EFFECTS OF INTENSIVE WINTER MANAGEMENT, PARTIAL SEASON GRAZING, AND SORTING BY FEEDLOT IN WEIGHT ON PERFORMANCE AND ECONOMICS OF YEARLING STEER PRODUCTION SYSTEMS

By

Jeffrey D. Folmer

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Jeffrey D. Folmer

SUPERVISORY COMMITTEE:

Approved	Date
Terry Klopfenstein Signature	8/24/04
Dr. Terry Klopfenstein Typed Name	
Galen Erickson Signature	8/24/04
Dr. Galen Erickson Typed Name	
Chris Calkins Signature	8/24/04
Dr. Chris Calkins Typed Name	
Ivan Rush Signature	9/7/04
Dr. Ivan Rush Typed Name	
Dillon Feuz Signature	9/1/04
Dr. Dillon Feuz Typed Name	
Don Adams Signature	8/27/04
Dr. Don Adams Typed Name	

University of Nebraska Lincoln

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Jeffrey D. Folmer, Ph. D.

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Advisor: Terry J. Klopfenstein

A two-year experiment was conducted to evaluate the effects of intensive winter management, partial season grazing, and sorting by feedlot initial weight on the performance and economics of yearling steer production systems. Normal yearling development consisted of a wintering period where steers graze corn residue or are fed hay in a drylot area. During the winter steers in the normal system received 2.27 kg (DM) wet corn gluten feed is fed daily. The intensive management system involved utilization of implants during the winter, feeding extra wet corn gluten feed (2.72 kg/d), and feeding an ionophore with the wet corn gluten feed. In addition, intensive system steers were removed early from summer pasture and placed on feed for finishing, while normal system steers grazed the entire summer before being placed on feed. Once in the feedlot a sorting treatment was applied to half of the steers. Steers were sorted into heavy 25%, middle 50%, and light 25% weight groups. Weight groups were marketed as follows: heavy 25% two weeks prior to unsorted control steers, middle 50% one week after unsorted control steers, and light 25% three week after unsorted control steers. Performance, carcass, and economic data were analyzed for both the systems and the sorting treatments in separate analyses. Steers in the intensive system gained faster and were more profitable if sold after the winter or summer grazing period. However, there were no differences in overall system profitability after the feedlot finishing period.

Sorting yearling steers by feedlot initial weight increased final weight, hot carcass weight, and (by design) increased days on feed. In addition, sorting decreased percentage overweight carcasses compared to unsorted control steers. However, sorting had no effect on feedlot profitability. Results of this experiment indicate that yearling steers can be produced in an intensive system and fed during the summer instead of the fall with no effect on profitability, and that sorting yearling steers by feedlot initial weight, and marketing them accordingly, may increase sale weight and days on feed, but may have no effect on feedlot profitability.

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Introduction

Beef production systems vary widely. It is necessary to have varied production systems to allow for a feedlot-fed supply of slaughter-ready cattle year round, due to most calving seasons occurring during the spring of the year. This is what dictates the need for the beef industry to develop yearling production systems that spread the supply of feeder cattle, resulting in a constant supply of finished slaughter-ready cattle throughout the year.

Yearling cattle are generally weaned late in the fall from their dams and are grown and managed through some type of wintering program. This can vary from intensive feedlot pen backgrounding to extensive forage systems. Feedlot backgrounding restricts growth rate by restricting nutrient intake with a high forage diet or a limit-fed high concentrate diet. In contrast, calf-fed cattle enter the finishing phase and are ready for slaughter the next spring or summer, never actually leaving the feedlot. Yearling cattle are generally at least one year old or more before entering the feedlot and experience some sort of grazing period during their development program. This can be accomplished with either all grazing or partial grazing periods. During the dormant season, crop residues and winter range can be used, but may require supplementation if increased rates of gain are desired.

Summer grazing typically follows the wintering period and is fairly simple. Yearlings are grazed on summer grass until they reach a desired weight, or time endpoint. However, some producers utilize partial season grazing as a viable option to add weight and market feeder cattle at the (perceived) height of summer feeder cattle prices. Partial season grazing utilizes summer grazing for only part of the traditional grazing season.

Usually this produces increased rates of gain when compared to full season grazing due to the normal decrease in forage quality typical of mature, late summer forages.

