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Contract Grazing on Winter Annuals: Risks and Returns for Cattle Owners

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Contract Grazing on Winter Annuals: Risks and Returns for Cattle Owners

Abstract

Critical factors affecting risk and profitability for cattle owners under contract grazing include cattle weight at purchase and time spent on pasture and feedlot. Buying lighter animals and placing them in pastures before sending them to feedlot is the most profitable as well as least risky option. Even in the least risky scenario, the cattle owner would still incur losses 28% of the times. The results also show a possibility that at contract-grazing rates of $0.41 per pound of gain or more, the cattle owner would place cattle directly on the feedlot, bypassing the pasture.

Introduction

Traditionally, stocker production has been an integrated operation. Producers breed calves, wean them and put them on a pasture. Calves graze on the pasture consuming feed high in roughage (e.g. oats, ryegrass, rye, millet) for 90-180 days. After that, they are given a concentrated feed (e.g. corn) for another 100-200 days based upon their weight till they are ready for slaughter.

Integrated operations are capital intensive. Johnson et al. (1987) reported the cost of back-grounding 200 steers on a 100 acre farm on ryegrass would be $50,000 for animal purchase and an additional $10,000 for forage production. Moreover, the operator has to take both production risk and price risk. Production risk arises as a result of variability in weight gain of cattle due to agronomic and climatic factors. Variability exists in both the purchase and selling prices of cattle due to market forces resulting in price risk. Cattle prices have always been volatile (Spreen and Arnade, 1984). The cattle owner has limited options for reducing price risks by opting for cattle futures or forward contracting (Harrison et al., 1996)

Since the mid-twentieth century, the use of grazing contracts in cattle production has become common in the cattle industry (Anderson et al., 2004). In this case, a pasture owner does not need to breed or purchase calves and incur heavy investments. Pasture owners could allow cattle owners to graze their animals on the pasture for a fee, which is usually in the form of a set amount per unit of weight gain. Thus, contract grazing provides a revenue-generating opportunity for those pasture owners whose cattle purchasing opportunity is limited (Zaragoza-Ramírez et al., 2008)

With the option to contract graze, we define two new categories of operators: a) pasture owners, who do not own any cattle and allow cattle owners to graze cattle on their pasture; and b) cattle owners, who own cattle but don't own any pasture. The cattle owners would purchase weaned calves and then contract with the pasture owner to add weight to them. Contract grazing presents an opportunity to the cattle owner to reduce fixed investment costs. Although being a cattle owner is less profitable than being an integrated operator (Anderson et al., 2004), it is advantageous in the form of less fixed capital requirements. The term "integrated operator" in this paper refers to an operator who owns both the cattle and the pasture.

Many previous studies in contract grazing have been forage studies comparing the risks and returns of a pasture owner to a cattle owner and/or integrated operator. Zaragoza-Ramírez et al., (2008) have suggested traditional cattle ownership to be more profitable than contract grazing assuming there are no investment limitations. Johnson et al. (1987) showed that an integrated cattle owner has larger profits than a non-integrated cattle owner, with only slightly higher levels of risk, whereas risk for the cattle owner is substantially higher than for the pasture owner. Most studies have shown that contract grazing presents lower risk to the pasture owner as compared to total ownership under an integrated program (Anderson et al., 2004; Harrison et al., 1996; Johnson et al., 1987). Little research has compared different strategies for cattle owners in terms of risk and returns.

The objective of this paper is to study the factors affecting risk and profitability for the cattle owner and to assess various options available for reducing risk. Critical decision factors for the cattle owner include the initial weight at which to buy the cattle, the duration for which they are kept in the pasture and the duration for which they are kept in the feedlot. Johnson et al. (1987) noted that weight gains in pasture vary from year to year whereas they are predictable in feedlots. We also examine the case where the cattle owner bypasses the pasture and places cattle directly on the feedlot.

Data

The data for cattle weight gain on pasture used in this study were collected from various field experiments (PRN# 2007-118) conducted over four years (2006-2009) at the Beef Cattle Unit of the Alabama Agricultural Experiment Station's E.V. Smith Research Center, Shorter, AL. For each year, weaned cattle were weighed and randomly placed on different paddocks on the pasture using a completely randomized design. The cattle grazed continuously throughout the grazing period and were weighed approximately every 28 days. A total of 854 cattle were studied over four years with an average starting weight of 530 lbs and an average ending weight of 790 lbs resulting in an average daily gain (ADG) of 2.6 lbs/day. The details of the forages, stocking rates, grazing days and treatment are shown in table 1.

