MANAGEMENT PRODUCTION SYSTEMS AND TIMING STRATEGIES FOR CULL COWS

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MANAGEMENT PRODUCTION SYSTEMS AND

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CHAPTER I

INTRODUCTION

Marketing cull cows provides a significant source of income to U.S. cow-calf producers. Experience has shown that most producers spend time on feeding and marketing steers, heifers, and reproductive cows. Although cull cows represent 15-30% of a cow-calf herd's revenue, little attention is given to cull cow marketing. Most cow-calf producers traditionally cull and sell their cull cows in the fall when prices are at the seasonal low. However, alternative timing of cull cow marketing may increase net revenue that cull cows bring to the cow-calf operation.

Feuz (2001) reported that cull cow prices generally follow a consistent seasonal pattern. Prices are usually lower in November, December, and January and higher in March, April, and May. He also suggests that feed cost, price differences between cull cows' slaughter grades, and percentage of cull cows in each grade should be considered when making a decision of when to sell cull cows.

The primary question addressed here is whether the common management strategy, i.e., marketing cull cows at culling time, is more profitable compared to feeding culled cows for alternative periods of time. Peel and Doye (2007) stated that many producers choose to dispose of cull cows as quickly and easily as possible with small consideration for increasing the salvage value of these animals.

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They add that better management and marketing strategies could increase the value of cull cows by 25-45%. However, feeding cost, risk of holding cows for alternative periods of time, and price fluctuation should be evaluated as opposed to only the potential for enhancing value.

In addition, Wright (2005) mentioned that when deciding to feed culled cattle, a producer must consider the effects on facilities as well as time on feed. Management systems that can be used to improve animal performance will help improve the profitability of feeding cull cows. He also points out that cow type should be considered as well as feed cost and marketing timeframe. Feeding and marketing strategies that could significantly increase the final weight and improve dressing percentage and quality grade need to be identified.

The general objective of this research is to determine alternative production management systems and timing strategies for marketing cull cows. Specifically the impact on net revenue to the cow-calf enterprise from cull cow marketing of two production management systems across five marketing periods is analyzed

Background

Cattle in breeding condition that are found open (not bred) are typically taken immediately to a livestock auction as slaughter cows. Since many cowherd owners check cows for pregnancy and sell cull cows at about the same time each year, cull cows are frequently sold at the seasonal low for slaughter cows (October or November). Alternatives typically involve holding cows for a longer period and feeding them on a specified forage or concentrate ration. Thus, producers must consider the added cost of maintaining cull cows compared with the added potential revenue from holding them for

a period of time. The key research question is: Is it more profitable to sell cows when they are culled, or should they be fed on forage or concentrate ration for a period of time before being sold? The answer to this question is very important for cow-calf producers because well-informed marketing, rather than simply selling, on one hand would add value to income from cow sales, and on the other hand, the understanding of factors affecting value will help producers to take advantage of seasonal trends and fluctuations in cow condition.

The purpose of this research is to determine alternative management and marketing strategies for cull cows. In this research, feeding cull cows on forage and on a grain ration are the two different feeding operations that will be assessed to determine which would be the most profitable for cow-calf producers in Oklahoma.

Objectives

The general objective of this research is to determine alternative management and marketing strategies for cull cows. More specifically, objectives of this research are:

1. To determine costs and returns associated with feeding cull cows for 42, 78, 111, 134, and 164 days after weaning the last calf.
2. To compare the difference in weight gain, dressing percentage, average daily gain (ADG), and cost per gain between cull cows fed on forages and supplement in a confined environment and cull cows grazing on forages for 42, 78, 111, 134, and 164 days.
3. To determine the factors affecting the highest net returns associated with feeding cull cows at the best feeding period.

CHAPTER II

REVIEW OF LITERATURE

This chapter provides a brief background on feeding and marketing cull cows. It also reviews the limited amount of previous literature related to cull cow marketing, reasons for culling cows, price seasonality of the cull cow market, carcass grades, factors affecting culled cow value, effects of the Canadian cull cow market on the U.S. cull cow market, and previous studies on feeding and marketing cull cows.

Cull Cow Marketing

Carter and Johnson (2006) noted that dollars are generally left on the table when it comes to marketing cull cows. This is due to the fact that many producers assume profit can be made on a cow by just selling her calves, but this happens very seldom (Hughes 1995). Hughes also argues that producers can maximize the profitability of a breeding cow by including the salvage value of the cow. The majority of cattle producers use a spring calving season and wean their calves in the fall. During weaning time, producers check cattle for pregnancy and decide which cattle should be culled from their herd.

Reasons for Culling Cows

Feuz (2001) reported that cows are culled for the following reasons: open cows, old age, replacement breeding stock, physical defects, and inferior calves.

Price Seasonality of the Cattle Market

Seasonal price patterns are the normal movements of price that occur within a year. Agricultural products experience price seasonality due to the fact that agricultural products are the function of climatic seasons. This produces seasonality in animal production and movements, thus creating seasonal price patterns (Peel and Meyer 2002). The cull cow market experiences strong price seasonality due to large numbers of culled cattle going to the market at the same time, thus deflating prices (Figure 1).

Cull cow prices reach a seasonal minimum during the months of November, December, and January. The seasonal price maximum for culled cattle occurs during the months of March, April, and May. While most cows are culled in the fall due to a spring calving season, there could be potential for profits returned to the producer by feeding the culled cattle until the higher price prevails due to the changes in price seasonality (Feuz, Stockton, and Bhattachary 2006). Research shows that lighter weight cattle suffer more price seasonality than do heavier animals, except for cull cows, which have the largest seasonal price swings of all cattle classes (Peel and Meyer 2001). Therefore, it can be concluded that if we are able to provide an alternative time to market the cull cows versus the normal time the culled cattle go to market, there may be a financial incentive provided by the change in the price pattern. Therefore, any strategy that can market culled cattle at any other time than when the majority of culled cattle are being marketed could help increase revenue for the producer.

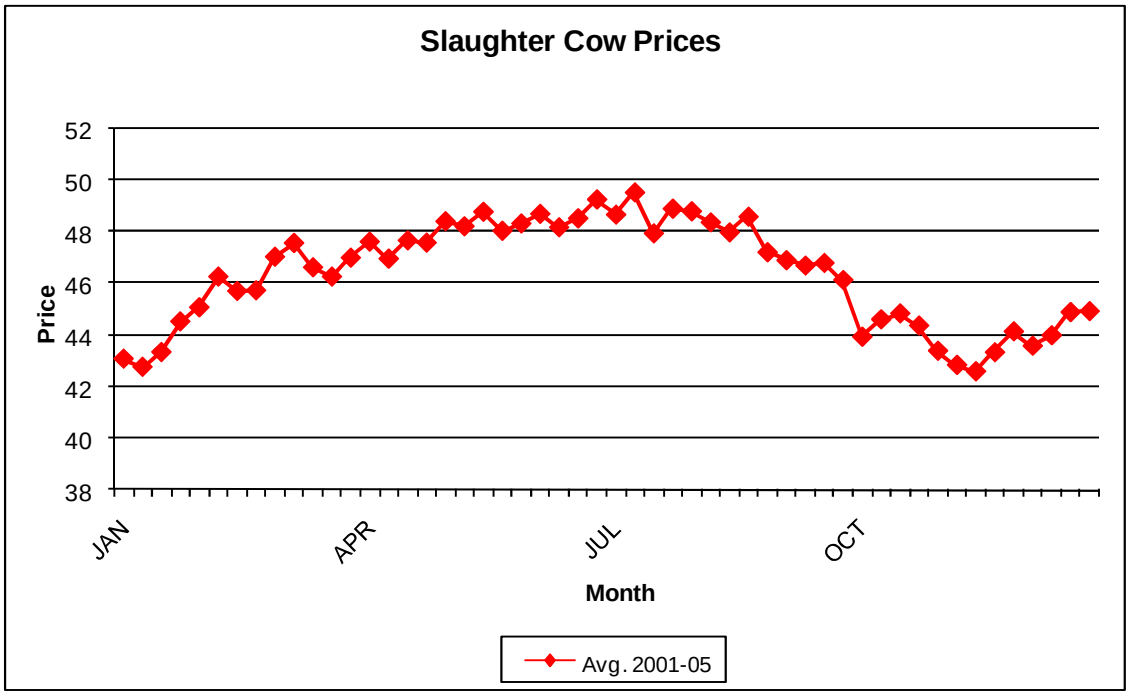

Figure 1. 2001- 2005 Average Seasonal prices

Feeding Culled Cattle

The feeding of culled cattle will improve the final weight, dressing percentage, and quality grade of the cattle (Wright 2005). While this seems self-evident, these factors must be considered when deciding to feed culled cattle past the culling date. However, the opportunity cost of doing such must be considered as well. These various opportunity costs include but are not limited to: interest expense, feeding costs, yardage costs, and labor invested in taking care of the cattle themselves. When feeding culled cattle, selection of cattle to be fed is extremely important. This program should not include any cattle that are unsound, injured, or simply unhealthy. The most desirable type cattle is a healthy cow that is in thin to moderate condition. The reason that these cattle are the most desirable is that they have the ability to gain a substantial amount of weight while on feed, without just adding fat content.

The amount of time on feed and type of type are also something to consider. A primary concern about time on feed is fat color. Some research has shown that fat color will change from yellow to white in as few as 56 days, while other research has shown that fat color will take as long as 105 days to change. The change in fat color represents a financial reward to the producer (Wright 2005).

With that in mind, the choice of feeding program for culled cattle becomes very important. The type of feeding program will affect the financial returns to keeping culled cows past the culling date. There are numerous feeding scenarios for producers to choose from but each will be dependent on the costs and expected returns from such a program. A uniform feeding pattern for all culled cattle does not seem apparent with feed costs and feeding options differing in various locations and feeding facilities (Wright 2005). A decision tool that can aid a producer in knowing if a feeding program will return benefits to the production program is estimating a partial budget. This budget should include estimated feed costs, amount of time on feed, and other factors that are included in production agriculture. By doing this, the producer is able to contrast different feeding programs and decide which program nets the greatest returns to their enterprise (Feuz 2001).

