Foundation for Development of Forage Based Feeding Strategies for Beef Meat Animals from Weaning to Finish

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Finishing beef animals on forage based rations is biologically possible and may be economically expedient. The ruminant digestive system of beef cattle evolved functions that effectively digest forage feed types (Phillips et al. 2009). Prior to World War II, most beef animals were finished on forage rations (Hutcheson and Eng 2007). Historically, livestock on a forage diet of regional perennial grass pastures and late cut perennial grass hays usually required three to four years to reach slaughter weight. After World War II when abundant cheap grain became available as a result of government farm programs, livestock feeders found that the length of the feeding period could be reduced by pushing young beef animals into greater rates of weight gain by feeding rations that had high concentrations of energy from grain. Barley has been the predominant feed grain in central and western Canada. Corn grain has traditionally been the first choice for fast track high energy rations in the United States (Phillips et al. 2009). Corn grain has low fiber and contains high energy primarily from nonstructural carbohydrates.

Feeding high energy grain diets to ruminant livestock that have forage diet digestive systems can cause digestive problems by reducing rumen pH. Prevention of digestive tract illness in growing livestock on high energy grain rations requires specialized ration management expertise. Feeding high energy grain rations also requires expensive specialized facilities and equipment. These additional costs prevent most cow-calf producers from finishing their own calves.

The current industrial model of finishing beef cattle on high energy grain rations in large feedlots was developed in North America post World War II because inexpensive crude oil provided low cost transportation and low grain production costs (Phillips et al. 2009). However, those conditions are rapidly changing today with greater world demand on crude oil supplies and increasing use of corn grain for biofuel production (Allen et al. 2009, Hanson and Hendrickson 2009). The current fast track paradigm of finishing beef cattle on high energy corn grain rations in large feedlots concentrated toward the center of the nation will inevitably require adjustments and modifications to reduce costs (Hanson and Hendrickson 2009). These changes will most likely include a reduction in the quantity of high energy grain and an increase in the quantity of high quality forage in the combined background, stocker, and feeder rations to reduce feed costs (Phillips et al. 2009). The first changes to the fast track paradigm will be that weaned animals will be fed higher quality forage diets during the backgrounding and stocker stages, and finished in a shorter period of time on high energy grain rations and these animals will still be classified as grain-fed beef. The next changes will be finishing an increasingly greater percentage of the feeder cattle population on forage based rations and these animals will be classified as forage-fed beef. A shift to smaller regional slaughter/packing plants may eventually be developed to reduce transportation costs (Paine 2009, Phillips et al. 2009).

Two different forage based beef finishing concepts are developing currently as alternatives to grain finished beef in large feedlots. These two concepts are: grass-fed beef and forage-fed beef (Hutcheson and Eng 2007).

Grass-Fed Beef

The older grass-fed beef concept is an offshoot of the hippie “Back to Nature” movement of the 1960's (Ikerd 2009). The grass-fed beef concept primarily attracts producers and consumers with life philosophies that are a little different from the mainstream population. The three perceptions related to grass-fed beef that increasingly draw interest are: that the different nutritional values of grass-fed meat have greater health benefits; that grazing pastures is more humane for the animals than being fed in pens; and that grass-fed beef is less harmful to the environment than grain-fed beef from large feedlots (Hutcheson and Eng 2007, Boody et al. 2009, Hanson and Hendrickson 2009, Ikerd 2009, Pain et al. 2009, Paine 2009, Sanderson et al. 2009).

The term grass-fed has a USDA standard definition: Grass and forage shall be the feed source consumed for the lifetime of the ruminant animal, with the exception of milk consumed prior to weaning. The diet shall be derived solely from forage consisting of grass (annual and perennial), forbs, browse, or cereal grain crops in the vegetative (pre-grain) state. Animals cannot be fed grain or grain byproducts and must have continuous access to pasture during the growing season (Federal Register 2007).

Traditional grass-fed strategies result in low rates of gain around 1.25 to 1.50 pounds per day. At low rates of gain, animals younger than 24 months deposit little intramuscular fat. Finishing grass-fed animals with a fair quantity of marbling requires 28 to 33 months. The standard recommendation for reducing the length of time to produce a finished animal has been to supplement the grass ration with high TDN fibrous coproduct feedstuff.