Data from different experiments were used to represent one source of risk to the cattle owner. Under contract grazing, a cattle owner enters into a contract with a pasture owner to place cattle on pasture and then pays the pasture owner a fixed amount per pound of weight gain. The contract generally specifies pasture practices such as types of forages fed, stocking rates, additional feed/supplements given, implants and immunizations given. In reality, however, in spite of the contract, the pasture owner actually has complete control of pasture practices (Mcfarland, personal communication, 2009). Forages might vary year to year depending on choices of the pasture owner. The pasture owner would also control practices such as stocking rate or feeds/supplements. For example, in the case of a good forage crop, the pasture owner might skip the supplements or may increase the stocking rate. Similarly, if the crop is poor the pasture owner might provide additional supplements/implants if the cost of supplements/implants per pound of weight gain is less than the value of the additional gain.

In sum, although profits of both the pasture owner and cattle owner depend upon the weight gained by the cattle, only the pasture owner has control of the pasture practices. To reflect actual risk presented to the cattle owner, the data must be randomly collected over different years, using different forages with differences in pasture practices such as feeds/supplements, implants, and immunizations.

A feedlot presents a controlled environment for the cattle. At the feedlot, cattle are not affected by the amount or quality of forage. Year, weather and rainfall have little or no effect as cattle are fed a predetermined ration. For the feedlot, the cattle owner has complete control and can decide what is fed to the cattle. Most feedlots will provide details on an individual animal basis.

Data for the feedlot operations were obtained from the Alabama Pasture to Rail Program conducted by Alabama Cooperative Extension System (ACES) every year (ACES, 2011). This retained ownership program provides individual post-weaning growth, carcass and health information to cattle owners. Under this program, cattle owners consign cattle having an average weight between 600 and 850 lbs. The cattle are sent to Decatur County Feed Yard, Oberlin, KS. Upon arrival, cattle are fed starter ration and free choice hay. Cattle are managed on an individual basis rather than by the pen, which means feed and weight gain records of individual animals are maintained.

The cattle are sold upon reaching approximately 0.4 inch back fat. Cattle are sold individually based upon carcass characteristics to Cargill on a negotiated grid which is based on yield and quality grade (USDA yield grade 3 calves grading). Premiums and discounts are added to individual carcass data. The quality grade of cattle is determined by the quality of fat on the cattle. The variation in quality also presents a risk to the cattle owner.

The data contained starting weights, number of days on feedlot, expenses on feed, ending weight and gross revenue from sale of each animal. Data for a total of 489 cattle were collected over three years, 183 cattle for 2006, 86 cattle for 2007 and 220 cattle for 2008. The average starting weight was 660 lbs. Cattle gained an average of 606 lbs over 182 days resulting in an ADG of 3.29 lbs/day.

Cattle purchase price data for the state of Alabama were obtained from ACES publications (Prevatt and Todd, 1997; Prevatt et al., 2008). A total of 21 years of data (1986-1996 and 1998-2007) was used for four weight ranges; 400-500 lbs, 500-600 lbs, 600-700 lbs and 700-800 lbs for medium and large number 1 grade feeder steers. Cattle prices for each category were adjusted to the 2007 prices using the consumer price index (CPI). Actual individual selling price data were available from the feedlot for each animal sold.

Model

A stochastic simulation model using Simulation and Econometrics to Analyze Risk (SIMETAR) software was used to empirically estimate the return on investment (ROI) distributions for a cattle owner. SIMETAR is an Excel™ add-in for conducting complex stochastic simulation models for decision making and risk analysis. The ROI function is given by the ratio of total profit to total costs.

(I) $ROI = \pi/C$

where π is the profit function and C is the cost function. The profit function (π) is represented by:

(II) $\pi = N^* (S - C)$

where N represents number of animals. S is the gross revenue per animal ($) and is stochastic. The Cost function (C) is represented by:

(III) $C = (CPP^*Wt)+TC_p+(WG_p^*CP_p)+TC_f+(WG_f^*CF)$

where CPP is the stochastic purchase price of a weaned animal ($/lb); Wt is the average weight of the animal purchased; TC_p is the transportation cost to transport the weaned animal to the pasture ($); WG_p is the stochastic weight gained by the animal at the pasture (lbs); CP_p is the contract price ($/lb) for weight gained at the pasture and is varied across a range of prices for the analysis; TC_f is the transportation cost to transport the animal from pasture to feedlot ($); WG_f is the stochastic weight gained by the cattle at the feedlot (lbs) and CF is the stochastic feed cost per pound of weight gained for the animal at the feedlot ($/lb).