Quality and Carcass Grades

Feuz (2001) reported that when feeding culled cattle, improving quality and carcass grades are a main emphasis for the feeding program. By improving both of these characteristics, the producer will receive an increased financial return for the cattle marketed. The degree to which the USDA grade can be improved is a direct function of the quality of feed program that the culled cattle are placed on. He also argues that a

feeding program with a higher quality of feed will return a higher USDA grade, but there may not be a financial benefit to the producer if the costs of a higher quality feeding program negate the increased revenue from the improved USDA grade.

When determining how to improve cattle slaughter grades, one must first consider the cows' present grade and to which grade they could improve. There are five distinct grade classifications for slaughter cows, namely Commercial, Utility-Breaker, Utility-Boner, Cutter, and Canner. Cull cow prices are dependent upon grade classification; and the more desirable the grade, the higher the price. A producer may base his feeding program around the current and expected grade of the cattle.

While culled cattle can gain large amounts of weight in relatively short amounts of time on high grain diets, the higher gains do not come without cost. For instance, calves and yearlings can normally achieve a pound of gain from 6 to 7 pounds of feed. In contrast, to gain the same pound, culled cattle require 7.5 to 9.5 pounds of the same feed. With the high average daily gains and relatively poor feed conversion rates, it would not be unreasonable for a cow to consume dry matter at between 2.25% and 2.60 % of her body weight (Wright 2005). This high level of intake will lead to high feed costs. Therefore, any management factors that can be used to improve animal performance will help improve the profitability of feeding cull cows

There has been some research done concerning the effects of feeding cull cows. In Wright's article, he used an experiment by Matulis et al. (1987) which showed that feeding cull cows on a high energy diet for as few as 50 days can significantly increase the final weight and improve the slaughter quality grade of the cattle. Carter and Johnson

(2006) show that cull cows on full feed from 28 to 56 days will increase their carcass weight, due to an increase in carcass lean meat as well as carcass fat.

Factors Increasing Cull Cow Value

Despite the fact that 10% -25% of gross income for the producer comes from culling cows; many producers focus their energy on marketing steers, but very few put energy into marketing their cull cows (Hughes 1995). Making the decision to sell cull cows at the time of culling versus feeding those cattle for an additional time before marketing depends on three main factors, namely: 1) seasonality of cattle prices, 2) price differences between cull cow slaughter grades and percentages of cull cows in each grade, and 3) costs of feeding cull cows. While there are numerous strategies for marketing culled cattle in Oklahoma, there are some considerations that a producer should take into account when marketing cull cows (Feuz 2001).

Falconer, Bevers, and Bennett (2006) indicated that adding weight to thin cull cows is particularly valuable, as compared to marketing crippled cattle directly to a packer. Selling cull cows before they become fat, selling them outside of seasonal low price periods, considering cull cows as a valuable asset , and always being cautious and concerned about withdrawal times from antibiotics when marketing cows , would greatly increase overall net returns. By using all these input factors and the amount of output gained, the producer is able to use the information in a partial budget to make a production decision (Peel and Doye 2007). This will help determine if feeding culled cows is a profitable venture to the firm and if so, what type of feeding program they should implement for optimal returns.

Effects of Canadian Cull Cow Market on U.S. Cull Cow Market

There are market forces that drastically impact the profitability of feeding culled cattle. The single most drastic effect came from the U.S. government banning imports of culled cattle from Canada after a cow in Canada was found with the disease BSE (Bovine Spongiform Encephalopathy) (Feuz, Stockton, and Bhattachary 2006). This ban greatly reduced the amount of cattle available for slaughter in the U.S, considering that 45% of all cull cows in Canada were shipped to the U.S. for slaughter prior to the ban. This caused an increase in slaughter prices for cattle in the U.S.

In general, a strong market and low cost of feeding, would suggest a greater financial incentive to feeding cull cows because net returns are expected to be positive. However, if the market turns weak and feeding costs are high, then there may not be as much financial incentive to feeding culled cattle because net returns are expected to be negative. The strength of the market is partially dependent on the trade restrictions or lack thereof between the U.S. and Canada. In addition, the value of added absolute weight gain is heavily dependent on magnitude of seasonal price change. Therefore, adding value to cull cows when feeding costs are low and marketing prices are high is better than selling cull cows when market prices are low and feeding costs are high.

Producers should keep a close eye on what policies are being discussed and what decisions are being made in reference to the importing of cull cows from Canada when considering feeding cull cows. Moreover, impact of dairy herd reductions should be taken into consideration. If a producer does not pay attention to such information, he may begin a feeding program that looks like it will return net profits only to see it return net

losses due to the changes in the market. So the effects of the Canadian cull cow market have a direct relationship on producers' production and marketing decisions.

In order to effectively estimate potential returns, producers should evaluate a number of scenarios over several periods of time. For instance, the ban on Canadian beef imports created a strong cull cow market here in the United States. However, with the recent opening of the border, one may expect that the cull cow market may not remain as strong.

Previous Studies on Feeding and Marketing Cull cows

To our knowledge, few studies have used the repeated measures technique to estimate management production systems and timing strategies of cull cows. Nevertheless, there are relevant studies on feeding and marketing cull cows. Thus, William et al. (1980) used a stochastic dynamic programming model to estimate optimal selling time and feeding levels prior to selling in Montana. Results from this study showed that holding and feeding cull cows, assuming a single slaughter grade, would increase expected net returns by $20 to $40 per head as compared to selling them at early stages, November and December. However, due to a change in grade of cows being held and fed, expected net returns would increase as much as $55 per head. Although this study concluded that holding and feeding cows would be profitable, results would be stronger if the feeding ration had been fully described to producers.

Garoian et al. (1990) used a dynamic programming model to determine optimal strategies for marketing calves and yearlings from rangeland at a Texas Experiment station ranch. Results from this study revealed that smaller cow herds and retaining calves in the fall to sell as short or long yearlings could increase net returns over larger

traditional cow-calf production. Results also showed the marketing effect is always positive while the feeding effect may be positive or negative depending on initial conditions.

Schroeder and Featherstone (1990) used a discrete stochastic programming to determine marketing and retention decisions for cow-calf producers. Hedges and options were used to price at least a portion of the retained cattle for all but almost risk- neutral producers. Results from this study indicated that more risk- adverse producers forward priced almost all cows retained and the percentage of calves hedged relative to those priced using options was highly sensitive to futures price volatility. Furthermore, results revealed that under periods of high volatility, hedging was found to be the dominant forward pricing strategy while under periods of low volatility, moderate risk-adverse producers preferred to use options hedging. Finally, regardless of volatility level, strongly risk-averse producers preferred hedging to put options.

Frasier and George (1994) used Markovian decision analysis to determine optimal replacement and management policies for beef cows in a ranch in the Sandhills region of Nebraska. Results from this study showed that during the optimal winter feeding program, cows are maintained at a body condition slightly less than moderate with immediate early return to estrus. This would result in earlier and shorter calving which improves profitability. Providing cows with appropriate nutrition in the spring and winter months and to cull cows that are not bred was found to be a better method of keeping a shorter calving season.

CHAPTER III

METHODOLOGY

This chapter summarizes the methods and procedures used to determine alternative production management systems and timing strategies for marketing cull cows. Specifically, this section focuses on the conceptual framework, the data collection methods, the experimental procedures, and the data analysis approach.

Conceptual framework

The goal of any cow-calf enterprise is to maximize profit, given a limited amount of inputs such as labor, capital, land, and management. The timing of marketing cull cows and the decision to hold and feed cull cows beyond culling, impacts the net revenue of a cow-calf enterprise. However, the net return of keeping cull cows may increase or decrease depending on the availability and affordability of forage and grain. The key question is: Is it more profitable to sell cull cows immediately after they are culled or should they be fed for alternative time periods and marketed later?

When considering a problem that deals with cull cows feeding and marketing strategies, one may consider the following indirect profit function, where firms choose sale dates and rations that maximize the net return.

(1) $\pi^{*}_{i} = [\, f(P_{fi}, P_{g_i}, P_{l_i}, P_{vmi}, P_{c_i}(W_{s_i}, Sale\ Date_i), W_{s_i}(W_{w_i}, Ration_i)]$

where i = 42,78, 111, 134, and 164 days, π_i^{*} is indirect profit (implicit profit function) in dollars per head, P_{f_i} is the price of forage, P_{g_i} is the price of grain, P_{l_i} is the price of labor, P_{vmi} is the price of veterinary medicine, P_{ci} is the ending price of cow, which is a function of weight at sale W_{s_i} and sale date, W_{s_i} is the weight at sale which is also a function of weight at culling W_{wi} , and ration. The profit function obtained from the combination of all variables provides a tool for evaluating alternative marketing strategies.

The profit from grazing cull cows on forages for 42, 78, 111, 134, and 164 days was compared with feeding cull cows on hay and supplement for 42, 78, 111, 134, and 164 days. Peel and Doye (2007) argued that costs, death risk, and price fluctuation of holding cows a longer period of time have to be weighed against the potential for adding value to them. Net returns evaluated based on a partial budget approach with feeding cull cows for 42, 78, 111, 134, and 164 days after culling and under two management alternatives were compared. In this case, marginal returns can be defined as:

(2) $\mathrm{M}_i = P_{end} Wt_{end} - P_{begin} Wt_{begin} - \sum_{i=1}^{n} C_{ij}$

where M_i is marginal returns for the i^{th} feeding period, $\mathrm{P_{end}}$ represents the price of the cow at marketing, $\mathrm{Wt_{end}}$ represents the ending weight of the cow, $\mathrm{P_{begin}}$ represents the beginning price of the cow at culling, $\mathrm{Wt_{begin}}$ is the culling weight of the cow, and *Cij* is the cost of j^{th} inputs for the i^{th} feeding interval.