Producers wishing to capitalize on the grass-fed beef mystique but desiring to shorten the finish time and to broaden the customer base have adjusted the USDA grass-fed protocol. These producers feed a 100% forage diet to growing livestock up to the last eight weeks. After that, the animals are fed a diet of 75% high quality forage and 25% grain, usually oat or rolled oat. The grain is fed at a rate of less than 0.5% body weight to prevent forage intake and digestibility problems. These animals are grass-raised and mostly grass finished, and have been labeled in the market as mostly grass-fed beef.

The grass-fed beef market operates outside of the established channels of commercial grain-fed beef and exists primarily by direct sale from producer to consumer (Pain et al. 2009, Paine 2009, Phillips et al. 2009). Grass-fed beef will continue as a separate market from grain-fed beef. Grass-fed animals have been typically harvested at less than full finish condition because of the long feeding period. Small regional meat markets are used to butcher and package the grass-fed meat. The standard meat quality grading systems of the United States and Canada have discriminated against grass-fed beef because of its low carcass weight, dark color lean muscle, yellow color fat, low marbling, strong "grassy" flavor, and low tenderness (Baublits et al. 2003, Hutcheson and Eng 2007, Pain et al. 2009). Meat toughness can be improved by increasing the carcass cold storage hang time and the cut meat can be mechanically tenderized.

A few companies have recently emerged that purchase grass-fed cattle that meet high protocol standards of full finish condition and sell packaged meat products to upscale restaurants and grocery stores. These purveyor companies have increased the demand for grass-finished cattle and reduced the time needed for individual producers to market their own animals to consumers.

Compared to grain-fed beef, grass-fed beef is perceived to have greater health benefits for humans because grass-fed meat has lower total fat content, higher conjugated linoleic acids, higher omega-3 fatty acids, higher beta-carotene, and greater concentrations of antioxidant compounds (Daley et al. 2010). The nutritive values of pasture finished meat were compared in a two study review by Hutcheson and Eng (2007). Domesticated perennial grass pastures that had forage at low to medium quality were grazed by cattle with and without supplementation. The supplement was high TDN fibrous coproduct feedstuff (soyhull) fed at a rate of 1% body weight per day. The nonsupplemented cattle produced the typical low quality grass-fed meat that contained all of the nutritional values perceived to have human health benefits. The supplemented cattle had increased carcass weight and improved carcass quality, and the meat had decreased polyunsaturated fats and decreased omega-3 fatty acids which decreased the "grassy" flavor, but the meat did not have decreased conjugated linoleic acids, which are thought to have an important impact on prevention or suppression of cancer. Meat from grass finished ruminant animals with or without supplementation are among the richest known sources of conjugated linoleic acids (Hutcheson and Eng 2007). Grass finished cattle produce 2 to 3 times more conjugated linoleic acids than cattle fed high grain diets (Daley et al. 2010). The actual cause and effect relationships among the different types of grasses in the forage diets, the chemical content of the meat, and the effects on human health require additional research to substantiate any improved differences for grass-fed beef from grain-fed beef (Boody et al. 2009, Paine 2009).

The grass-fed beef concept has advanced slowly primarily from producer innovation and trial and error tactics. The concept has had little assistance from academic scientists. Grass-fed beef is expected to remain a small, but increasing, specialty meat market (Ikerd 2009, Paine 2009, Phillips et al. 2009) because of its high cost per pound and its extensive quality differences from grain finished beef (Paine 2009).

Forage-Fed Beef

The forage-fed beef concept is slowly emerging and has the intent to grow and finish beef animals on forage based rations. The forage-fed animals are expected to gain weight at around 2 pounds per day, deposit intramuscular fat, grow to full finish weight, reach the quality grade and yield grade of their genetic potential (Hutcheson and Eng 2007) at around 18 to 24 months of age (Hutcheson and Eng 2007, Pain et al. 2009), and to be marketable within the established commercial channels alongside grain-fed beef (Baublits et al. 2003). The cost per pound of gain for forage-fed beef is expected to be less than that for grain-fed beef (Jannasch et al. 2002). The forage-fed concept has a science based foundation of an increasing quantity of supporting academic research.

