ECONOMIC DIFFERENCES AMONG BEEF PRODUCTION SYSTEMS OF THE NEBRASKA SANDHILLS

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Introduction

The profit difference among various beef production systems is a topic of great interest. With increasing feed cost and volatile markets, increased emphasis is placed on efficiency and the adoption of non-traditional production and marketing methods.

Systems research provides an excellent vehicle to investigate these questions and to identify the interactions among the many variables that make up the system. Questions such as selling calves at alternative stages of development, using alternative calving seasons and forage sources, and varying cow size are addressed using biological and economic factors in a complete system. The interaction of these variables potentially affects profitability in one of three ways, either as a change in cost, a change in revenue or both. These changes in cost and/or revenue result from a shift in resource use and/or adjustment in prices of inputs or product.

Relative to studies on beef cattle profitability few studies have been done to investigate it from a system perspective. Of these studies such as Bryant *et al.* (2011), Williams and Stockton (2010), Ramsey *et al.* (2005), McDonald and Schroder (2003), Marsh and Feuz (2002), DiCostanzo and Meiske (1994), and   Mintert *et al.* (1993) are focused on a specific aspect of the system. This research however focuses on the overall system effects on profitability making it unique. Profitability of nine unique production systems in Nebraska Sandhills are identified and compared. Based on the nine production systems, profitability of 37 production subsystems is ranked.

Data

Cow-calf Production Data

Four years of cow-calf production data collected at the Gudmundsen Sandhills Laboratory (GSL) Whitman, NE are used in this analysis. Cows were assigned to one of five treatment groups: Treatments 1 & 2 - March calving cows wintered on native range or corn residue, Treatments 3 & 4- June calving cows wintered on native range or corn residue, and Treatments 5 - August calving cows wintered on corn stalk residue. Steers born in March entered the feedlot as calf-feds only. Heifers born in March were retained at GSL and developed as replacement animals for all treatment groups. Steers and heifers born in June and August were assigned randomly to 1 of 2 post weaning management system treatments: 1) to enter the feedlot as calf-feds immediately after the 30 day preconditioning period or, 2) enter the feedlot as yearling calves after grazing cool season grass dominated meadow for the summer grazing season. Cows were assigned to their respective calving date and wintering treatment for at least one year before data collection commenced.

Economic Data

Historical prices (from 2002 to 2011) for the production inputs and outputs were collected from various sources as listed in Table 1. The 10 year price and cost information along with the production data from GSL were used to estimate profit by assigning the costs and returns for each of the 787 cows for the 2002 to 2011 year period. Based on the individual costs and returns, net returns for each cow for each of the 10 years were calculated providing 7870 individual observations. Using nine different profit end points economic analysis appropriate with panel data was performed providing nine regression equations which were adjusted for the effect of interrelationships among cow size, age and calf size. The detail information on cost and return calculation is skipped here because of space consideration. This information is available from authors on request.

Finished animals were valued in two ways: 1) as live slaughter cattle, and 2) as grid price carcasses. The grid pricing scheme uses premiums and discounts based on the quality grades, yield grades and the weight of the hot carcass.

Net returns were for the nine economic scenarios which included different combinations of calf ownership (raised vs. purchased) and destination market (live vs. grid). Returns for three different marketing options were included: 1) sale of weaned calves- weaned calve sold at the time of weaning, 2) sale of yearlings - at end of the summer grazing calves were either retained at weaning or purchased at weaning and sold as yearling cattle (for June and August calving systems only), and 3) sale of slaughter cattle- calves that were retained or purchased as weaned calves and purchased yearling and sold as live slaughter or grid priced cattle.

Model

The data was analyzed using Shazam Standard Edition econometric package. The nine different production systems are listed in the heading section of Table 5. The general specification for each of the nine models is represented in equation 1.

(1) Net Return$_i$ *= f(production year, marketing year, calving season, weaning age, birth weight, weaning weight, average cow weight, cow age, stalks, steers, calf-fed)*

Where i = 1 to 9 different scenario net returns

The independent variables production years, marketing years, calving season, stalks, steers, calf-fed are all state or quality characteristics measures and are used as indicator variables in the estimation process. Production year represents the year in which the calf was born accounting for the four different production years. Marketing year does the same for cost and revenue for the 10 years from 2002 to 2011. Calving seasons represent the three seasons (March, June or August) calves were born. The stalks variable indicates whether cows were wintered on corn stalk residue or natural range. Steers is an indication of calf gender, calf-fed identifies the type of feeding regime calves were subject to as they were matured and were prepared for harvest. The remaining variables in the models: 1) average cow weight, the average annual weight of the dam over three different stages of production, 2) cow age, age of the dam in years at the birth of the calf, 3) birth weight and weaning weight, the recorded weights of the calves at the birth and weaning, and 4) weaning age, age in days of calves at the time of weaning.