An empirical distribution was estimated and used to simulate CPP. Prices for each weight range were reflected as a ratio to the base weight (400-500lbs). This ensured that each simulation reflected the decline in prices ($/lb) for heavier animals. Average feed cost (CF) per pound of weight gained for the animal at the feedlot is also estimated using an empirical distribution. Linear regressions were performed to estimate ending weights at the pasture and feedlot respectively (WG_p and WG_f) and to ascertain the impact of variables such as starting weight, and number of days on the ending weight. The estimations of WG_p and WG_f are discussed in detail further below in the section named estimated relationships.

The gross revenue (S) per animal is partly dependent on the quality of fat on the animals. The fat gained on the feedlot is of higher quality than that from the pasture operations due to the nature of the feed given to the cattle. To capture this variable into the analysis, a quality variable was created to reflect the fat gained at the feedlot by taking a ratio of weight gained on feedlot to the starting weight of the animal. Linear regression was performed to see the effect of starting weight, quality, year and number of days on feedlot on gross revenue per animal. The estimation is discussed in detail below.

Assumptions

For the pasture study, the grazing data were divided into three subgroups with starting weights ranging between 400-500 lbs, 500-600 lbs, and 600-700 lbs. Summary statistics for the three weight ranges are presented in table 2. It is assumed that the cattle owner would purchase the cattle within a radius of 300 miles of the pasture. A radius of 300 miles is assumed based on personal communication with a cattle owner in Alabama (McFarland, personal communication, 2009) and also because this radius would cover most of areas supplying weaned cattle in Alabama, Mississippi, Georgia and Northern Florida. Transportation costs were obtained from the pasture to rail program using actual transport costs for transporting animals from the pasture to feedlot. They were calculated at $3.1 per mile for a truck load. A weight loss of 2% during transportation was applied to the data (McFarland, personal communication, 2009). Cattle in the above three categories were grazed for 100, 95 and 90 days respectively so that the average ending weights would be approximately 700 lbs, 800 lbs and 900 lbs, respectively. These ending weights are realistic, given the starting weights, and correspond to the typical starting weights at the feedlot and also match the conditions of the Alabama pasture to rail program.

Feedlot data were divided into six categories. The first three are for the above mentioned scenarios where the animals are taken from pasture and sent to the feedlot. The remaining three categories were created for placing the cattle directly onto the feedlot, skipping the pasture. The average starting weights for these categories are approximately 550 lbs, 650 lbs and 750 lbs. The summary statistics for the feedlot data are in table 3. A contract price of $0.30/lb for the pasture grazing was assumed for the base scenario keeping in line with the equal return grazing fee of $0.3080/lb found by Anderson et al. (2004). The equal return grazing fee is the fee at which both pasture owner and cattle owner would have equal returns.

Estimated Relationships

Linear regression was performed to ascertain how starting weight, number of days and year affect the ending weight of the animal and to obtain the predicted ending weight for the cattle while in pasture and feedlot. The relationship between ending weight to starting weight, number of days and year was assumed to be linear. Since weight gain at the feedlot is not affected by the weather, year did not have any significant effect on the weight gain and was excluded from the final regression results. The regression results for the weight gain at pasture and feedlot are given in table 4 and table 5, respectively.

Linear regression was performed to see the effect of year, starting weight, quality and number of days on pasture on the gross revenue per animal. Although year does not have an effect on the weight gain, it would affect the gross revenue due to market cycles. Equation 4 was estimated using ordinary least squares (figures in parentheses are the estimated standard errors of the coefficients).

$$\text{(IV)} \quad S = \underset{(11416.18)}{-37824.76} + \underset{(5.68)}{18.64 \cdot Y} + \underset{(33.05)}{421.81 \cdot Q} + \underset{(0.07)}{1.51 \cdot SW} + \underset{(0.20)}{0.87 \cdot D}$$

$R^2 = 50.8\%$

where S is gross revenue per animal, Y is the year, Q is the quality of the animal, SW is the starting weight of the animal and D is the number of days on feedlot.

Results

The ROI data were simulated with 500 iterations using SIMETAR. Profit/loss and return on investments (ROI) for all categories described above were calculated and compared for a batch of 100 cattle. Table 6 provides results of the simulation, including ROI. The results show that buying lighter animals and feeding them in pastures before sending them to feedlot is the most profitable option. The most profitable option for the base scenario was to purchase the animals with an average weight of 450 lbs, put them in a pasture for 100 days followed by 220 days on feedlot to earn an average of 7.83% ROI. The ROI for the remaining five categories are 5.47%, 2.44%, 2.42%, 1% and -0.15% respectively as shown in table 6.