Many animal production studies have found that traditional grass finished or pasture finished cattle produce low carcass weight, dark colored lean muscle, yellow colored fat, strong “grassy” flavor, low marbling, high muscle shrinkage, and nontender (tough) meat. Because these results are typical, grass finished carcasses are severely downgraded by the United States and Canada quality grading standards (Jannach et al. 2002, Baublits et al. 2003, Hutcheson and Eng 2007, Pain et al. 2009). Most commodity beef packers have little interest in grass finished or pasture finished beef because of the usual low quality meat (Hutcheson and Eng 2007, Phillips et al. 2009).

However, not all forage finished cattle are predestined to produce low quality meat. A study conducted in eastern Canada compared the finished quality of meat from steers and heifers grazing perennial grass pastures with the finished quality of meat from similar cattle fed a grain-silage ration in a feedlot. The mean daily weight gain was 2.0 lbs/d for the pasture cattle and 2.4 lbs/d for the feedlot cattle. The nonsupplemented pasture cattle had slightly lighter carcass weight, the same lean yield percentage, equivalent marbling score, and the same A1 Canadian quality grade compared to the feedlot cattle. The adipose fat of the pasture cattle did not have the typical grass-fed yellow coloration. The pasture cattle produced a profit of $0.29 (Canadian) per pound of gain greater than that of the feedlot cattle (Jannasch et al. 2002). The important finding from this pasture-feedlot comparison trial in Canada was that when perennial grass pastures are grazed during the period that the forage has high quality and the livestock can gain around 2 pounds per day, the meat produced is at a high quality grade that is not different than that of grain-fed meat.

A forage-fed beef study in Tennessee compared supplemented and nonsupplemented steers and heifers rotationally grazed on domesticated perennial grass pastures during fall, winter, and spring. The nonsupplemented cattle produced the typical low quality grass-fed meat. The supplemented cattle were fed a high TDN fibrous coproduct feedstuff (soyhull) at a rate of 1% body weight per day. The supplemented cattle finished with greater live weight, heavier carcass weight, larger loin eye, improved lightness of lean muscle, increased back fat, increased yield grade, and increased marbling score and quality grade than that of the nonsupplemented cattle. Neither group had yellow colored fat (Baublits et al. 2003). The important finding from this supplemented-nonsupplemented pasture finish trial in Tennessee was that when perennial grass pastures are grazed during periods that the forage is not at high quality and the livestock can not gain around 2 pounds per day, the meat produced is the typical low quality grass-fed beef. Supplementation of livestock grazing low quality forage with high TDN fibrous coproduct feedstuff fed at a rate of 1% body weight per day can improve the animals weight gain sufficiently for the animals to finish at high quality grades. The usual treatment for problems of forage types with low quality is to feed a supplement. It would seem that if the forage types were used during the period that they were at high quality, supplements would not be necessary. It is cheaper to add roughage to high quality forages than it is to supplement nutrients to low quality forages to meet livestock requirements (Manske and Schneider 2007).

Hutcheson and Eng (2007) reviewed a pasture finish study that compared carcass characteristics of large, medium, and small framed steers grazing for eleven months on the same cool and warm season domesticated perennial grass pastures overseeded with annual forage crops. All steers were slaughtered at 20 months of age. The large framed steers had greater live weight, heavier carcass weight, and larger loin eye area than the medium and small framed steers, however, the large framed steers had significantly less back fat, lower yield grade, and lower quality grade than the medium and small framed steers. The small framed steers had greater back fat and greater quality grade than the medium framed steers. The important finding from this comparison of cattle frame size and carcass quality trial was that when cattle with three frame sizes are fed the same pasture forage ration that is below their nutritional requirements, the small framed cattle will perform better than the medium and large framed cattle. Also, it is no surprise to anyone, that large framed cattle require greater nutritional quality from a ration to produce meat at a satisfactory quality grade than medium and small framed cattle. Feeding large framed cattle a forage diet supplemented with high TDN fibrous coproduct feedstuffs may not result in the livestock finishing at high quality grades. Large framed cattle were designed for the fast tract high energy grain-fed rations and it probably would be best if large framed cattle remained with that paradigm. It is physiologically possible for medium and small framed cattle to be fed a high quality forage diet and to finish at choice quality grades. However, rations of less than high quality forage would result in these livestock finishing at select or standard quality grades without supplementation. Fibrous coproduct feedstuffs supplemented at 1% body weight could improve the finish quality grades.