The raw estimates of model (1) represent the *ceteris paribus* condition where the coefficient estimates on the independent variables are interpreted as the effect when all other variables are held constant. Under this condition coefficient estimate do not account for interrelationships among the variables. Such as in the case of cow weight, where birth weight and weaning weight cannot be expected to remain unchanged as cow weight is varied. To leave this unadjusted would ignore the effect that cow size and/or age have on calf size. Similarly, weaning age is known to affect calf weaning weight which is by design is different for each of the three calving seasons. Since the coefficient estimates of model (1) fail to reflect these facts a method was devised to capture the true effect of the independent variables on the dependent variables. This was accomplished by specifying the interrelationships among the dependent variables and incorporating them into the model (1) estimates. A series of three auxiliary regressions models (2)-(4) are used to identify the nature of the appropriate relationships.

(2) Weaning age = f(production year, calving season, cow age)

(3) Birth weight = f(production year, calving season, average cow weight, cow age)

(4) Weaning weight = f(production year, calving season, weaning age, birth weight, average cow weight, cow age, steers, stalks)

This issue is similar as in a simultaneous equations problem. In this case, however, there is a one way dependency, the secondary models, (2)-(4), are independent of the primary model, (1) making it possible to do the regressions separately using single stage ordinary least squares. Therefore, the true effects of the dependent variables on the independent variables are captured by combing the estimates from both the primary and auxiliary regressions.

By including the possibility of combination of nine production systems in terms of calving seasons, winter treatments for cows, and feed lot treatment of calves resulted in 37 unique production subsystems (Table 7 and Table 8[1]). The ranking of the returns from subsystems is done using a stochastic computer simulation described in the following sections

Creation of the stochastic cow herd and stochastic returns

A cow herd consisting of hundred cows representing an average herd at GSL was created. Cows were varied by age and size. Ages ranged from 2 to 12 years old, with correlated sizes ranging from 362.87 kg (800 lbs) to 748.42 kg (1650 lbs). Truncated normal distributions of cows by age and weights of different ages were created. These distributions were used to create a herd of 100 cows with the appropriate age composition. From this simulated cow herd a single cow was randomly drawn. This individual cow was used in each of the 37 subsystems for randomly selected production and market year to establish an individual animal net return. This process was repeated 5000 times providing the net returns to map a cumulative distributions function (cdf) of a subsystem and to represent the variation of net returns expected in a beef cow herd. Additionally descriptive statistics on the mean returns were reported and compared.

[1] The name index used in naming the 37 production system is presented in Table 8.

The subsystems were ranked based on net returns using both the mean and a cdf. Three different types of representative herds were ranked for all 37 systems, an average sized (AW) herd, a herd with disproportionate number of light weight (LW) cows, and a herd with extra heavy weight cows (HW)[2]. The simulation was constructed and carried out using Microsoft Excel with the add-on Simetar 2011.

Results

Results on weaning age, birth weight, and weaning weight

Table 3 shows the three auxiliary or secondary regressions results for weaning age, birth weight, and weaning weight. Weaning age was significantly affected by all production years, calving seasons, and cow age. Production year 1, fall calving season, calf gender, cow weight, and cow age were significant in determining calf birth weight. Weaning weight was significantly affected by production years, calving seasons, weaning age, calf gender, calf birth weight, cow weight, and cow age. The estimates from Table 3 were used to adjust the estimates on the net returns from nine production systems.

Results on nine production systems

The regression results for each of the production system are presented in Table 5. Tables 4 and 6 summarize all of the variables as they relate to profit by treatment groups. Table 2 provides definition of variables.

Production Year

The effect of production year on the profit from the various scenarios exhibited a clear pattern among terminally sold slaughter animals, for best and worst years (scenarios 4 thru 9). Year 2

[2] The average weight of the average, light and heavy cow categories varies with the cow age. For example in this paper 485.70 kg (1070.8 lbs), 430.91 kg (950 lbs), and 589.66 kg (1300 lbs) are assumed as the weight of 2 years old normal, light, and heavy weight cows.

and 3 were reversed in order for scenarios 8 and 9. Yearlings performed better in year 3 than in year 2. Animals sold in the fat cattle markets; scenarios 4 thru 9 had a much larger contribution to profit (Table 5).

Scenarios where animals were sold in intermediate markets, scenarios 1 thru 3, showed dissimilar rankings. In the case where weaned cattle were sold, scenario 1, production year 3 ranked the best followed in descending order by years 4, 1, and 2. In the case where yearling cattle were raised and sold, scenario 2, no production year was statistically different than the base production year making them equally ranked. In the case where cattle were bought as weaned calves and sold as yearling calves, scenario 3, production year 2 was ranked highest with all other ranks being equally ranked (Table 6). The rankings of all the scenarios where weaned calves (purchased or raised) were sold as slaughter cattle in the terminal markets were identical in order, production year 1 added the most to profit followed by 2, 3 and year 4 (Table 6).