The above conceptual framework leads to the following hypotheses:

1. Due to higher grain costs relative to forage, it is hypothesized that cull cows fed on grain would have lower net returns compared to cull cows grazing on grass.

2. Average daily gain, total gain, and cost per gain from grain fed cull cows are higher than grass fed cull cows.

3. Factors such as beginning weight, average daily gain (ADG), feed cost per gain, and treatment management systems significantly influence the net returns.

Methods, Procedures, and Data

An experiment involving feeding cull cows on grain and supplement versus cull cows fed on forages was conducted by Samuel Roberts the Noble Foundation from October 2007 to April 2008. This experiment was a two-factor experiment with repeated measures comparing two levels of management alternatives (grass or dry lot) having *n* cows randomly assigned to the two management alternatives and with measures taken across 5 feeding intervals. Management alternative and length of feeding have fixed effects, while individual cows have random effects on each response variable being considered. Each management alternative includes 24 cows. Time periods included are 42, 78, 111, 134, and 164 days on feed. Thus, a mixed model that simultaneously measures both fixed and random effects was chosen as most appropriate for this experiment.

Data were collected approximately monthly on weight, USDA grade, dressing percentage, costs (feed, animal health, etc.), and estimated market value. For each interval, estimated animal performance and net returns were calculated. Both the estimated USDA grade and estimated dressing percentage were used to assign a price to each cow, based on prices reported by the Agricultural Marketing Service (AMS) for cull

cows in Oklahoma sold the same week. The value of each cow at each period was calculated as follows cow weight (in hundred weights) multiplied by assigned line weight prices. In addition, costs and value were estimated for each cow in each production system at each feeding interval. Mean comparison between cows fed on grass and dry lot at each weight period was analyzed.

Mean comparisons between grass fed cows and dry lot cows at each weigh period were analyzed. A mixed model was estimated using a restricted maximum likelihood (REML) estimation technique. Likelihood ratio tests (LRT) indicated that an unstructured covariance matrix was most appropriate in comparing mean and variance differences in weight gain, ADG, cost per gain, and net margin between cull cows fed on grain and supplement and those fed on forages (Appendix Page 47).

In order to test the hypotheses of this research, both maximum likelihood and regression analysis were used.

Maximum likelihood estimation was used to implement the mixed model with fixed and random effects in testing hypotheses 1 and 2, using the following statistical equation:

The statistical model

(3) $Y_{ijk} = \mu + \alpha_i + \beta_k + \alpha\beta_{ik} + \theta_{j(i)} + \varepsilon_{ijk}$

where i is the dry lot or grass treatment, k is the feeding interval (42, 78, 111, 134, and 164 days), Y_{ijk} is the observation at time k on cows of treatment level i (where Y_{ijk} represents the value of various dependent variables to be compared), μ is the overall mean, α_i is the treatment level effect, β_k is the time effect, $\alpha\beta_{ik}$ is the treatment*time

interaction effect, $\theta_{j(i)}$ is the random effect due to j cows in the i^{th} treatment, and ε_{ijk} is random error with $\varepsilon_{ijk} \approx \text{iid N}(0, \sigma_{\varepsilon}^{2})$.

Finally, the net returns obtained from the restricted maximum likelihood estimates of both dry lot and grass treatment at 111 days were regressed on key variables such as beginning weight, average daily gain (ADG), and feed cost per gain.

Regression analysis was used to test this hypothesis as follows:

Regression Model Specification

(4) Net returns = $\beta_1 + \beta_2 begweight + \beta_3 ADG + \beta_4 Feed\cos t$ where net returns = net returns, begweight= beginning weight, ADG= average daily gain, feedcost = feed cost

CHAPTER IV

RESULTS AND DISCUSSION

This section outlines results and discussions of the major findings. Specifically, this chapter focuses on summary table and figures of some key physical and economic variables, least square means comparison between grass and dry lot, and regression analysis.

Least Squares Means

Table 1 reports summary statistics for some key variables considered in the study, including , the mean, standard deviation, maximum and the minimum values of weight, average daily gain, gain, revenue, feed cost, other cost, total cost, net returns, cost per gain, revenue per gain, and dressing percentage.

Average means obtained from summary statistics were used to generate various graphs to better understand the variation between dry lot and grass alternatives for these key variables. Figure 2 shows that weights for cows on dry lot for all intervals were higher than for cows on grass. Also, Figure 3 shows that net returns for cows on grass were higher than for cows in dry lot. Figure 4 shows that ADG for cows on dry lot were higher than for cows on grass. Moreover, Figure 5 shows that cost per pound of gain of cows on dry lot were higher than for cows on grass. Finally, Figure 6 shows how prices changed as result of the seasonal price patterns.

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Figure 1 summarizes average of slaughter cow price from 2001 to 2005. Figure 1 showed that prices were low in fall and high in spring.

Tables 1 and 2 in the appendix section were used to decide which covariance structures best fit the repeated measures experiment. The results suggest that an unstructured covariance structure was found to be the most appropriate for the model used in this study.

Table 1.Summary statistics on key physical and economic attributes of cull cows from October 2007 to April 2008

Time Period	**Attribute**	**Grass**				**Dry lot**			
		Mean	*Std dev*	*Min*	*Max*	*Mean*	*Std dev*	*Min*	*Max*
At culling (October)	*Beginning weight(lbs/head)*	1260.75	147.92	1048.00	1608.00	1269.04	171.54	1034.00	1644.00
	Beginning dressing percent(%/head)	49.21	2.19	46.00	54.00	50.42	1.74	48.00	53.00
	Beginning Revenue($/head)	568.02	71.30	468.36	739.04	591.72	87.93	473.46	774.16
	Beginning price($/ cwt)	45.05	1.22	43.06	47.76	46.63	1.28	44.12	48.94
0-42 Days (November)	*Weight(lbs)*	1353.54	143.94	1090.00	1660.00	1367.29	139.96	1120.00	1610.00
	Dressing percent	49.21	2.19	46.00	54.00	50.42	1.74	48.00	53.00
	Total gain(lbs)	92.79	34.20	42.00	174.00	98.25	72.22	-34.00	337.00
	Average daily gain(lbs/day/head)	2.21	0.81	1.00	4.14	2.34	1.72	-0.81	8.02
	Feed costs($/head)	18.81	0.00	18.81	18.81	24.11	0.00	24.11	24.11
	Other costs($)	1.96	0.00	1.96	1.96	3.35	0.00	3.35	3.35
	Total costs($/head)	20.77	0.00	20.77	20.77	27.46	0.00	27.46	27.46
	Revenue($/head)	536.47	59.35	422.17	656.39	562.76	67.02	415.57	650.13
	Net returns per pound of gain($/lb/head)	-1.20	0.91	-3.27	0.05	-4.98	20.49	-100.65	7.33
	Cost per pound of gain($/lb/head)	0.26	0.11	0.12	0.49	0.85	2.76	-0.81	13.73
	Ending price($)	39.63	1.17	37.42	41.73	41.16	1.23	38.34	44.12

Time Period	Attribute	Grass				Dry lot			
		Mean	*Std dev*	*Min*	*Max*	*Mean*	*Std dev*	*Min*	*Max*
	Net Margin($)	-52.32	18.66	-82.7	4.27	-56.42	38.17	-125.58	68.7
0-78 days (January)	*Weight(lbs)*	1342.08	131.35	1090.00	1625.00	1429.58	135.58	1200.00	1665.00
	Dressing percent	49.21	2.19	46.00	54.00	50.46	1.69	48.00	53.00
	Total gain(lbs)	81.33	50.97	-19.00	169.00	160.54	82.19	21.00	412.00
	Average daily gain(lbs/day/head)	1.04	0.65	-0.24	2.17	2.06	1.05	0.27	5.28
	Feed costs($/head)	34.39	0.00	34.39	34.39	113.37	0.00	113.37	113.37
	Other costs($)	4.93	0.00	4.93	4.93	8.60	0.00	8.60	8.60
	Total costs($)	39.32	0.00	39.32	39.32	122.75	0.00	122.75	122.75
	Revenue($/head)	585.59	68.09	449.74	714.58	654.06	79.73	446.74	713.95
	Net returns per pound of gain($/lb/head)	-2.30	5.51	-20.04	11.20	-1.62	3.80	-17.74	0.84
	Cost per pound of gain($/lb/head)	0.69	1.03	-2.07	3.93	1.12	1.14	0.30	5.85
	Ending price($)	43.63	1.6	40.88	47.04	45.75	1.9	41.06	48.85
	Net Margin($)	-21.76	21.01	-39.55	35.66	-60.41	38.26	-62.35	105.73
0-111 days (February)	*Weight(lbs)*	1328.75	128.20	1065.00	1570.00	1426.67	145.80	1175.00	1680.00
	Dressing percent	49.08	2.08	46.00	54.00	50.92	1.75	48.00	54.00
	Total gain(lbs)	68.00	53.34	-38.00	154.00	157.63	115.14	-150.00	402.00
	Average daily gain(lbs/day/head)	0.61	0.48	-0.34	1.39	1.42	1.04	-1.35	3.62
	Feed costs($/head)	49.79	0.00	49.79	49.79	197.86	0.00	197.86	197.86