Feedlot finishing is the last phase in yearling production systems. Feedlot finishing phases for yearlings are typically much shorter than that of a calf-fed animal. Yearlings typically do most of their growth in frame structure and muscle in the wintering and summer phases, therefore, the feedlot phase is mostly used for finishing; however, some muscle growth does occur.

Yearling cattle, typically on feed for around one hundred days, can present some problems when it comes to marketing them properly. Heavy weight carcasses are the biggest problem due to the large size of the cattle entering the feedlot and rapid rates of growth when placed on feed. Eliminating the heavy weight discounts on the largest cattle has the potential to have a positive impact on the profitability of feeding yearling cattle. Sorting yearling cattle into heavy, medium, and light groups may have positive impacts on profitability by allowing a producer to market the heavy and medium weight cattle at appropriate days on feed. This will avoid heavy weight discounts, while allowing the medium and light weight cattle maximum days on feed. This would allow extra weight and fat gain (marbling), potentially producing more profit through more salable weight, and a higher quality carcass without receiving the heavy weight discounts on the larger cattle.

The first objective of the research reported in this dissertation was to evaluate both the economics and animal performance of two systems of yearling production. The first system targeted increased winter gains utilizing corn residue grazing, supplemental

wet corn gluten feed, implant strategies, ionophore feeding during the wintering period and short season grazing in the summer to increase average daily gain when compared to the lower gains of a traditional system utilizing corn residue grazing as season-long summer grazing. The second objective was to evaluate both the economic and performance effect of sorting yearling steers by weight when entering the feedlot and marketing them in three groups (heavy, medium, and light) at different time points resulting in more days on feed when compared to the traditional "all in, all out" marketing approach.

Literature Review

Beef Production Systems

Ruminant livestock production systems should continue to be viable in the future for many reasons. First, ruminant animals have unique abilities. Rumen bacteria can convert cellulose (the most abundant plant product in the world) into energy and protein compounds useful to the ruminant animal (Van Soest, 1994). Second, ruminants only consume about 37% of grains fed to livestock and produce 61% of the human food energy from animal agriculture (Oltjen and Beckett, 1996). Third, ruminants allow for the productive use of highly erodible (un-farmable) lands for grazing purposes (Oltjen and Beckett, 1996). Fourth, ruminants have the ability to convert the 250 Mcal of crop residues and by-products that would otherwise go to waste into beef for human consumption (Smith, 1980; Reid and Klopfenstein, 1983). Lastly, Oltjen and Beckett (1996) found only about 25% of the potentially grazed lands were utilized for beef production. Therefore, beef production should continue to be a viable enterprise for human food production. In addition, research into forage-animal interactions, further utilization of grazable forages, and efficiencies of beef production systems, is needed (Hodgson, 1977).

Intensive vs. Extensive Beef Production Systems

Beef production in the United States can be divided into two major beef production systems. First is an intensive system where immediately after weaning, calves are placed into a feedlot on a high concentrate ration for finishing. In the second system of production, inputs are more variable, but usually consist of a growing period for the

calves after weaning. This growing period is often comprised of grazing some sort of crop residue or stockpiled forage, or can utilize low quality forage throughout the winter.

After this wintering period the cattle may be placed directly into the feedlot for finishing or enter a summer and even a fall grazing period before entering the feedlot for finishing. These extensive forage beef production systems are generally called yearling production systems. These systems will typically utilize younger and/or smaller framed cattle that are smaller at weaning. They are also necessary for regulation of a constant beef supply throughout the year. Lewis et al. (1990a) compared extensive and intensive beef production systems, and found the overall cost of gain and final "break even" price was lower for cattle finished through the extensive production system. This was attributed to heavier finished weights produced in the extensive system.

Today, the beef industry is very concerned with quality of the product produced. Some research has been done to evaluate the quality of beef produced in extensive or intensive production systems. Harris et al. (1997) utilized two groups of cloned Brangus steers to evaluate the performance, carcass traits, and meat palatability of steers fed as calves or yearlings. The first group was fed to a constant age endpoint of 16 months, with the second group fed to a constant weight endpoint of 530 kg. When harvested at the same age endpoint there was no difference in feedlot average daily gain. Calf-fed steers were heavier, and had higher dressing percentages, numeric yield grades, and quality grades. However, top loin steaks did not differ in palatability traits. When steers were fed to a constant weight endpoint yearling steers gained more rapidly in the feedlot, and had lower numeric yield grades. However, there were no differences in meat palatability