Market Year

Terminally marketed animals versus those marketed as weaned or yearling animals enjoy their highest contribution to profits during different marketing years. Table 4 shows that the 2011 year contributed the most to the profit for weaned or raised yearling animals while the year 2003 was the highest for almost all the terminally marketed animals except for scenario 7, which occurred in 2005 as followed by the 2003 year. The distinction in ranks among fed cattle and growing cattle disappeared for the year that contributed least to profit. All the scenarios except scenario 2, shared 2009 as the year with the least net returns. Scenarios where animals were raised had a larger variation among profit contributions from market years than those that were purchased (Table 5). Variation in profit contribution for live slaughter animals was greater than those sold on the grid. These variations relate to the riskiness inherent in the various scenarios, and may be part of the explanation why cow-calf producers are reluctant to retain ownership.

Calving Season Treatment

Out of nine scenarios, only two scenarios; scenario 1 and 6 had a significant calving season treatment. This indicates that calving season treatment does not play a significant role in the profitability of most of the production systems. In both scenarios summer calving was ranked first and spring calving ranked last. Fall calving was ranked at par with spring for scenario 1 and ranked second for scenario 6 (Table 6).

Weaning Age, Birth Weight, and Weaning Weight

Weaning age of the calf had a positive effect when animals are raised (scenarios 1, 3, 6, and 7) but did not contribute significantly to returns on purchased animals and resold animals (scenario 2, 4, 5, 8, and 9, Table 6). This result supports the idea of an efficient market. The value of calves' physical performance is captured by the first seller. In the case of raised fat cattle scenario 6, the contribution of weaning age to return was greater for live animals than those marketed on a grid price system (Table 5). The fact that older animals sold on a grid are likely to be heavier at slaughter and are therefore more likely to receive a discount for heavier weights may be part of this difference.

Birth weight results differ from weaning age with the addition of scenario 4 and 5 as being statistically significant. These two scenarios add those calves purchased at weaning and sold as fat cattle. Comparing contribution of birth weight on the returns from raised fat cattle (scenario 6 and 7, Table 5) to the contribution from the purchased fat cattle (scenario 4 and 5, Table 5) reveals that the contribution from raised animals is higher than the purchased animal. Birth weight contributes less when fat cattle are marketed on a grid compared to live animals.

Knowing that birth weight is a known predictor of mature size provides part of the explanation of why the purchase of weaned animals sold as fat cattle becomes statistically significant.

As expected the weaning weight has a positive contribution when animals are raised as exhibited in scenario 1, 3, 6, and 7 (Table 6). Animals had a negative contribution when animals are purchased as shown by scenarios 2 and 5 with scenario 4 being statistically insignificant (Table 6). This result is a reflection of market information differences among the three variables, weaning age and birth weight are not directly observed at the time of sale whereas weaning weights are. Similar to results on weaning age and birth weight, weaning weight contributes less to returns when fat cattle are marketed under a grid price system. (Scenario 6 and 7, Table 5)

Cow Weight

Cow weight minimizes returns in five scenarios all of which were estimated to be quadratic making it possible to take first and second derivatives. In two case cow weight maximizes returns and was found to be increasing with cow weight. The remaining thwo scenarios cow weight was not found to have a statistical effect on returns (Tables 5 and 6). In scenario1 and 3 calves raised and sold as weaned or yearlings calves born to light weight cows were preferred. Returns were minimized by 601 kg (1325 lbs) and 575 kg (1267 lbs) cows respectively. These are relatively heavy cows when compared to the 549 kg (1210 lbs) average for the herd. Contrastingly, the returns for those sold as live fat cattle (scenario 4, 6, and 8) were minimized for light weight cows giving the advantage in returns to the relatively heaviest cows. Scenario 9, where purchased yearlings are sold as fat cattle, returns were minimized at a cow weight of 547 kg (1206 lbs), about 2 kg less than the average weight. This indicates that both light and/or heavy weight cows are preferred to average cows (Table 6).

Cow Age

Of the nine base scenarios six found cow age to have a statistically significant effect on returns. Purchased weaned calves and yearlings marketed as fat cattle on the grid (scenarios 5 and 7, Table 6) maximized returns with older cows ages of 8.1 and 12 years or greater respectively, Scenarios where calves were marketed as live slaughter animals (scenarios 4 and 6, Table 6) maximized returns with young cow ages of less than 3 and 4.4 years respectively. Net returns for the sale of weaned calves (scenario1) were maximized with cows of 5.1 years of age. Raised yearling calves (scenario 3) maximized returns with aged cows 12 or more years of age. In the remaining scenarios 2, 8, and 9, cow age was not significant in contributing to returns. These scenarios sold purchased weaned calves as yearlings (scenario 2) and purchased yearlings as fat cattle (scenario 8 and 9).