Time Period	Attribute	Grass				Dry lot			
		Mean	*Std dev*	*Min*	*Max*	*Mean*	*Std dev*	*Min*	*Max*
	Other costs($)	8.42	0.00	8.42	8.42	13.53	0.00	13.53	13.53
	Total costs($)	58.21	0.00	58.21	58.21	212.18	0.00	212.17	212.18
	Revenue($/head)	654.39	69.99	501.29	773.82	735.62	94.01	435.34	807.33
	Net returns per pound of gain($/lb/head)	1.99	6.57	-5.16	29.72	-1.52	5.70	-25.01	3.74
	Cost per pound of gain($/lb/head)	-0.18	4.27	-19.40	3.88	1.93	2.58	-1.41	12.48
	Ending price($)	49.25	1.46	46.14	53.65	51.56	2.06	46.42	55.43
	Net Margin($)	28.16	29.87	6.15	109.47	-68.28	72.92	-152.3	157.45
0-134 days (March)	*Weight(lbs)*	1305.00	124.07	1075.00	1540.00	1471.46	148.11	1200.00	1705.00
	Dressing percent	49.40	2.12	46.50	54.00	50.85	1.65	48.00	53.50
	Total gain(lbs)	44.25	54.48	-68.00	149.00	202.42	91.23	61.00	447.00
	Average daily gain(lbs/day/head)	0.33	0.41	-0.51	1.11	1.51	0.68	0.46	3.34
	Feed costs($/head)	64.76	0.00	64.76	64.76	262.59	0.00	262.59	262.59
	Other costs($)	13.18	0.00	13.18	13.18	18.71	0.00	18.71	18.71
	Total costs($)	77.10	0.00	77.10	77.10	282.08	0.00	282.08	282.08
	Revenue($/head)	646.89	69.19	513.46	774.00	729.4	91.89	464.59	845.17
	Net returns per pound of gain($/lb/head)	2.86	3.34	-7.74	9.76	-0.50	2.40	-7.36	2.17
	Cost per pound of gain($/lb/head)	0.50	4.85	-15.42	11.01	1.70	0.86	0.63	4.62
	Ending price($)	49.57	1.47	37.98	54.00	51.49	2.06	46.35	55.36

Time Period	Attribute	Grass				Dry lot			
		Mean	*Std dev*	*Min*	*Max*	*Mean*	*Std dev*	*Min*	*Max*
	Net Margin($)	1.77	29.66	15.52	112.28	-116.13	56.68	-38.74	162.08
0-164 days (April)	*Weight(lbs)*	1314.17	122.02	1075.00	1535.00	1471.46	148.11	1200.00	1705.00
	Dressing percent	49.10	2.21	45.50	54.00	50.98	1.69	48.00	54.00
	Total gain(lbs)	53.42	61.20	-88.00	161.00	202.42	91.23	61.00	447.00
	Average daily gain(lbs/day/head)	0.33	0.37	-0.54	0.98	1.23	0.56	0.37	2.73
	Feed costs($/head)	82.39	0.00	82.39	82.39	327.32	0.00	327.32	327.32
	Other costs($)	17.52	0.00	17.52	17.52	24.51	0.00	24.51	24.51
	Total costs($)	99.07	0.00	99.07	99.07	352.61	0.00	352.60	352.61
	Revenue($/head)	647.01	63.92	464.13	716.07	722.49	96.19	403.37	837.16
	Net returns per pound of gain($/lb/head)	3.20	3.97	-10.67	12.64	-1.10	3.24	-10.41	2.61
	Cost per pound of gain($/lb/head)	1.70	4.85	-7.08	19.81	2.12	1.08	0.79	5.78
	Ending price($)	49.23	1.33	47.14	51.8	51.47	2.46	48.94	56.28
	Net Margin($)	55.34	34.94	-40.47	108.09	-186.98	59.3	-101.5	83.71

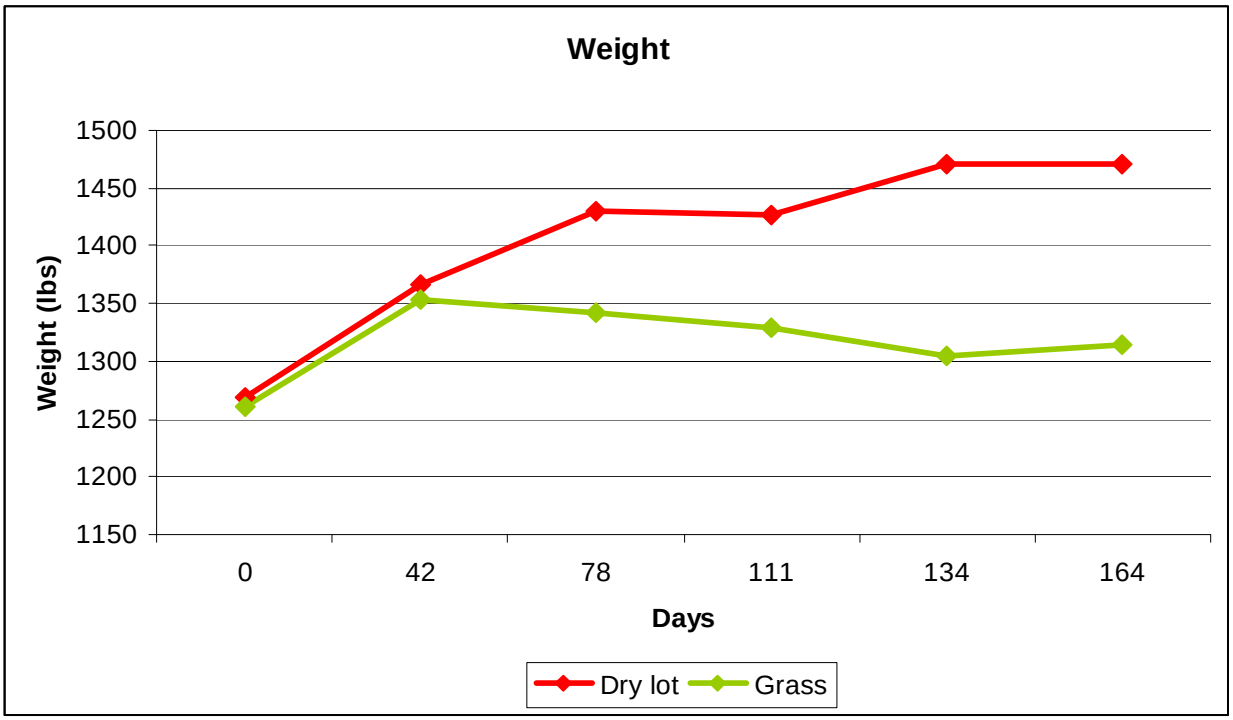

Figure 2. Average cow weight at each weight date for both treatments

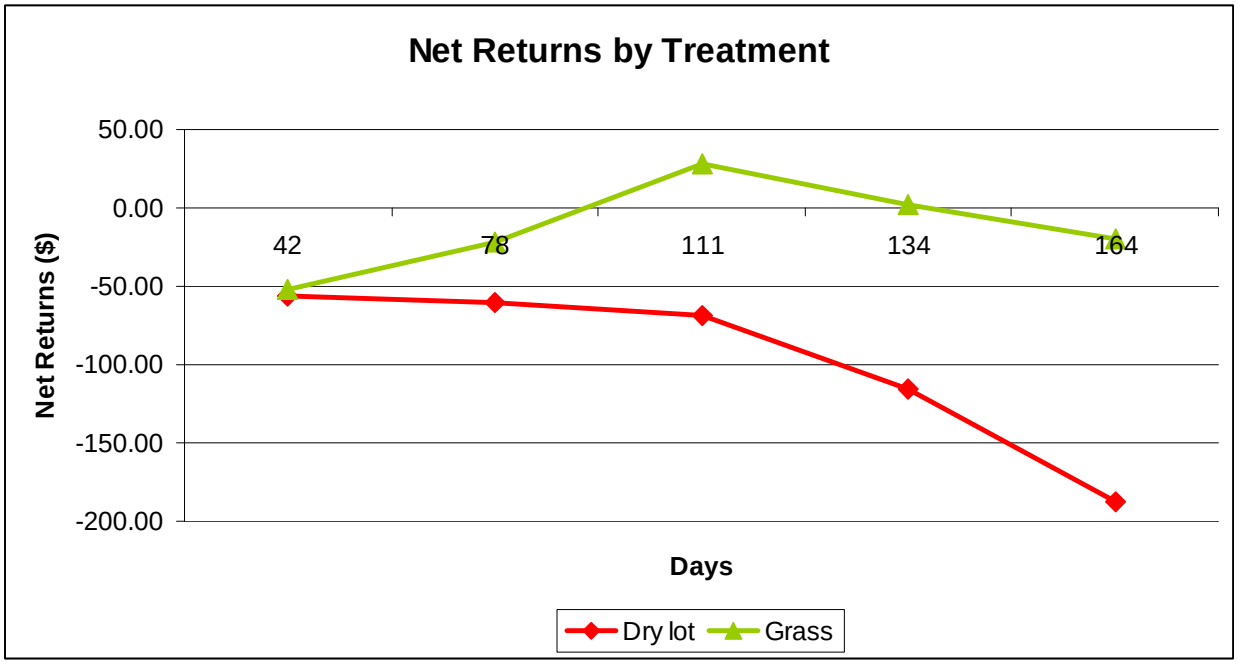

Figure 3. Average net returns per cow as compared to day 0 at each feeding interval for both treatments