between calf-fed and yearling-fed steers. Camfield et al. (1999) utilized four different growth types in a 9-year study of steers in either feedlot or pasture development regimens. Growth types were large frame-late maturing, intermediate framed-intermediate maturing, intermediate framed-early maturing, and small framed-early maturing. Among feedlot and pasture developed steers the early maturing steers had greater marbling scores, quality grades, and yield grades. In addition, between both developmental regimens the larger framed-late maturing steers had larger longissimus muscle area, heavier body weight, and hot carcass weights. In conclusion, the authors stated that while this study was not designed to compare feedlot or pasture development it does demonstrate the variation that exists in carcass traits for the growth types. Producers may use these data to evaluate their cattle and production systems to improve the efficiency of beef production.

Klopfenstein et al. (2000) evaluated the effect of different backgrounding and growing programs on carcass quality and yield. Four different groups of cattle were used to determine these effects. The first group of 534 serially slaughtered steers was found to increase 12 percentage units of USDA Choice grade and marbling score increased by 30 units (400 = Slight ^{00}) with each 1-mm increase of rib fat. The second data set was a group of 372 calves over 5 years that were wintered at either 0.23 or 0.61 kg/d gain. When the data for these cattle were adjusted a constant rib fat thickness, there were no differences in quality grade. Group three was 418 steers from seven experiments conducted during the summer, over seven years. Steers grazed summer pasture and had rates of gain of either 0.57 or 0.61 kg/d. Once again when cattle were adjusted to equal

rib fat thickness there were no differences in quality grade. The fourth group described in Klopfenstein et al. (2000) 90 cattle was either finished as calf-feds or yearlings by Brewer et al. (2003). Calf-feds were 14 months and yearlings were 19 to 21 months of age at harvest. Calf-fed steers displayed an additional 0.39 cm of rib fat, but this had no effect on shear force, juiciness, tenderness, or overall palatability of the meat. Calf-fed steers had significantly more tender meat than yearlings, but the risk of an undesirable steak from yearlings was less than 0.2% based on shear force and less that 2.8% based on the consumer taste panel. These authors concluded that if cattle were fed to a constant fat endpoint, backgrounding program had little or no effect on marbling or carcass quality grade.

Extensive Yearling Production Systems

Yearling production systems exist in many scenarios utilizing a varied supply of resources. In Nebraska, the traditional yearling production system weans calves in November and they are allowed to graze or are fed stockpiled winter forage or crop residue such as the residue that is left over after harvesting a field of corn. This may or may not be followed by a short hay-feeding period allowing the animals to gain some weight while waiting for the summer grazing period to begin. Summer grazing typically takes place from May through August-September, depending on the system, and amount of forage available. This would be followed by a feedlot finishing phase and marketing of the cattle in November or December.

Wintering Period

During the wintering period, animals are intentionally restricted in the amount of gain they achieve primarily by feeding forages or by allowing the animals to graze low quality forage or crop residues. This allows the animal to "grow" or develop frame and muscle structure without accumulating the fat reserves of a finishing animal. This also produces inexpensive gain as the forages they are consuming are of a quality level and chemical composition that limit their use in human consumption. This also helps to distribute the beef supply throughout the year as traditionally calving is concentrated in the spring of the year, and a constant year-round beef supply is needed from the feedlot sector.

Winter Grazing of Stockpiled Forages

Stockpiled forage consists mainly of forage crops and native pastures that have been deferred or remain un-grazed through the summer months so that they may be utilized during the winter months. This type of system is very important to the beef industry. It can reduce winter feed costs by reducing hay harvest and transportation costs. In addition, it can improve range condition through dormant season grazing.

Many researchers have demonstrated the value of grazing stockpiled winter forages in yearling production systems. Horn et al. (2000) found steers grazing dormant old world bluestem gained from 0.26 to 0.4 kg/day for 93 days from December 7th to March 10th. In addition, Bodine et al. (2001) reported similar results with average daily gains ranging from 0.11 to 0.23 kg/day. Paisley and Horn (1996) found steers grazing winter wheat pasture from December 19th until April 12th gained from 1.35 to 1.41

kg/day. Also, Ackerman et al. (1997) found steers grazing either dormant native tall grass prairie, or dormant old world bluestem had similar average daily gains ranging from 0.19 to 0.14 kg per day for the native prairie and bluestem, respectively. Paisley et al. (1997) found steers gazing dormant native tall grass prairie gained from 0.28 to 0.35 kg/day from October 16th through March 29th of the following year. The steers then grazed additional native tall grass prairie from March 29th until June 17th of the same year and they found average daily gains of 1.05 to 1.06 kg per day for the second grazing period. Paisley et al. (1999) found steers grazing native tall grass prairie gained from 0.28 to 0.35 kg/day. These data demonstrate that yearlings can be grazed through the winter on dormant forage and produce some weight gain.