Winter Grazing Treatment and Gender Effect

Winter corn stalk grazing and gender had similar effects on returns. Winter corn stalk grazed animals and the steer had positive effect on returns compared to winter ranged animals and heifers when animals are raised (scenario 1, 3, 6, and 7, Table 6). For purchased animals, there is no difference between winter grazing and gender treatments (scenario 2, 4, 5, 8, and 9, Table 6). Any cost savings or gender difference carried forward, when the animals are purchased for resale is captured by the seller. In the case of winter grazing it is helpful to remember that only summer and fall cattle were raised for yearlings and only the summer season calving groups were pastured on both winter range and corn stalk residue. This makes these results only relevant to summer born calves.

Feedlot Treatment

The finishing phase of production had calves start the process as either a weaned calf, calf-fed, or as a yearling animal. Given this fact only scenarios which included both treatments were analyzed (scenarios 4 thru 7 (Table 6). Feedlot treatments were not found to be statistically significant in explaining returns in any of the relevant scenarios.

Results on System Rankings

The nine base scenarios results provided the information to create simulations of returns for 37 unique production subsystems.

Ranking based on mean returns

The mean net returns for the 37 subsystems (Table 9) indicate that the rankings within the AW and LW herds are identical. Subsystem SuM3SY [3]has the highest average returns followed by the SuM6S and FaM3SY for these two herd categories. However, HW cows are ranked differently with the SuM6S subsystem switching with SuM3SY for the highest rank followed by FaM3SY as is the case for the other two herds.

Mean returns are generally higher for subsystems which included summer born calves, calves raised and sold as yearlings and cows winter grazed on corn stalks residue over other systems. Unfortunately spring born yearlings were not part of the original study making it impossible to rank this system.

Ranking based on cumulative distribution of returns

Figure 1 provides the cdf plots of net returns for the three representative herds. The vertical axis of the cdf graphic provides a cumulative probability value while the horizontal axis measures net return in $/head. The figures present returns from only those subsystems where the probability of positive returns is greater than or equal to 90 %. This implies that those systems with more than

[3] See Table 7 and Table 8 for the detail nomenclature of the systems

10 % probability of earning negative returns are not pictured in the figures. For all herds, seven subsystems are shown. The cdf plots look similar for all three representative herds with six subsystems; SuM6S, SuM3SY, FaM3SY, FaM2SY, SuM2SY, and SuM2RY having less than 5 % probability of earning negative returns. Among the six subsystems FaM2SY, SuM2SY, and SuM2RY have considerably less variability with earning ranges from about $69-$255/head, $77-$265/head, and $64-$240/head for the AW, LW, and HW herds respectively. The most variable subsystems with less than 5 % probability of negative returns for all three types of herd are the SuM6S, SuM3SY, and FaM3SY. These three subsystems among those illustrated have the highest net return potential but relatively more variability. The returns in case of SuM6S, SuM3SY, and FaM3SY range from about -$117 to $529/head, -$102 to $519/head, and -$90 to $555/head for AW, LW, and HW herds respectively. The LW herd has the smallest range followed by almost equal range for the AW and HW cows.

Ranking of the systems based on the cdf plots can be done using two criterions – 1) potential of higher earnings and 2) variability of returns i.e. exposure to downward return risk. Stochastic Dominance with Respect to a Function (SDRF) technique takes accounts of above criterion including the risk aversion of an individual to rank the dominance of cdf plots. SDRF ranking for a range of risk aversion coefficient (0.001 to 0.003) was done for systems SuM6S, SuM3SY, and FaM3SY in Simetar 2011. SuM3SY is the highest ranked for AW herd followed by SuM6S and FaM3SY. Additionally the subsystem SuM3SY is the highest ranked for LW herds, followed by the FaM3SY and SuM6S respectively. In case of HW herds, the ranking switches at the first place compared the other herd weights with SuM6S the most preferred followed by SuM3SY and FaM3SY.

Conclusion

Production years have varying degrees of effect on different production systems, with less variation observed for those systems that conclude prior to an animal's entry into the feedlot for finishing. Economics varies widely across the marketing years as well. Among nine base scenarios, summer calving season is most profitable most of the time, followed by the fall season. Weaning age, birth, and weaning weight as expected generally make a positive contribution to profit when animals are raised. Grid marketing tends to reduce the positive effect of these three variables on profit. Lighter weight of dams are preferable for the weaned calves and yearling sale while for terminal fed cattle market heavy weight dams are preferable. Increased profits for live fed cattle are for younger cows while grid marketing scenarios favor older cows. Corn stalk residue grazing adds more to returns over natural winter range grazing for raised systems. Steers generally contribute more to returns than heifer when animals are raised. Surprisingly, feedlot treatments are not significant in affecting contribution to profits.

Ranking of the 37 Nebraska Sandhills beef production subsystems based on mean returns and the SDRF provide a consistent highest ranking for AW and LW herds. For these two herds, on average, SuM3SY i.e. selling raised yearlings born in the summer with the use of winter grazed corn stalk residue is single most profitable system and at least the second most profitable for all three types of herds. SuM6S i.e. raised calves born in the summer and sold as fat cattle is more profitable than any other subsystem for HW herd. Selling raised yearlings or fat cattle dominated all three herd types and calving seasons. It is important to remember that the results presented here are indicative of a given set of physical conditions framed in a historical economic time frame relevant to a location. Given these conditions are common across a wide area it is expected to have some general application.

