1977; Webster 1980).

Wright (1988) estimated that the amount of energy associated with a change of one condition score (five-point system) is equivalent to 3200 and 6500 MJ (765 and 1554 Mcal) dietary ME for weight loss and gain, respectively. Their calculations, and practical experience, showed a decrease in condition score from 3 to 2.5 over winter resulted in a 17% savings in feed from October to early March.

Wagner et al. (1988) fed 72 mature nonpregnant cows in the winter at a maintenance feeding level. On the nine-point condition scoring system cows with condition score 3 or 7 required 4 and 9%, respectively, less energy to maintain metabolic weight than cows with a condition score of 5. The authors calculated a 14% savings in winter feed by keeping cows in a condition score of 3 instead of 5. To maintain a cow in a condition score of 7, however, was calculated to require 10% more feed than for a cow with a condition score of 5.

Houghton et al. (1990a) fed 128 Charolais-Angus cows in pens of eight head each. Feeding of a ration which provided 70% of NRC energy recommendations did not result in the expected loss in body condition. The authors calculated that maintenance requirements ($\text{ME}/\text{kg}^{0.75}$) in cows fed such diets was 62% of the maintenance requirement of cows fed at the maintenance feeding level. Further there were indications that it was less costly energetically to support fat tissue than lean tissue. They concluded that some indicator of body condition needs to be used in combination with weight or weight plus milk production to estimate levels of energy required by cattle during late gestation.

DiCostanzo et al. (1990) looked at within-herd variability of maintenance requirements for

non-pregnant, non-lactating beef cows using the deuterium oxide dilution technique. The mean ME required for maintenance was 157 kcal/kg^{0.75} daily with a standard deviation of 18. It was concluded that maintenance requirements were lower per kg for fat than for protein (20.7 vs. 192.9 kg/kg, respectively), with the estimate for fat approaching zero. This means that maintenance energy costs were less for fatter cows than thinner cows at the same liveweight. Animals with greater proportions of liver and hearts in their empty body had higher maintenance requirements ($r = 0.40$ and 0.35 , respectively). Body condition score was only poorly related to ME requirements for maintenance ($r = -0.18$) whereas fat around the intestinal tract was more highly related ($r = -0.71$) within this group of Angus cows.

DiCostanzo et al. (1991) fed 14 non-pregnant and non-lactating cows and determined those that were inefficient, average and efficient. The amounts of ME required for maintenance were 180.2, 154.6 and 135.1 kcal/kg^{0.75} daily, respectively. Inefficient cows tended to have less fat, deposit more protein and have larger livers. They also found that the more efficient cows tended to produce calves with a greater 205-day weight. The researchers estimated that total yearly ME requirements would be 17% higher in inefficient cows than in efficient cows.

2.1.5. Effect of age

In a review of this aspect of factors influencing maintenance requirements, the NRC (1996) concludes that the maintenance requirement of mature, productive cows is not less than that of post-weaned, younger growing animals. However, there is literature which conflicts with this suggestion. As examples, Corbett et al. (1985) suggested that maintenance requirements are reduced by 3% per year on a metabolic weight basis and Carstens et al. (1989a) reported an 8% decrease in ME required for maintenance between 9 and 20 months of age. The Commonwealth Scientific and Industrial Research Organization (1990), in Australia, suggests that maintenance requirements do vary with age and will be minimized by the time cattle reach 6 years of age.

2.1.6. Other factors influencing maintenance requirements

The reason for differing maintenance requirements has been addressed. It is known that cows with higher milk output potentials tend to have the highest maintenance requirements (Ferrell and Jenkins 1984; Nielsen 1995). Montano-Bermudez et al. (1990) concluded that differences in milk production explained 23% of the variations in maintenance energy requirements between cattle breeds. Therefore, because of the relationships between calf growth and cow milk production, estimates of maintenance requirements of the dam may be improved by consideration of early growth rate data of calves.

Researchers (e.g. Ferrell et al. 1979, 1986; Thompson et al. 1983a; DiCostanzo et al. 1990) have determined that cow maintenance requirements are influenced by the amount of protein mass in the body much more than they are by the fat mass. In the NRC (1996), however, maintenance requirements on a metabolic weight basis are adjusted upwards for cows with higher body condition scores. Although this is not the purpose of the body condition adjustment, this approach would be exactly opposite of what should be done if only the type of tissue being maintained is being considered.