Winter Grazing Crop Residues

Many other researchers have demonstrated the value of winter grazing crop residues. For many years corn residue grazing has been used in the U. S. in beef production systems. Corn residue grazing is used either for maintenance of gestating beef cows or for low cost growing of beef calves after weaning, after this period, beef calves can go back to grass, or to the feedlot. The use of corn residue can be very advantageous to beef production systems by providing a low cost feed resource that doesn't compete with human food resources (Guteirrez-Ornelas, 1989). Corn residue is made up of several components and can be quite variable. Stalks, cobs, leaves, husks, and grain are the major components of the residue and they vary in the nutrient content. Stalks and cobs have the lowest nutrient content and availability, and are rarely consumed. Leaves and husks are higher in nutrient content than the stalks and cobs, and are readily

consumed. Grain has the highest nutrient content and availability, and with experienced grazing animals, is the first thing to be consumed in the field. Research has shown that experienced corn residue grazers will consume most of the corn in the first month of grazing (Fernandez-Rivera and Klopfenstein, 1989a). Problems can develop when experienced grazers are present. They may develop acidosis during the first days of grazing in an un-grazed residue field, if there is an abundance of residual corn grain (Clanton, 1989). This problem can be cured by strip grazing, which will allow higher stocking rates, in turn forcing the cattle to consume more of the low quality components of the residue along with the grain (Clanton, 1989).

Diet quality is also affected as the grazing season continues. Forage quality begins to decrease even before harvest (Hunt et al., 1989), and continues to decrease after physiological maturity of the plant (Bartle et al., 1984). Decreases in residue quality are more pronounced when the residue is grazed and the most digestible material is selected (Fernandez-Rivera and Klopfenstein, 1989b). High moisture grain harvest provides a higher quality residue product if utilized immediately after harvest (Klopfenstein et al., 1987: Clanton, 1989).

Studies also indicate differences in forage quality due to irrigation (Fernandez-Rivera and Klopfenstein, 1989a), planting density (Graybill et al., 1991), and hybrid variety (Clanton, 1989). Dry land corn residues have a higher proportion of leaf and husk (the higher digestible portion of the residue) to stem, but generally the total amount of residue available is higher for irrigated fields. In addition, the effects of irrigation may be confounded by planting density (Fernandez-Rivera and Klopfenstein, 1989a).

Corn residues from different corn hybrids have also been shown to be different in nutrient content. Roth et al. (1987) found hybrids differing in *in vitro* dry matter digestibility of the stalks and cobs. Differences were also found for grain and husk yield, although grain yield was not related to *in vitro* dry matter digestibility. An inverse relationship between neutral detergent fiber and *in vitro* dry matter digestibility was also observed, suggesting differences in cell soluble content. In addition, the researchers observed a low association between stalk *in vitro* neutral detergent fiber digestibility and *in vitro* dry matter digestibility; this was attributed to the difference in cell solubles. Since cell solubles decrease rapidly after physiological maturity, the authors suggested it might be advantageous to emphasize *in vitro* neutral detergent fiber digestibility in selection of corn hybrids. This research also found differences among varieties in crude protein, neutral detergent fiber, and *in vitro* dry matter digestibility for husk and leaves, which lead to differences in forage quality of corn residue produced from different hybrids. Lastly, the authors found hybrids that possessed improved residue quality that did not adversely affect grain yield. This has not always been the case in past research; generally corn residue of higher quality is from lower yielding hybrids (Klopfenstein et al., 1987). When grazing corn residues, producers need to analyze the resource with which they are presented. Corn residues decrease in digestibility as the grazing season progresses, especially under grazing pressure. Also, residual grain is correlated (r=.79) with average daily gain of steers (Jordan et al., 1997).

Much research has been done in the area of corn residue grazing. Most research has focused on stocking rate of cows and calves and supplementation of grazing cattle.