Table 1: Data and the Sources

Data	Source
Calf prices	Livestock Information Marketing Service (LMIC) spread sheets (www.lmic.info)
Live slaughter cow prices	Livestock Information Marketing Service (LMIC) spread sheets (www.lmic.info)
Cull cow prices	Compiled from Livestock Market News, AMS-USDA (www. ams.usda.gov)
Bred cow prices	CattleFax, CO (www.cattlefax.com)
Grazing prices	Jonson, B., S. V. NewKirk, and T. Rosener. “2010-2011 Nebraska Farm Real Estate Market Highlights.” Department of Ag. Economics, University of Nebraska-Lincoln (http://agecon.unl.edu/)
Hay prices	National Agricultural Statistics Survey (NASS) data (www. nass.usda.gov)
Corn stalk grazing prices	Dawson county survey data
DDG prices	Livestock Information Marketing Service (LMIC) spread sheets (www.lmic.info)
Prime rates	Federal Reserve (www.federalreserve.gov)
Gasoline prices	U.S. Energy Information Administration (www.eia.gov)
Carcass premiums and discounts	Livestock Information Marketing Service (LMIC) spread sheets (www.lmic.info)
Feedlot cost	Animal Science Department, Kansas State University (http://www.asi.ksu.edu/p.aspx?tabid=302)

Table 2: Variable Definitions

Variable name	Definitions	Variable name	Definitions
PYR1	Production year 1	FALL	Fall calving
PYR2	Production year 2	SPRING	Spring calving
PYR3	Production year 3	WAGE	Weaning age
Y2	Marketing year 2002	BWT	Birth weight
Y3	Marketing year 2003	WWT	Weaning weight
Y4	Marketing year 2004	CW	Cow weight
Y5	Marketing year 2005	CW2	Cow weight squared
Y6	Marketing year 2006	CAGE	Cow age
Y7	Marketing year 2007	CAGE2	Cow age squared
Y8	Marketing year 2008	STALKS	Corn stalk grazing
Y9	Marketing year 2009	STEERS	Steers
Y10	Marketing year 2010	CONSTANT	Model intercept

Table 3: Regression Estimates on Birth weight, Weaning Weight, and Weaning Age

Variable	Weaning Age Coefficient Estimates and (P-values)	Birth Weight Coefficient Estimates and (P-values)	Weaning Weight Coefficient Estimates and (P-values)
PYR1	-10.26 (0.00)	1.75 (0.00)	-13.92 (0.00)
PYR2	-10.91 (0.00)		-15.89 (0.00)
PYR3	-16.55 (0.00)		-13.88 (0.00)
FALL	-51.22 (0.00)	-0.94(0.04)	-24.96 (0.00)
SPRING	-87.73 (0.00)		-12.65 (0.00)
WAGE			0.65 (0.00)
STEERS		2.72 (0.00)	14.41 (0.00)
BWT			1.73 (0.00)
CW		0.0146 (0.00)	
CW2			0.0000649 (0.00)
Cage		0.27 (0.01)	*4.22 (0.07)
Cage2	-0.09 (0.00)		-0.39 (0.04)
STALKS			-3.76 (0.03)
CONSTANT	339.13 (0.00)	26.64 (0.00)	215.68 (0.00)

*Statistical significance at the 10% level. If this variable is dropped from the model cow age is not part of the model. It was expected that there is some relationship between cow age and weaning age, it was therefore left in the model

Table 4: Market Year Rankings, From the Most Profitable to the Least Profitable

Market Year Ranked by Contribution to Profit	Sell Raised Weaned Calves Scen. 1	Purchase Weaned Calves, Sell as Yearlings Scen. 2	Sell Raised Yearlings Scen. 3	Purchase Weaned Calves, Sell as Slaughter Cattle		Sell Raised Slaughter Cattle		Purchase Yearlings, Sell as Slaughter Cattle	
				Live Scen. 4	Grid Scen. 5	Live Scen. 6	Grid Scen. 7	Live Scen. 8	Grid Scen. 9
1st	Y11	Y5	Y11	Y3	Y3	Y3	Y5	Y3	Y3
2nd	Y5	Y11	Y5	Y5	Y5	Y5	Y3	Y6	Y2
3rd	Y4	Y6	Y4	Y4	Y2	Y4	Y4	Y2	Y6
4th	Y6	Y4	Y6	Y2	Y4	Y6	Y11	Y8	Y8
5th	Y3	Y10	Y10	Y6	Y10	Y11	Y10	Y7	Y5
6th	Y10	Y7	Y3	Y10	Y6	Y10	Y2	Y5	Y7
7th	Y7	Y3	Y7	Y7	Y7	Y2	Y6	Y4	Y4
8th	Y2	Y8	Y2	Y11	Y11	Y7	Y7	Y11	Y11
9th	Y8	Y9	Y8	Y8	Y8	Y8	Y8	Y10	Y10
10th	Y9	Y2	Y9	Y9	Y9	Y9	Y9	Y9	Y9