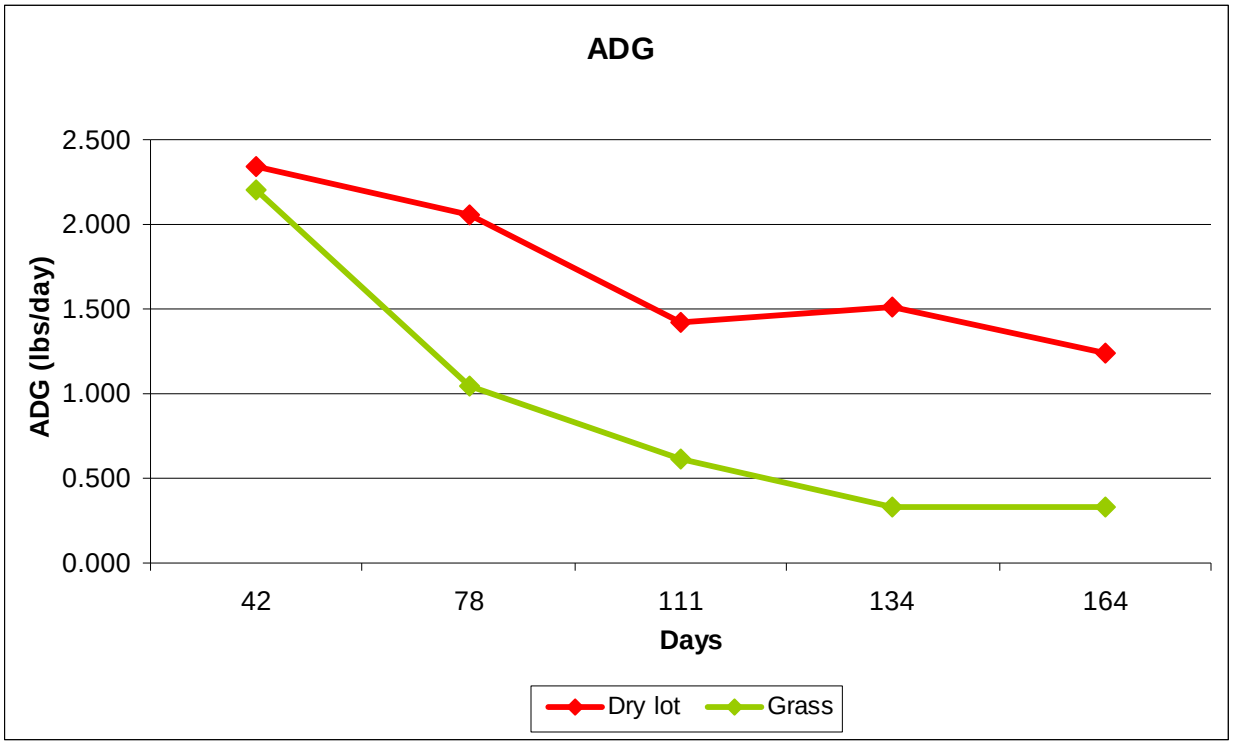

Figure 4. Average Daily Gain per cow at each feeding interval for both treatments.

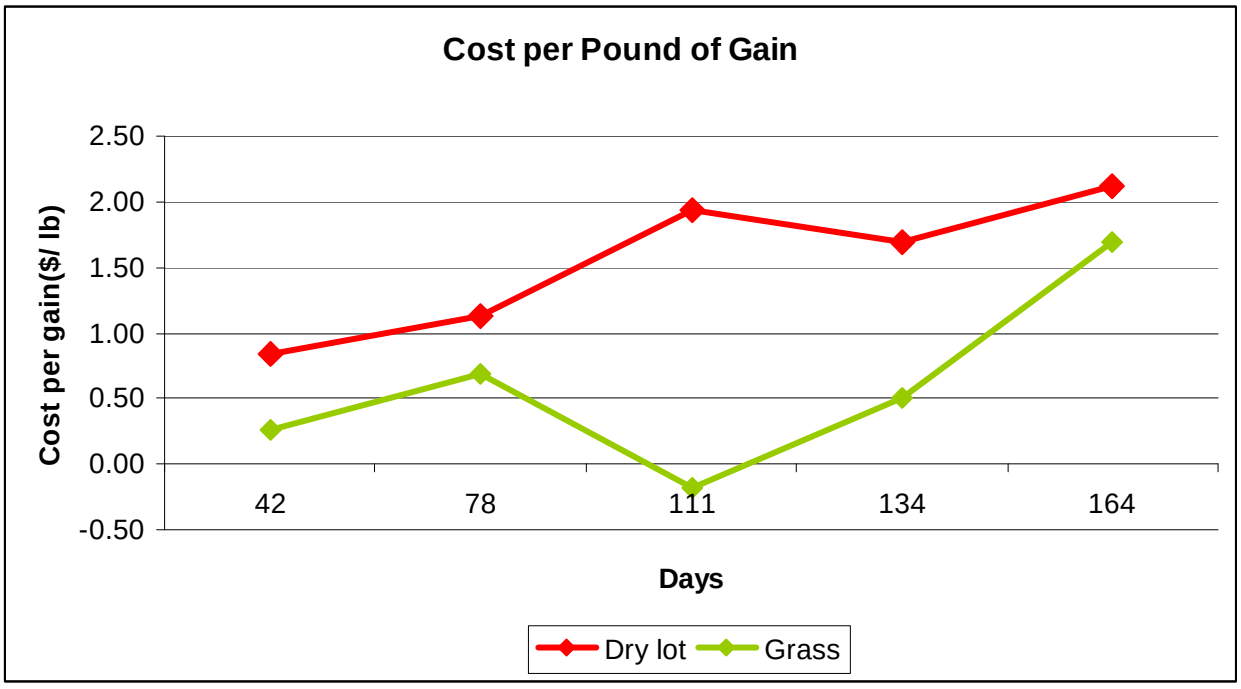

Figure 5. Average cost per pound of gain at each feeding interval for both treatments.

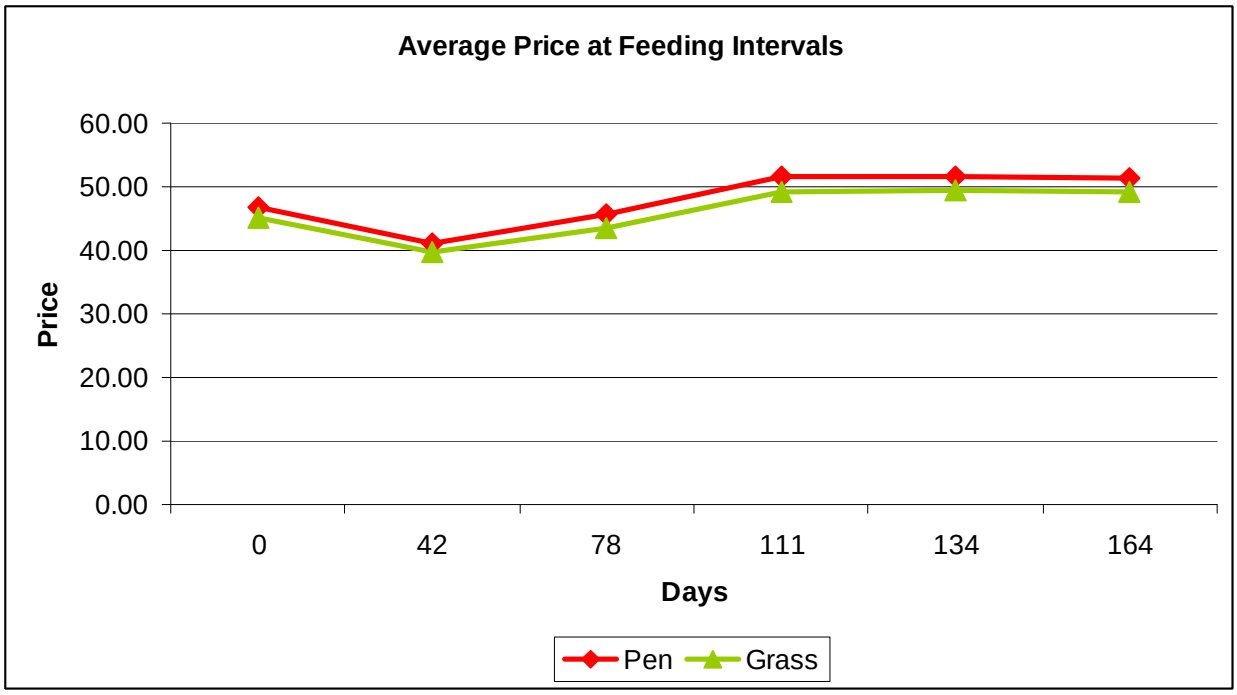

Figure 6. Average price at each feeding interval for both treatments.

Table 2 presents estimates from least square means for net returns, ADG, gain, cost per gain, and revenue per gain between grass and dry lot treatments. Negative numbers mean that dry lot was better than grass, while positive numbers favored grass over dry lot. The parameter estimates for net returns were positive and statistically significant for 78, 111, 134, and 164 days and favored grass over dry lot. This implied that net returns at 78, 111, 134, and 164 days on grass respectively generated $32.18, $95.52, $126.89, and $117.48 more than net returns on dry lot. The cost per pound of gain for dry lot cows was significantly higher than for grass cows at 111 days. Furthermore, revenue per pound of gain, which reflects price changes combined with weight gain, was statistically higher for grass cows at 78 and 164 days.

Average daily gain (ADG) and total gain of dry lot cows was significantly higher than for grass fed cows at 78, 111, 134, and 164 days and was statistically significant.

Table 2. Grass compared to dry lot

Time Period	Net returns Estimates	ADG Estimates	Gain Estimates	Cost per gain Estimates	Revenue per gain Estimates
42	3.89	-0.13	-5.46	-0.59	1.88
	(8.951)	(0.388)	(16.312)	(0.564)	(2.142)
78	32.18***	-1.02***	-79.20***	-0.35	1.6158***
	(8.754)	(0.252)	(19.740)	(0.321)	(0.336)
111	95.52***	-0.80***	-89.62***	-2.17*	0.79
	(15.193)	(0.233)	(25.903)	(1.086)	(0.887)
134	126.89***	-1.18***	-158.17***	-1.2783	1.16
	(12.598)	(0.161)	(21.690)	(1.094)	(1.035)
164	184.6***	-0.90***	-163.37***	-0.4721	1.4908***
	(13.078)	(0.137)	(22.641)	(1.081)	(0.260)

* = significant at 10%, ** =significant at 5%, and ***= significant at 1%
The numbers in parentheses are the standard error.

Table 3 presents least square means for net returns, ADG, gain, cost per gain, and the revenue per gain from the comparison of cows on across different intervals. Table 3 presents comparisons for grass cows only across adjacent feeding intervals. Negative values mean the following period is better than the preceding ones; while the reverse is the case for positive values.

Net returns of grass fed cows at 78 and 111 were significantly higher than net returns of grass cows in the preceding period. Cost per pound of gain and revenue per gain were not statistically different between adjacent intervals. ADG and total gain indicated a decline in weight gain as the experiment progressed beyond 42 day. The only exception is between 134 to 164 days where weight gain for the grass treatment cows increased.