Standard post-weaning feeding practices are insufficient for forage-fed beef. The young beef animals developed by the typical practices of backgrounding at low rates of gain over winter, then pastured on crested wheatgrass in the spring and on native rangeland during the summer until August can be finished on high energy grain rations. However, these traditionally managed stocker cattle could not be fed a high quality forage ration and finished in less than 24 months at a high quality grade because very little if any intramuscular fat is deposited during the long periods of time the animals rate of gain is less than 2 pounds per day and a high quality forage ration cannot make up that deficiency.

Calf birth date greatly effects the length of the feeding period on forage rations which in turn effects forage costs and the returns. Calves born after mid April and gain less than 2 pounds per day while alongside their mothers will have insufficient intramuscular fat deposited at weaning, will require longer than 17 additional months on a high quality forage diet to reach finish weight, and the meat may not be at high quality grades. Calves born before 1 April, weaned at 7.5 months of age at 610 pounds will have some intramuscular fat deposited, will reach finish weight in less than 13.5 months on a high quality forage diet, and will produce meat at high quality grades.

Medium and small framed livestock can be finished at high meat quality grades on forage based rations when the forage quality is high enough to provide all of the livestocks nutritional requirements and a rate of gain of around 2 pounds per day can be maintained. The concept of forage-fed beef finished at high meat quality grades requires a separate definition and protocol from grass-fed beef.

The term forage-fed does not yet have a USDA standard definition. A future definition will be similar to: high quality annual and perennial forage will be the primary diet of the ruminant animal. The meat produced must finish at high quality grades. If supplemental energy is required, high TDN fibrous coproduct feedstuffs can be included in the diet. The diet will not include feed grain that has the source of energy from nonstructural carbohydrates. The forage based ration can be delivered as pasture, as hay in feed yards, or as any combination that is efficient and does not pollute water resources.

Forage rations that do not have sufficient nutritional quality for livestock to gain 2 pounds per day will require energy supplementation to obtain a desirable degree of finish and quality grade. However, grain supplements high in energy from nonstructural carbohydrates (starches and sugars) cause lower ruminal pH, which reduces growth of fibrolytic bacteria resulting in reductions in forage intake and problems in digestibility (Kunkle et al. 1999, Baublits et al. 2003, Hales et al. 2007). Supplements that have high total digestible nutrients (>75% TDN) and low nonstructural carbohydrates (<30% NSC), which includes many fibrous coproduct feedstuffs, provide sufficient energy and have low impact on forage intake and digestibility (Kunkle et al. 1999, Baublits et al. 2003, Hales et al. 2007). High TDN fibrous coproduct feedstuffs include, but are not limited to, soybean hulls, wheat middlings, corn gluten feed, beet pulp, distillers grains, and brewers grains.

The necessity of the forage types fed to growing beef meat animals to have nutritional quality high enough to maintain a two pound per day rate of gain presents a challenge because several commonly available forage types do not meet the indispensable quality and quantity characteristics. All perennial grasses grazed or hayed after the flower (anthesis) stage are eliminated, and all annual cereal grasses grazed or hayed after the early milk stage are eliminated because of insufficient nutritional quality. Warm season annual crops are eliminated because the long-term precipitation pattern and the plant water stress frequency indicate that there is only a 14% chance for annual warm season herbage production to be near the potential quantity and an 86% chance that water deficiency conditions will result in insufficient herbage production (Manske et al. 2010). Winter cereals planted at traditional seeding dates are eliminated because the quantity of forage produced is insufficient for late season pasture use. Annual cereal grasses are eliminated from use as dependable systematized summer pasture forage because of an insurmountable logistics problem; their phenological growth development is not controlled by the length of daylight but controlled by the quantity of soil temperature and moisture causing the time period between seeding date and grazing readiness to be unpredictable with a variance from 5 weeks to 16 weeks or greater (Manske and Nelson 1995).