Table 5: Complete Listing of All Nine Scenarios and the Final Adjusted Coefficient Estimates and Their Statistical Significance

Variables	Scenario 1 Coefficient Estimates (P-values)	Scenario 2 Coefficient Estimates (P-values)	Scenario 3 Coefficient Estimates (P-values)	Scenario 4 Coefficient Estimates (P-values)	Scenario 5 Coefficient Estimates (P-values)	Scenario 6 Coefficient Estimates (P-values)	Scenario 7 Coefficient Estimates (P-values)	Scenario 8 Coefficient Estimates (P-values)	Scenario 9 Coefficient Estimates (P-values)
PYR1	-20.22 (0.00)			126.08 (0.00)	130.94 (0.00)	96.50 (0.00)	110.92 (0.00)	138.68 (0.00)	150.62 (0.00)
PYR2	-23.20 (0.00)		18.70 (0.00)	75.32 (0.00)	92.08 (0.00)	45.06 (0.00)	70.88 (0.00)	59.62 (0.00)	67.95 (0.00)
PYR3	-15.41 (0.01)		-12.62 (0.09)	42.63 (0.00)	41.34 (0.00)	21.07 (0.00)	21.53 (0.00)	85.29 (0.00)	71.69 (0.00)
Y2	-137.47 (0.00)	-88.44 (0.00)	-238.08 (0.00)	101.85 (0.00)	118.01 (0.00)	-41.01 (0.00)	-26.30 (0.00)	165.14 (0.00)	159.82 (0.00)
Y3	-77.37 (0.00)	-62.77 (0.00)	-143.55 (0.00)	209.98 (0.00)	194.36 (0.00)	129.54 (0.00)	113.91 (0.00)	185.93 (0.00)	175.24 (0.00)
Y4	-47.81 (0.00)	-32.20 (0.00)	-79.88 (0.00)	109.45 (0.00)	113.71 (0.00)	60.75 (0.00)	65.01 (0.00)	56.88 (0.00)	37.78 (0.00)
Y5	-16.92 (0.00)	0.49 (0.00)	-18.00 (0.00)	132.72 (0.00)	138.69 (0.00)	114.70 (0.00)	120.67 (0.00)	76.68 (0.00)	67.46 (0.00)
Y6	-68.56 (0.00)	-19.51 (0.00)	-91.22 (0.00)	92.80 (0.00)	43.87 (0.00)	22.27 (0.00)	-26.67 (0.01)	168.70 (0.00)	120.73 (0.00)
Y7	-136.43 (0.00)	-46.82 (0.00)	-181.26 (0.00)	57.45 (0.00)	37.34 (0.00)	-79.36 (0.00)	-99.47 (0.00)	101.12 (0.00)	42.98 (0.00)
Y8	-183.48 (0.00)	-77.10 (0.00)	-275.22 (0.00)	-12.76 (0.00)	-6.57 (0.58)	-203.47 (0.00)	-197.29 (0.00)	132.01 (0.00)	107.93 (0.00)
Y9	-188.53 (0.00)	-81.37 (0.00)	-281.43 (0.00)	-39.84 (0.00)	-28.62 (0.00)	-234.56 (0.00)	-223.34 (0.00)	-37.32 (0.00)	-54.85 (0.00)
Y10	-77.41 (0.00)	-36.65 (0.00)	-120.29 (0.00)	67.96 (0.00)	76.30 (0.00)	-12.84 (0.11)	-4.50 (0.00)	-8.72 (0.33)	-10.84 (0.00)
FALL						-47.57 (0.00)			
SPRING	-100.27 (0.00)					-142.09 (0.06)			
WAGE	0.76 (0.00)		0.52(0.10)			1.80 (0.00)	1.42 (0.00)		
BWT	2.90 (0.00)		2.97(0.09)	3.85 (0.00)	2.71 (0.00)	7.28 (0.00)	5.56 (0.00)		
WWT	1.75 (0.00)	-0.95 (0.04)	1.04(0.21)		-0.53 (0.00)	1.60 (0.00)	0.91 (0.00)		
CW	-1.28 (0.00)		-0.99(0.00)	0.35 (0.04)		-1.79 (0.00)		-2.58 (0.01)	-2.12 (0.01)
CW2	0.00107 (0.00)		0.00086(0.02)		0.000064 (0.00)	0.0017 (0.00)		0.0024 (0.00)	0.0019 (0.00)
CAGE	5.51 (0.00)		5.09(0.17)		6.70 (0.04)	9.94 (0.00)	5.57 (0.00)		
CAGE2	-0.54 (0.00)			-0.25 (0.01)	-0.42 (0.05)	-1.12 (0.00)			
STALKS	54.65 (0.02)		145.58(0.03)			83.28 (0.00)	103.64 (0.00)		
STEERS	67.28 (0.00)		65.40 (0.00)			77.46 (0.00)	48.52 (0.00)		
CALFFED									
CONST	441.92 (0.00)	228.61 (0.00)	477.63 (0.00)	-405.63 (0.00)	-300.45 (0.00)	303.48 (0.00)	-246.5624 (0.0)	298.91 (0.35)	158.76 (0.57)