Table 3. Comparison of Net returns, ADG, Gain, cost per gain and revenue per gain for Grass

Time interval	Net returns Estimates	ADG Estimates	Gain Estimates	Cost gain Estimates	Revenue per gain Estimates
42-78	-28.16***	1.17***	11.46	-0.49	-1.76
	(4.312)	(0.147)	(6.855)	(0.417)	(1.442)
78-111	-47.91***	0.43***	13.34	0.94	0.751
	(7.391)	(0.082)	(8.727)	(0.754)	(0.616)
111-134	3.50	0.29***	23.75***	-0.75	-0.57
	(6.018)	(0.082)	(8.437)	(1.277)	(1.152)
134-164	49.27***	0.004	-9.17**	-1.30	0.54
	(3.929)	(0.028)	(4.245)	(1.282)	(0.717)

* = significant at 10%, ** =significant at 5%, and ***= significant at 1%
The numbers in parentheses are the standard error.

Table 4 reports least square estimates for net returns, ADG, gain, cost per gain, and revenue per gain of dry lot with dry lot comparison. Negative values favored later periods while positive values favored preceding periods.

Net returns of dry lot cows at 78, 111, and 134 days were significantly higher than net returns of cows on dry lot during the following interval. Cost per pound gain and revenue per gain were not statistically different across adjacent interval.

ADG of dry lot cows at 42, 78, and 134 days were significantly higher than ADG of cows during the later periods. Total gain of dry cows at 78, 134, and 164 days were statistically greater than total gain of cows during the preceding periods.

Table 4. Least square mean results for cows in dry lot for weigh intervals

Time Interval	Net returns Estimates	ADG Estimates	Gain Estimates	Cost per gain Estimates	Revenue per gain Estimates
42-78	0.12	0.28*	-62.29***	-0.25	-2.03
	(4.318)	(0.147)	(6.854)	(0.417)	(1.442)
78- 111	15.43**	0.64***	2.92	-0.88	-0.08
	(7.391)	(0.082)	(8.727)	(0.754)	(0.616)
111-134	34.87***	-0.09	-44.79***	0.15	-0.20
	(6.018)	(0.082)	(8.437)	(1.278)	(1.152)
134-164	106.97***	0.278***	-14.375***	-0.5	0.84
	(3.929)	(0.028)	(4.245)	(1.283)	(0.717)

* = significant at 10%, ** =significant at 5%, and ***= significant at 1%
The numbers in parentheses are the standard errors.

Table 5 reports changes from the base period (culling date) to specific measurement dates (e.g. 0-42 days, 0-78 days) for both treatment groups. Net returns of cows on grass from the base date to 42, 78 and 164 days were negative while those from the base date to 111 and 134 days intervals were found to be positive and statistically significant, implying that grass fed cows should be marketed at 111 or 134 days.

Net returns for dry lot cows at 42, 78, 111, 134, and 164 days were negative and statistically significant. This means that dry lot cow operations were not profitable this year and one possible explanation may due to the prevailing high feeding costs.

Results suggest that 111 days is the appropriate time to market grass fed cull cows. These findings were not consistent with previous research that concluded that economic gain from cull cows could be achieved between 56 to 90 days (Carter and Johnson 2006; Schnell et al 1997; Torell et al 2001). One possible explanation could be a difference in their placement weight. Cost per gain generally increased with longer feeding periods. Overall, cost per pound of gain of cows on dry lot for all time intervals were higher than cost per pound of gain of cows on grass. Revenue per gain varied for the feeding periods, again reflecting a combination of seasonal price

changes and weight changes for cows in both treatments. Overall, revenue per gain of cows on grass for all time intervals was higher than revenue per gain for cows on dry lot.

Table 5 shows that the average daily gain (ADG) and overall gain for both treatments were generally statistically significant. Results reveal that as time of feeding increases, gain continues but at a declining rate across feeding intervals for both total gain and average daily gain. This implies that cull cows rapidly gain weight during the first period of their placement, but then the rate of weight gain decreases.

Table 5. Least Square mean results for the culling dates From Base Period to specific time interval for grass fed and dry lot cows

Treatment	Time Interval	LS Means Net returns	LS Means ADG	LS Means Gain	LS Means Cost per gain	LS Means Revenue per gain
Grass	42	-53.17***	2.21***	92.79**	0.260	-0.22
		(6.330)	(0.274)	(11.534)	(0.398)	(1.514)
	78	-25.01***	1.04***	81.33***	0.74***	1.55***
		(6.190)	(0.1787)	(13.958)	(0.227)	(0.238)
	111	22.90**	0.6133***	68***	-0.19	0.80
		(10.744)	(0.165)	(18.316)	(0.768)	(0.627)
	134	19.40**	0.33***	44.25***	0.55	1.38*
		(8.908)	(0.114)	(15.337)	(0.774)	(0.73)
	164	-29.87***	0.33***	53.42***	1.85**	0.84***
		(9.247)	(0.096)	(16.009)	(0.764)	(0.184)
Dry lot	42	-57.07***	2.34***	98.25***	0.845 **	-2.09
		(6.330)	(0.274)	(11.534)	(0.398)	(1.514)
	78	-57.19***	2.06***	160.54**	1.09***	-0.07
		(6.190)	(0.178)	(13.958)	(0.227)	(0.237)
	111	-72.62***	1.42***	157.62***	1.97**	0.01
		(10.744)	(0.1649)	(18.316)	(0.768)	(0.6276)
	134	-107.49***	1.51***	202.42***	1.83**	0.22
		(8.908)	(0.114)	(15.338)	(0.774)	(0.732)
	164	-214.46***	1.23***	216.79***	2.32***	-0.65***
		(9.247)	(0.0968)	(16.009)	(0.779)	(0.1840)
Log-likelihood value		-2295.8	-175.1	-2273.3	-1045.4	-1092.7

* = significant at 10%, ** =significant at 5%, and ***= significant at 1%
The numbers in parentheses are the standard error.

Regression Estimation

Linear regression analysis was used to determine factors influencing net returns at 111 day for both grass and dry lot. Factors such as beginning weight, ADG, and feed cost per gain were considered.

Table 6 reports parameter estimates of linear regression model at 111 days. Figure 3 showed that net returns for grass at 111 days were higher while net returns for dry lot were all negative. Therefore, the best time to market grass fed cows occurred at 111 days

Both grass and dry lot models have correct coefficient signs for ADG, feed cost per gain, and treatment which were correctly specified and expected. The sign for beginning weight in both models was negatively related to net returns. It was thought lighter cows would have a lower body condition score and thus might benefit from compensatory gain. Falconer, Bevers, and Bennett (2006) note the importance in terms of added value of adding weight to thin cull cows.

Results of linear regression models at 111 days indicated that a one pound increase in beginning weight would decrease net returns by $0.52/lb and $0.47/lb respectively for grass and dry lot. Results also showed that one pound increase in feed cost per gain would decrease net returns by $ 3.14/lb and $5.17/lb respectively for grass and dry lot. Finally, results revealed that a one pound increase in ADG would on average increase net returns by $67.42 and $ 64.80 for grass and dry lot respectively

Table 6. Regression of net returns on key variables

Linear Model (Grass)		Linear Model (Dry lot)	
Variables	Parameters	Variables	Parameters
Constant	-126.13*** (33.767)	Constant	-305.09*** (72.024)
Beginweight	-0.52*** (0.055)	Beginweight	-0.47*** (0.068)
ADG	67.42*** (7.576)	ADG	64.80*** (8.400)
Feedcostgain	-3.14 (2.824)	Feedcostgain	-5.17 (7.772)
R^2	0.84	R^2	0.77

* = significant at 10%, ** =significant at 5%, and ***= significant at 1%
The numbers in parentheses are the standard errors.

Sensitivity Analysis for Net Returns based on Feed Cost and Marketing Price

Table 7 shows the sensitivity analysis of net returns for cattle on grass based on marketing price and feed costs. Results indicated that net returns would be positive even at high feed costs as long as prices adjusted to seasonal patterns accordingly. Net returns would be more positive as producer feed costs and market price were seasonally high. This implies that market price is more important than feed cost. Therefore, net returns would be negative when market price was low and feed costs were also low. Finally, net returns would be both negative generally when both feed costs and market prices were at low levels.

Table 7 Sensitivity Analysis for Net Returns at 111 days on grass

	Marketing Price at 111 Days					
Feed cost	**45.25**	**47.25**	**49.25**	**51.25**	**53.25**	**55.25**
29.8	-11.02	14.49	39.95	65.50	91.01	116.51
39.8	-21.02	4.49	29.95	55.50	81.01	106.51
49.8	-31.02	-5.51	19.95	45.50	71.01	96.51
59.8	-41.02	-15.51	9.95	35.50	61.01	86.51
69.8	-51.02	-25.51	-0.05	25.50	51.01	76.51
79.8	-61.02	-35.51	-10.05	15.50	41.01	66.51

Table 8 shows results of sensitivity analysis of dry lot net returns based on market price and feed cost. Results indicated that net returns would be positive when market price was seasonally high. Net returns would be negative for nearly all other combinations of prices. This implies that producers should target periods of high market prices and keep feed cost as low as possible.

Table 8 Sensitivity Analysis for Net Returns at 111 days on dry lot

Marketing Price at 111 days						
Feed cost	**45.56**	**47.56**	**49.56**	**.51.56**	**53.56**	**55.56**
100	-147.83	-33.69	-6.3	21.09	48.48	75.88
110	-157.83	-43.69	-16.3	11.09	38.48	65.88
120	-167.83	-53.69	-26.3	1.09	28.48	55.88
130	-177.83	-63.69	-36.3	-8.91	18.48	45.88
140	-187.83	-73.69	-46.3	-18.91	8.48	35.88
150	-197.83	-83.69	-56.3	-28.91	-1.52	25.88

Partial Budget Summary

Table 9 shows the summary of partial budgets for different time intervals and production systems. The OSU budget was used as a base to compare dry lot and grass for both periods. Net returns for cows on dry lot are negative, implying that it is not profitable to hold cows and feed them on dry lot at 0-42, 0-78, 0-111, 0-134, and 0-164 intervals given results of a one year experiment and market conditions in 2007-2008.