Jenkins et al. (1986) discussed the possibility that energy requirements are related to visceral organ size and DiCostanzo et al. (1990) determined that ME required for maintenance was positively correlated with liver weights and the relative portion of heart and liver to empty body.

Differences in metabolic activity as exemplified by differences in protein turnovers and ion transport are also likely to have a major influence on energy requirements (NRC 1996).

2.2. Type of tissue gained or lost during weight change

The type of tissue lost or gained during weight change determines the weight changes which will accompany changes in body condition scores as well as how the physiology of the cow responds

to the change. The NRC (1996) uses data provided by Ferrell to relate body condition score to the proportion of fat and protein in the empty body. According to their data, in a cow losing condition, 8.1% of the loss in weight will be protein and the amount of energy in each kg of weight loss will be 5.82 Mcal. The percentage fat in lost tissue is thus 57%, assuming gross energy values of 5.7 and 9.4 Mcal/kg for protein and fat, respectively.

The NRC (1996) points out that, in contrast with their approach, some researchers assume a variable percentage of fat in body tissue gained or lost depending upon condition score. This approach would be more consistent with their own data which shows variable chemical composition of the empty body for cows at various condition scores as given in Table 2.2. It is also more consistent with the literature. Thompson et al. (1983a) noted that the percentage of fat in empty body weight gain ranged from 20 to 41% in two groups of cows gaining weight. With a low energy diet, body fat was lost over the winter but body protein was gained. Di Costanzo et al. (1990) similarly observed that cows actually gained protein while they lost fat during a maintenance phase whereas during ad libitum feeding they gained 9.7 times as much fat weight as protein weight. DiCostanzo et al. (1991) observed that during weight gain cows gained between 2.4 and 9.7 times as much fat weight as protein weight, with efficient cows gaining the highest proportion of fat. Freetly and Nienaber (1998) noted that 5.3% of the weight loss was protein in cows losing condition whereas the tissue gain contained 12% protein when the cows regained weight.

Table 2.2 Composition of empty body at different condition scores¹

U.S condition score	Canadian condition score	Fat (%)	Protein (%)	Ash (%)	Water (%)	Shrunk body weight as % of condition score 5
1	1.0	3.77	19.42	7.46	69.35	77
2	1.5	7.54	18.75	7.02	66.69	81
3	2.0	11.30	18.09	6.58	64.03	87
4	2.5	15.07	17.04	6.15	61.36	93
5	3.0	18.84	16.75	5.71	58.70	100
6	3.5	22.61	16.08	5.27	56.04	108
7	4.0	26.38	15.42	4.83	53.37	118
8	4.5	30.15	14.75	4.39	50.71	130

¹From NRC (1996). Each kg of shrunk body weight is assumed to contain 5.82 Mcal. 1 Mcal of tissue energy mobilized provides 0.8 Mcal dietary net energy equivalent and 1.0 Mcal diet will result in 1.0 Mcal gain in energy.

On the basis of the above information, there is a problem with the NRC (1996) assumption that weight gain or loss in animals will contain the same proportion of fat at different body condition scores. In addition, it is widely believed that the efficiency with which protein is deposited is less than that for fat. Thus Ferrell et al. (1979) measured energetic efficiencies of protein and fat deposition to be 13 and 67%, respectively. In data of Geay (1984) efficiencies were 20 and 75%, respectively. Corresponding values obtained by Delfino and Mathison (1991) were 11 to 13% and 71 to 91%. The low efficiency of protein deposition would mean that thin cows gaining a relatively high percentage of protein in body tissue may require more energy for weight gain than fatter cows.