Table 6: Desirable Traits to Maximize Profits under the Different Production Systems

Desirable Traits by Group	Sell Raised Weaned Calves	Purchase Weaned Calves, Sell as Yearlings	Sell Raised Yearlings	Purchase Weaned Calves, Sell as Slaughter Cattle		Sell Raised Slaughter Cattle		Purchase Yearling Calves, Sell as Slaughter Cattle	
				Live	Grid	Live	Grid	Live	Grid
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
Production Year 1	3	1	2	1	1	1	1	1	1
Production Year 2	4	1	1	2	2	2	2	3	3
Production Year 3	1	1	2	3	3	3	3	2	2
Production Year 4	2	1	2	4	4	4	4	4	4
Fall	1	1	1	1	1	2	1	1	1
Spring	2	Not Modeled	Not Modeled	1	1	3	1	1	1
Summer	1	1	1	1	1	1	1	1	1
Weaning age	+	*NS	+	NS	NS	+	+	NS	NS
Birth weight	+	NS	+	+	+	+	+	NS	NS
Weaning weight	+	-	+	NS	-	+	+	NS	NS
Cow Weights									
@ Profit Max		NS		≥ 723.4 **	≥ 723.4 **		NS		
@ Profit Min	601	NS	575			519	NS	529	547
Cow Age									
@ Profit Max	5.1	NS	≥ 12 ****	≤ 3***	8.1	4.4	≥ 12 ****	NS	NS
@ Profit Min		NS						NS	NS
Corn Stalk grazing	+	NS	+	NS	NS	+	+	NS	NS
Range grazing		NS		NS	NS	NS	NS	NS	NS
Steers	+	NS	+	NS	NS	+	+	NS	NS
Heifers		NS		NS	NS			NS	NS
Calf-feds	Not Modeled	Not Modeled	Not Modeled	NS	NS	NS	NS	Not Modeled	Not Modeled
Yearlings				NS	NS	NS	NS		

*NS = Not statistically significant at 5% level of significance
**Returns increases linearly with cow weight, therefore, the maximum possible cow weight in the herd is optimal
*** Returns decreases by square of cow age, therefore, the minimum possible cow age in the herd gives the maximum return
**** Returns increases linearly with cow age, therefore, the maximum possible cow age in the herd is optimal

Table 7: List of Systems Used in Rankings

System No	System Name	System No	System Name
1	FaM1S	20	SuM2SY
2	FaM4S	21	SuM3SY
3	FaM6S	22	SuM8SY
4	FaM5S	23	SuM9SY
5	FaM7S	24	SpM1R
6	FaM2SY	25	SpM4RCF
7	FaM3SY	26	SpM6RCF
8	FaM8SY	27	SpM5RCF
9	FaM9SY	28	SPM7RCF
10	SpM1S	29	SuM1R
11	SpM4SCF	30	SuM4R
12	SpM6SCF	31	SuM6R
13	SpM5SCF	32	SuM5R
14	SPM7SCF	33	SuM7R
15	SuM1S	34	SuM2RY
16	SuM4S	35	SuM3RY
17	SuM6S	36	SuM8RY
18	SuM5S	37	SuM9RY
19	SuM7S		

Table 8: System Name Index

Initials	Index Name
Fa	Fall
Sp	Spring
Su	Summer
M#	Scenario #
M1	Sell Raised Weaned Calves
M2	Purchased Weaned Sell Yearlings
M3	Raised Sell Yearlings
M4	Purchase Weaned Sell Live
M5	Purchase Weaned Sell on a Grid
M6	Raised Sell Live
M7	Raised Sell on a Grid
M8	Purchase Yearlings Sell Live
M9	Purchase Yearlings Sell on a Grid
R	Winter Ranged
S	Corn Stalk Grazed
CF	Calf Fed
Y	Yearlings

Table 9: Systems Ranking on Mean Returns ($/head)

Rank	Normal Weight		Light Weight		Heavy Weight	
	System	Mean	System	Mean	System	Mean
1	SuM3SY	258.06	SuM3SY	265.28	SuM6S	269.51
2	SuM6S	247.74	SuM6S	251.04	SuM3SY	257.73
3	FaM3SY	238.61	FaM3SY	245.84	FaM3SY	238.29
4	FaM6S	203.17	FaM6S	206.47	FaM6S	224.95
5	FaM2SY	176.02	FaM2SY	182.21	SuM6R	186.23
6	SuM6R	164.46	SuM6R	167.76	FaM2SY	166.71
7	SuM2SY	152.29	SuM2SY	158.47	SuM2SY	142.98
8	SuM2RY	148.71	SuM2RY	154.89	SuM2RY	139.40
9	SuM3RY	112.47	SuM3RY	119.70	SpM6SCF	127.43
10	SpM6SCF	105.64	SpM6SCF	108.95	SuM3RY	112.14