Net returns for cows on grass at 0- 42, 0-78, 0-134, and 0-164 intervals were all negative meaning that producers will lose money if they operate on these time periods. However, a net return of grass at 0-111 interval was positive, implying that it is profitable for producers to sell their cull cows. These results were fairly consistent with those obtained by least square mean estimates using maximum likelihood technique. One possible explanation might be due to various assumptions made on shrink percentage, interest rate, price change from cull date to market date, and price premiums for increased body condition score.

Table 9. Partial Budget Summary

Variables	OSU	Grass (in days)					Dry lot (in days)				
	Budget	0-42 days	0-78	0-111	0-134	0-164	0-42days	0-78	0-111	0-134	0-164
Traditional management											
Cull cow (marketing) weight (lbs.)	1100	1260.75	1260.8	1260.75	1260.75	1260.75	1269	1269.04	1269	1269.04	1269.04
Shrink (%)	6.0	6	6	6	6	6	6	6	6	6	6
Sale weight (lbs.)	1034	1185	1185	1185	1185	1185	1193	1193	1193	1193	1193
Price ($/cwt.)	45.00	45.06	45.06	45.06	45.06	45.06	46.63	46.63	46.63	46.63	46.63
Gross revenue ($/head)	465.30	533.97	533.97	533.97	533.97	533.97	556.23	556.23	556.23	556.23	556.23
Cow feeding revenue											
Beginning cull cow weight (lbs.)	1100	1260.75	1260.8	1260.75	1260.75	1260.75	1269	1269.04	1269	1269.04	1269.04
Days on feed	90	42	78	111	134	164	42	78	111	134	164
ADG (lbs./day)	1.0	2.21	1.04	0.61	0.33	0.33	2.34	2.06	1.42	1.51	1.23
Fed cow (marketing) weight (lbs.)	1190	1354	1342	1328	1305	1315	1367	1430	1427	1471	1323
Shrink (%)	4.0	4	4	4	4	4	4	4	4	4	4
Sale weight (lbs.)	1142	1299	1288	1275	1253	1262	1313	1373	1370	1413	1270
Cull cow price from traditional management ($/cwt.)	45.00	45.06	45.06	45.06	45.06	45.06	46.63	46.63	46.63	46.63	46.63
Price change from cull date to marketing date ($/cwt.)	5.00	0	0	0	0	0	0	0	0	0	0
Price premium for increased BCS/quality grade ($/cwt.)	1.50	0	0	0	0	0	0	0	0	0	0
Final price ($/cwt.)	51.50	39.63	43.63	49.25	49.57	49.23	41.11	45.75	51.56	51.49	51.47
Gross revenue ($/head)	588.34	515.01	562.10	628.06	620.97	621.45	539.59	627.96	706.18	727.32	653.78
Cow feeding costs											
Interest rate (%)	7.0	7	7	7	7	7	7	7	7	7	7
Cattle interest ($/head)	8.03	4.30	7.99	11.37	13.72	16.79	4.48	8.32	11.84	14.29	17.49
Health supplies and medicine ($/head)	2.00	2	2	2	2	2	2	2	2	2	2
Death loss (%)	0.00	0	0	0	0	0	0	0	0	0	0
Death loss ($/head)	0.00	0	0	0	0	0	0	0	0	0	0
Labor and equipment ($/head)	4.00	1.78	4.61	7.97	12.21	16.45	3.11	4.56	12.00	16.85	22.22
Feed, hay, and pasture ($/head)	70.00	18.82	34.40	49.80	64.77	82.41	24.12	102.26	186.75	251.47	316.19
Additonal marketing costs (tags, commission, etc.) ($/head)	3.00	3	3	3	3	3	3	3	3	3	3
Total cost ($/head)	87.03	29.90	51.99	74.13	95.70	120.65	36.71	120.14	215.59	287.62	360.91
Traditional vs. Cow feeding Summary ($/head)											
Traditional gross revenue	465.30	533.97	533.97	533.97	533.97	533.97	556.23	556.23	556.23	556.23	556.23
Cow feeding gross revenue	588.34	515.01	562.10	628.06	620.97	621.45	539.59	627.96	706.18	727.32	653.78
Increased revenue	123.04	-18.96	28.13	94.09	87.00	87.48	-16.64	71.73	149.96	171.09	97.55
Less retained ownership costs	87.03	29.90	51.99	74.13	95.70	120.65	36.71	120.14	215.59	287.62	360.91
Net return from cow feeding	36.00	-48.86	-23.86	19.95	-8.70	-33.17	-53.35	-48.40	-65.64	-116.53	-263.36

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

This study investigated whether cull cows should be sold immediately after being culled from the herd or kept and fed on grass or in a dry lot for alternative periods of time. An experiment involving 24 cull cows fed on grass and 24 cull cows fed in a dry lot was conducted by the Samuel Roberts Noble Foundation from October 2007 to April 2008.

Results reveal that cows in both treatments gained a significant amount of weight initially. Cows in the grass treatment then began losing weight on average while the dry lot cows increased weight significantly. ADG for both groups declined following the first 42 days. Cost of gain generally increased for both groups as the feeding period increased. In general, cost per gain of cows in dry lot for all time intervals were higher than cost per gain of cows on grass.

Prices increased over the experimental period generally in line with the seasonal pattern. Therefore, increasing prices combined with modest weight gains led to higher net returns at 78 days or more for both treatment groups. Net returns for grass-fed cows exceeded those for dry lot cows for each period. Increasing cost per gain led to lower net returns for the dry lot cows.

Regression results for net returns for both grass and dry lot at 111 days revealed that beginning weight and feed cost per gain were negatively and significantly affected net returns. Average daily gain was positively related to net returns for both models.

Results from sensitivity analysis of cows on grass suggested that net returns would be positive when market price and feed were at high or when market price and feed cost were respectively at high and low. This implied that market prices were dominant regardless of feed cost level. However, the sensitivity analysis of dry lot revealed net returns would be positive if only market price and feed cost were at high and low levels, respectively.

In conclusion, holding cull cows beyond culling generated higher net returns than selling them immediately after culling, for a grass feeding program after 111 days. Producers should consider the weight, and condition of cows at culling, potential for gain at reasonable cost, results at various potential end points, and the normal seasonal pattern when considering how long to feed cows before marketing them. In sum, producers should consider their own resources and the best use of those resources.

Limitations of this research include only one year of data, small sample size (48 cull cows), and cows being in good body condition score. Further research comparing profitability between bred cow and cull cow would be helpful to cow-calf producers.