The list of viable forage candidates that provide sufficient quality and quantity includes the domesticated perennial grasses, crested wheatgrass and smooth bromegrass, hayed between the boot stage and the flower stage, or grazed between 1 May and mid June; the period of grazing can be extended to 29 August if the grazing defoliation is managed to stimulate vegetative tillers (Manske 2007). Spring seeded winter cereals, winter rye, winter wheat, or winter triticale, can be grazed during late summer and fall. Livestock prefer winter rye and select winter triticale the least. Annual cereal grasses, forage barley and late maturing oat, can be harvested between the flower stage and the early milk stage and fed as hay. Sole field pea crops can be harvested at a late growth stage and fed as hay.

A few crop varieties not currently grown in the Northern Plains have potential as sources of high quality forage. Southern varieties of spring cereal grasses, that have long growing seasons that when grown in the north would not reach the reproductive growth stages, could provide high quality forage as harvested hay or as late season pasture in the vegetative growth stages. Winter barley, which is grown in the west coast region winter kills when grown as grain in the Northern Plains, could provide excellent late season pasture forage during late summer and fall and would provide a seedbed of dead vegetation the following spring. Teosinte, which is the ancestor to modern corn, is a southern plant that has both perennial and annual growth forms and may have potential as a high quality forage source in the Northern Plains.

An example of a sequence of forage types that should have adequate quantity and quality for young beef meat animals to maintain around a 2 pound per day rate of gain from weaning to finish weight follows: weaned steers will graze a spring seeded winter cereal pasture of winter rye from 15 November to 15 December, then fed a mixed hay ration of forage barley, field pea, and roughage (most likely year old crested wheatgrass hay) from 15 December to 1 May, then graze crested wheatgrass on a 4 pasture rotation system from 1 May to 29 August, then graze a spring seeded winter cereal pasture of winter rye from 29 August to 15 November, and then fed a hay ration of forage barley and field peas (the roughage component will probably be greatly reduced) from 15 November until the animals reach their full finish weight.

Northern Plains beef producers will have an opportunity in the near future for increased participation in the post-weaning production of beef by feeding high quality forage rations to growing meat animals. The quality and quantity of the forage rations need to be sufficient to maintain a rate of weight gain at around 2 pounds per day in order for the beef meat animals to reach full finish weight at 18 to 24 months of age and to produce meat at high quality grades. Ruminant beef animals fed locally grown perennial and annual forage pastures and harvested hays that are not used in human diets and not in high demand for biofuels should provide low cost high quality forage finishing rations. The equipment and facilities needed to produce and deliver forage and feed to the forage-fed beef animals should not be any different than that needed for the cow herd. This forage-fed beef concept should develop to be a viable alternative choice to selling calves at weaning or to pay to have retained calves fed at a feedlot.

Acknowledgment

I am grateful to Sheri Schneider for assistance in production of this manuscript.

Steer Forage Type Sequence from Birth to Finish				
Steer Age at Period End	Dates	Forage Type	# Days in Period	Mean Weight at Period End
New Born (birth mid Mar to late Mar) youngest 1 mo	mid Mar to 3 May	Cow Early Lactation Forage Barley, Field Pea Roughage Hay Ration	45d	75 lbs
Young Calf 2 mo	3 May to 1 Jun	Cow Spring Lactation Crested Wheatgrass 2 Pasture Rotation	28d	160 lbs
Suckling Calf 6.5 mo	1 Jun to 15 Oct	Cow Summer Lactation Native Rangeland 3 Pasture Rotation	137d	550 lbs
Suckling Calf 7.5 mo	15 Oct to 15 Nov	Cow Fall Lactation Spring Seeded Winter Cereal Pasture	30d	610 lbs
Weaned Calf 8.5 mo	15 Nov to 15 Dec	Steer Fall Pasture Spring Seeded Winter Cereal Pasture	30d	670 lbs
Yearling 13 mo	15 Dec to 1 May	Steer Winter Ration Forage Barley, Field Pea Roughage Hay Ration	137d	944 lbs
Stocker 17 mo	1 May to 29 Aug	Steer Spring-Summer Pasture Crested Wheatgrass 4 Pasture Rotation	120d	1184 lbs
  19.5 mo	29 Aug to 15 Nov	Steer Summer-Fall Pasture Spring Seeded Winter Cereal Pasture	78d	1340 lbs
Finishing 20.5-21 mo	15 Nov to 15 Dec or 1 Jan	Steer Finish Ration Forage Barley, Field Pea Hay Ration	30 to 45d	1430 lbs
Finished			620 to 650d	

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