Calves need to be supplemented with protein due to their higher protein requirement compared to a gestating cow (Clanton, 1989). Also, Jordan et al. (1997) found the difference in average daily gain on protected and unprotected grazing fields could be explained by the amount of residual grain left in the field.

Supplementation and Plane of Nutrition

Animals grazing or being fed crop residues or poor quality forages tend to gain minimal amounts of weight due to the poor quality diet they are receiving. This results in an inexpensive way to develop animals. However inexpensive, this may not be the most economical use of the forage or the most economical system of producing yearling cattle. Diet quality is an issue of great importance and supplementation becomes important to get the optimum gain from the poor quality forage.

Protein and energy content of an animal's diet is important for efficient animal production. Diet quality in a typical winter grazing situation is of concern due to low protein contents and digestibility of dormant forages or crop residues. A great number of researchers have focused their efforts on this area due to winter feed cost savings and inexpensive weight gains these types of forages can provide. Jordan et al. (2001) evaluated seven levels (range of 1 to 3 kg) of supplemental wet corn gluten feed fed to steers grazing corn residue. This research found that 1.6 kg (DM) of wet corn gluten feed daily met the steer protein and phosphorus requirements. However, non-linear analysis of the data showed that maximum gain was achieved at feeding levels of 2.7 kg (DM). This also produced the most inexpensive winter gains and would allow for increased stocking rates on residue fields.

White et al. (1987) utilized 80 steers per year of a 3-yr experiment. Steers were wintered for 98 d at four different feeding levels. Steers were fed to lose 0.23kg/d, lose 0.07 kg/d, gain 0.19 kg/d, or gain 0.71kg/d. At the end of the wintering phase, 10 steers from each treatment were immediately put into the feedlot-finishing phase while the rest were grazed on summer pasture for 112 d before the feedlot-finishing phase. Results from this experiment indicate that the pasture gains were the inverse of the gains produced during the wintering phase, but were not significantly different, and restricted or lower gaining cattle only compensated 20% of the lost weight gain during the winter. In addition, steers that gained the most during the winter gained the most in the first 28 days of grazing and gained the most when immediately placed on feed. Also, steers that were wintered at higher rates of winter gain needed less time on feed regardless of time of initial feedlot finishing phase initiation. Effect of winter treatment on carcass characteristics was minimal. Because the number of days on feed was different, animals were allowed to be fed to the same degree of finish, which resulted in no differences in any measure of carcass quality or yield, with the exception of an interaction of kidney, pelvic, and heart fat being decreased in the cattle that gained weight during the winter. The authors provided no explanation for this effect; however it may have to do with physiological efficiency resulting from the nutritional stress of losing weight.

Jordan et al. (2002) utilized 80 steers in each of two years to evaluate the effects of two different rates of winter gain on subsequent summer grazing and feedlot performance. Steers were received after weaning and allotted to two treatment groups. Both treatment groups were allowed to graze corn residue for 98 days and then moved to

a dry lot for hay feeding for another 65 days. Group one was supplemented daily with 0.82 kg per head of a sunflower meal based supplement and group two was supplemented daily with 2.27 kg (DM) of wet corn gluten feed throughout the 163 day wintering period. Steers were then allowed to graze summer pasture for 123 days before entering the feedlot for finishing. A year by treatment interaction was observed for winter daily gain, summer start weight (winter end weight), summer daily gain, feedlot initial weight (summer end weight), feedlot final weight, and hot carcass weight. However the general trend was the same for both years. Steers supplemented with wet corn gluten feed had greater winter daily gain and weights at all points of measurement. This trend existed in both years with greater magnitude in year two. Economic analysis indicated that steers supplemented with wet corn gluten feed during the winter resulted in $25.53 more at harvest, due to the additional carcass and final weights that were gained through the winter and carried through the summer and feedlot phases.

Previous research in this literature review is in contrast to Lewis et al. (1990) who conducted two experiments over two winters. They wintered steers for 106 days at three different rates of gain, 0.28, 0.38, and 0.5 kg/d by feeding supplemental ruminal escape protein and alfalfa hay in addition to diets of husklage and stalklage. Results from these experiments indicate that different feeding levels during the winter and the increased gain that resulted were negated by compensatory gain during summer grazing. In addition, the differing rates of winter gain had no effect on feedlot finishing performance. In agreement with Lewis et al. (1990), Wanyoike and Holmes (1981) found cattle wintered for 12-weeks at 0.5 (low) or 1.08 (high) kg/d displayed a negative correlation for summer