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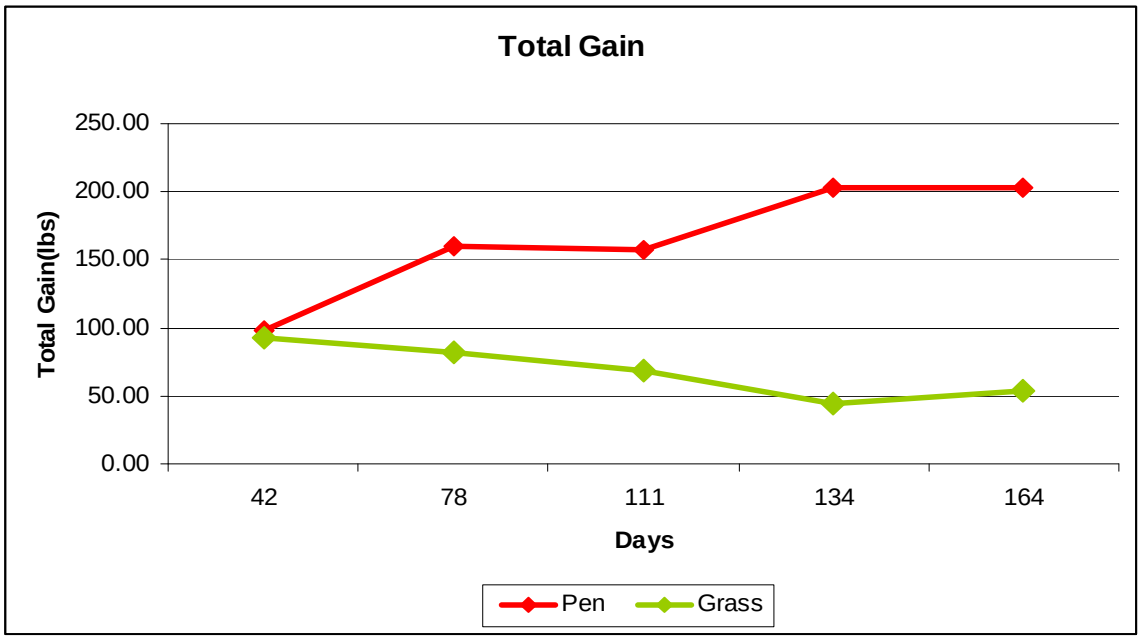
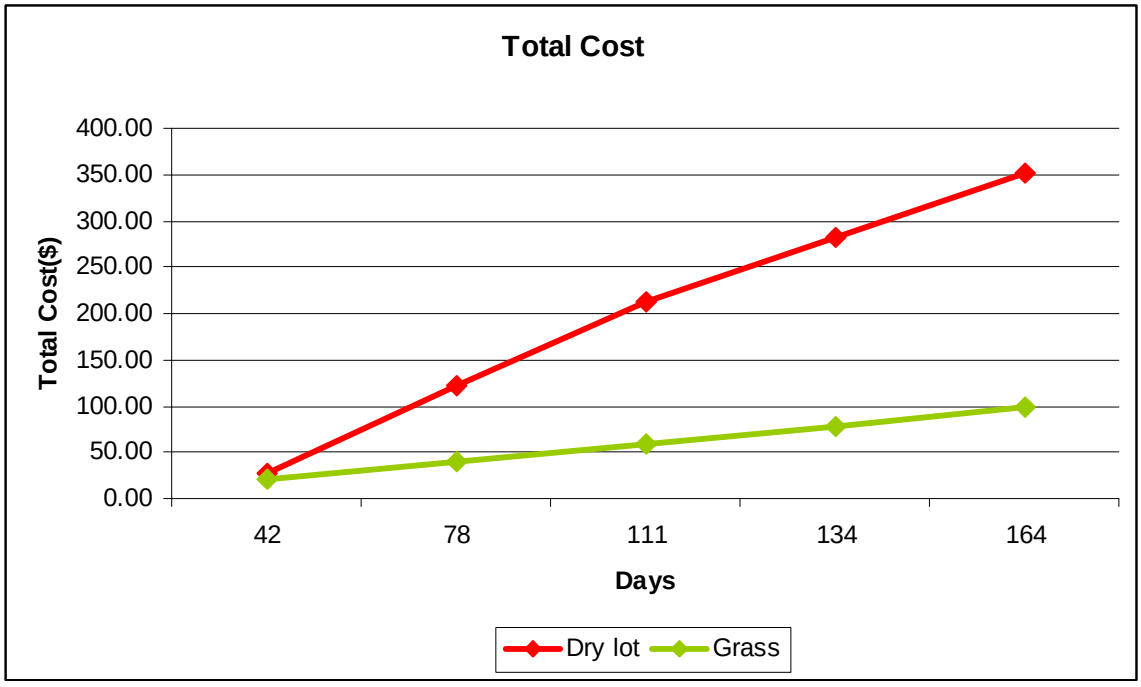
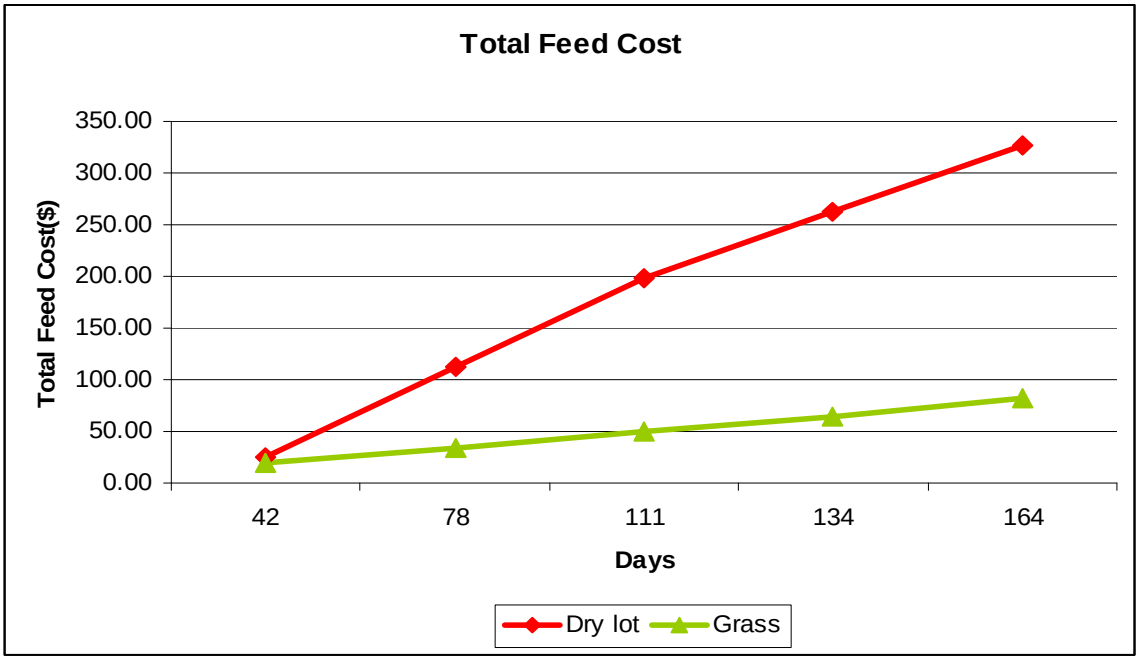
APPENDICES



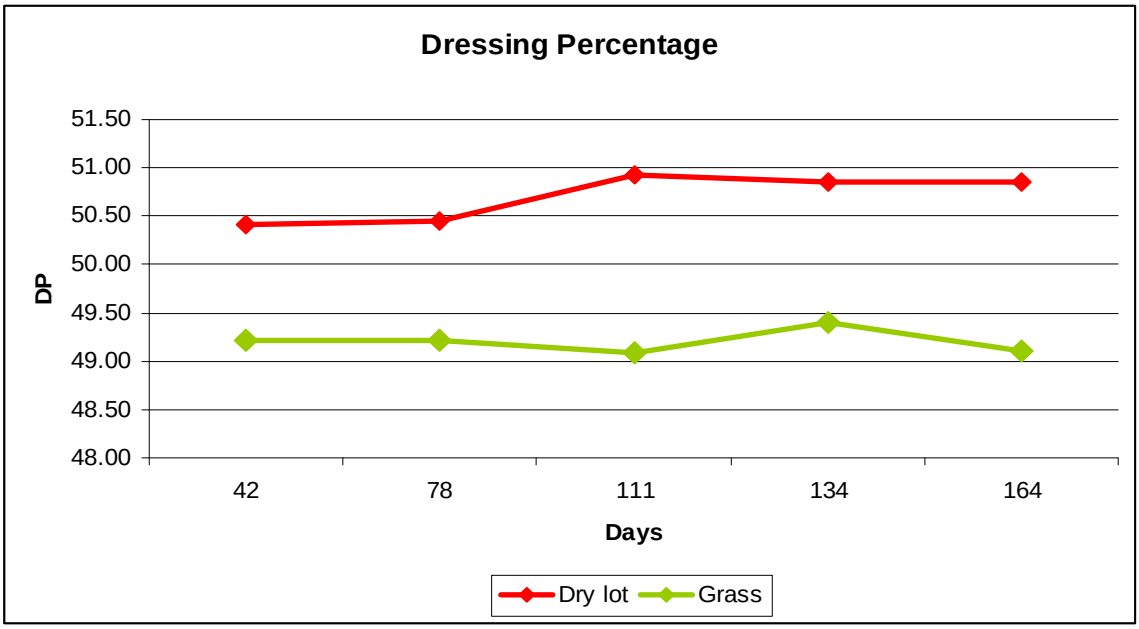
Appendix Figure 1. Total gain for cow at each feeding interval for both treatments



Appendix Figure 2. Average total cost per cow at each feeding interval for both treatments



Appendix Figure 3. Average total feed cost per cow at each feeding interval for both treatments



Appendix Figure 4. Average estimates dressing percentage at each feeding interval for both treatments

Appendix Table 1. Method of covariance structure selection for ADG

	VC	CS	AR(1)	ARH(1)	CHS	UN	CHS vs. UN
AIC	621.4	441.6	393.3	247.2	242.3	205.1	
AICC	621.5	441.7	393.4	247.6	242.7	207.4	
BIC	623.3	445.3	397.6	258.5	253.5	233.2	
LRT chisquare value	0	181.1	230.1	384.2	389.1	444.3	55.2
LRTDF	0	1	1	5	5	14	9
LRTP	1	1.9E-41	5.7E-52	7.54E-81	6.63E-82	5.7E-86	11.1156E-08
-2ResLogLikelihood	619.4	437.6	389.3	235.2	230.3	175.1	
Number of parameters	1	2	2	6	6	15	

VC=variance components, CS=compound symmetry, AR (1) =autoregressive, ARH (1)= heterogeneous autoregressive, CHS=heterogeneous compound symmetry, UN=unstructured

Appendix Table 2. Method of covariance structure selection for Net returns

	VC	CS	AR(1)	ARH(1)	CHS	UN	AR(1) vs. UN
AIC	2549.0	2550.5	2543.3	2489.9	2496.4	2484.8	
AICC	2549.1	2550.6	2543.4	2490.3	2496.8	2487	
BIC	2550.9	2554.3	2547.1	2501.1	2507.6	2512.9	
LRT chisquare value		0.5	7.7	69.1	62.6	92.2	23.1
LRTDF	0	1	1	5	5	14	9
LRTP		0.4795	0.005522	1.5477E-13	3.52E-12	1.45E-13	0.0059
-2ResLogLikelihood	2547	2546.5	2539.3	2477.9	2484.4	2454.8	
Number of parameters	1	2	2	6	6	15	

VC=variance components, CS=compound symmetry, AR (1) =autoregressive, ARH (1) =heterogeneous autoregressive, CHS=heterogeneous compound symmetry, UN=unstructured

VITA

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Scope and Method of Study: Randomized complete block design with repeated measures was used to determine management production systems and timing strategies of cull cows, by comparing average daily gain, net returns, at feed cost per gain of grass and dry lot over 42, 78, 111, 134, and 164 days.

Findings and Conclusions: Two management systems and five timing alternatives for cull cows were compared. Data were measured at intervals for cull cows on grass vs. in dry lot from October 2007 to April 2008. Cows in both treatments gained weight initially (42 days) but average daily gain declined following the first 42 days and cost of gain generally increased for longer feeding periods (78, 111, 134, and 164 days). Overall, net returns for grass-fed cows exceeded those for dry lot cows for each period. Regression results revealed average daily gain positively affected net returns while beginning weight and feed cost per gain were inversely related to net returns. Sensitivity analysis for grass fed cows indicated that net returns would be positive even at high feeding costs as long as prices adjusted to seasonal patterns. Net returns would be more positive when market prices were seasonally high and feed costs were low. Sensitivity analysis for dry lot showed that net returns would be positive when market price was unseasonally high, but net returns would be negative for nearly all others combinations of prices and feed costs.

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