2.3. *Body condition scores*

2.3.1. *Importance of body condition scores*

This report addresses the influence of winter weight changes on winter feeding costs of beef cows. The implications of winter weight changes on reproductive and calf performance cannot, however, be overlooked. The NRC (1996) suggest that reproduction in cows with a condition score of at least 5 (nine point scale) are minimally affected by pre- or postpartum weight changes but that postpartum anestrous interval is increased in cows in lower body condition which have lost weight prior to calving. In general, this appears to be a fair assessment of the literature (e.g. Selk et al. 1988; DeRouen et al. 1994; Morrison et al. 1999). Thompson et al. (1983a) reported that cows initially containing 11.8% empty body fat (condition score 4 according to NRC 1996 data) could lose substantial amounts of body fat from 4 to 1 month before calving without detrimental effects on subsequent cow or calf performance, provided that adequate amounts of energy were available

immediately after calving. These authors suggested that their conclusion agreed with that of Wilbank et al. (1962) and Jordan et al. (1968a,b). Houghton et al. (1990b) concluded that cows should be in moderate body condition (body condition score of 3 in a 5 point system and 15% body lipid) by the beginning of breeding season for optimal pregnancy rates. They also suggested that some low-quality forages can be used during gestation providing cows are not allowed to become too thin at parturition (body condition score should be greater than 2⁺ or 3⁻ and body lipid greater than 12.4%). In the study of Houghton et al. (1990b), over-conditioned cows at breeding had lower pregnancy rates. The authors cited research in support of their results but also acknowledged that other research was not supportive. Sinclair et al. (1998) confirmed that cows should have a body condition score of greater than 2.5 for optimum postpartum interval. Freetly et al. (2000) found that pregnancy rates did not differ between cows which lost weight in second vs. third stage of pregnancy when the condition score was greater than 5 (9 point scale) at the time of breeding. Calf birth weights were lower, however, in the group receiving less energy prepartum and weaning weights were reduced non-significantly by 7.4 kg. Boyd et al. (1987) also reported reduced weaning weights in calves of low birth weights, but they noted that reproductive performance was not influenced by the lower feeding level which commenced 50 days before expected parturition. Miller et al. (1999) reported that, although higher milking cows lost more body condition during lactation, they gained more backfat in the subsequent dry period which suggests that weight-cycling of beef cows during the year is possible.

On the basis of these research results it would thus appear that body condition score at the time of calving has a more important influence on reproduction than whether the animals has previously lost or gained weight. Although it appears that productivity of the calf may be reduced if feed restriction during pregnancy is too severe, the option of weight cycling option in cow production in which cows lose weight during winter and regain weight in summer appears to have much to offer cattlemen in terms of reducing winter feeding costs.

2.3.2. Relationship between body condition score and body fatness

Body condition scores are primarily designed to provide an objective assessment of body fatness. The NRC (1996) data suggests that body condition scores are quite accurate. Thus body condition score accounted for 67, 52 and 66% of the variation in body fat, protein and energy, respectively in their validation data. Thompson et al. (1983b) determined that a visual appraisal of body condition was the best predictor ($R^2 = 0.44$) of percentage empty body fat for Angus and Angus-Hereford cows. Wagner et al. (1988) reported that condition score accounted for 82 to 89% of the variation in carcass fat in Hereford cows. Houghton et al. (1990c) reported that *visual* body condition scores combined with weight explained 55% of the variation in total body lipid in cattle from thin to moderate condition.

There is insufficient data concerning the usefulness of body condition scoring in crossbred cows with varying percentages of beef- and dairy-type genetic background. Thus, although visual appraisal of body condition explained 44% of the variation in percentage empty body fat for Angus and Angus-Hereford cows (Thompson et al. (1983b), the best estimate accounted for only 3% of the variation in Angus-Holstein cows which had more internal body fat. Similarly, although body condition score was a very good predictor of body fat content in Hereford x Friesian cows (residual standard deviation of 20 kg fat), British Friesian cattle had greater changes in body fat per body condition score than Blue-Grey or Hereford x Friesian cattle (Wright 1988). Body condition scoring is, however, an accurate way of determining body condition in dairy cows (Wildman et al. 1982).

Because of the importance of body condition in beef cow management it is essential that good estimates of this parameter be available. Cows should be evaluated by two independent assessors for greater accuracy (Evans 1978). Although the above information indicates that body condition scoring provides a useful assessment of body fat, additional research is required to evaluate the usefulness of body condition scoring across genotypes with different propensities to

deposit subcutaneous and internal fat.

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