Fig 1: CDF Approximation of Returns

Fig 1 (a): CDF Approximations of Returns from Average Cows

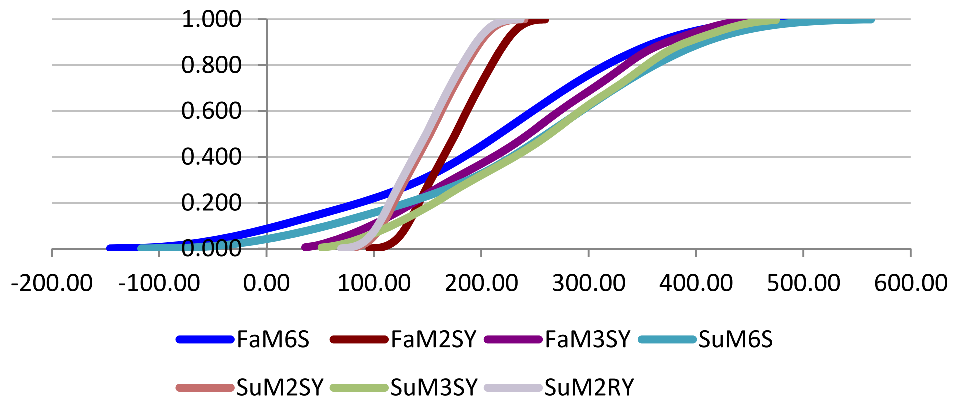


Fig 1(b): CDF Approximations of Returns from Light Weight Cows

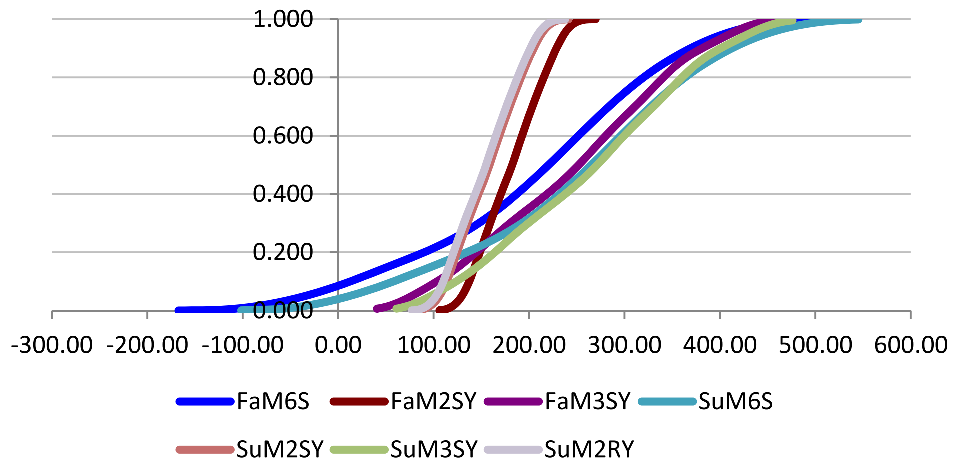
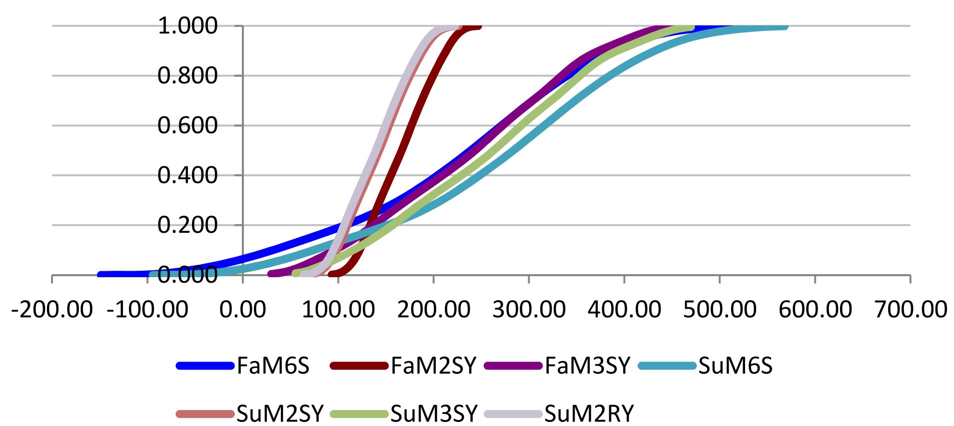


Fig 1(c): CDF Approximations of Returns from Heavy Weight Cows



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