To compare risk for the six scenarios, a stop light chart was created (figure 1). The probabilities of different ranges of ROI are depicted in the stoplight chart. The results show that most profitable option in the base scenario above is also the least risky option. In this scenario, the probability of having an ROI more than 10% is 45% and the farmer would still incur losses 28% of the times. This also shows that at a contract price of $0.30 /lb, there is a 28% to 43% chance of incurring a loss any given year depending on the starting weight of cattle. This is in line with 36% chance of losing money any year found by Johnson et al. (1987).

At a contract price of $0.30 /lb, returns for buying heavier cattle (600-700lbs) and putting them on pasture before taking them to feedlot are comparable to buying lighter cattle (500-600lbs) and placing them directly on to feedlot. This shows a possibility that at a higher grazing contract a cattle owner might skip the pasture route and place cattle directly on to the feedlot. This possibility is studied in detail in the following subsection.

The simulations were re-run with different contract grazing prices, for a case where cattle are bought at an average starting weight of 550 lbs. We compared the profitability and risk at five different contract prices ($0.20/lb, $0.30/lb, $0.40/lb, $0.50/lb and $0.60/lb). The ROI for the contract prices of $0.20, $0.30, $0.40, $0.50 and $0.60 were 7.08%, 4.73%, 2.48%, 0.32% and -1.75% respectively, for cattle that were contract grazed before going to the feedlot. By contrast, the ROI for going directly to the feedlot was 2.42%. Further sensitivity analysis showed that the "break-even" contract grazing price was $0.41/lb. At prices above this level, it is more profitable for the cattle owner to place the cattle directly on the feedlot.

The stop light chart (figure 2) in this scenario shows that by placing 550 lbs average weight cattle directly on to the feedlot, the probability of a positive ROI would be 58% of which 29% would provide more than 10% ROI. In comparison, at a contract price of $0.40/lb the probability of a positive ROI is 57% although the probability of a ROI more than 10% is 33% in this case.

To further study a cattle owner's preferences regarding skipping the pasture and placing cattle directly on the feedlot, a stochastic dominance analysis was performed. Stochastic dominance analysis (Hadar and Russell, 1969) is a technique used to compare probability distributions to study risk efficient action choices. The first and second degree dominance tables are shown in table 7. The second degree dominance table shows that the feedlot option is dominated by 20 cents, 30 cents and 40 cents which suggests that at higher contract prize for grazing, the cattle owner would be better off skipping the pasture and placing the animals directly at the feedlot. The stochastic efficiency chart (figure 3) confirms that the feedlot is the 4th preferred option after the contract rates of 20 cents, 30 cents and 40 cents respectively.

Conclusions

It is always more profitable to buy lighter cattle than heavier cattle in spite of the fact that lighter cattle command a premium in the market. Also the probability of positive ROI decreases with the higher starting weights of the cattle. At current contract prices, it is more profitable for a cattle owner to send the cattle to pasture before sending them to feedlot. However an increase in the contract prices might encourage the cattle owners to skip the pasture altogether and put cattle directly onto the feedlot.

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Table 1. Experiment Details for Pasture Data (E V Smith Research Center, Shorter, AL)

Year	Cattle	Forages	Stocking Rates (head/acre)	Grazing Days	Treatments
2006	185	Marshall Rye Grass Gulf Ryegrass Rye Oats	1, 1.2, 1.5, 1.6, 2	78, 82	Implants/No-implants Hay/No-Hay
2007	228	Marshall Rye Grass Gulf Ryegrass Wheat MaxQ Fescue	1.2, 1.6, 2, 2.5, 3	113,114	Implants/No-implants Till/No-Till
2008	222	Marshall Rye Grass Gulf Ryegrass Wheat MaxQ Fescue	1.4, 1.5, 2, 2.5, 2.6, 3	112, 113	Implants/No-implants Till/No-Till
2009	219	Marshall Rye Grass Gulf Ryegrass Marshall Rye Grass + Wheat MaxQ Fescue	1.4, 1.5, 2, 2.5, 2.6, 3	91	Implants/No-implants

Table 2. Summary Statistics for Pasture Data (E V Smith Research Center, Shorter, AL) (2006-2009)

Weight Range	Number of Animals	Average Starting Weight (lbs)	Average Ending Weight (lbs)	Average Weight Gained (lbs)	Average Days on Pasture	Average Daily Gain (lbs)
400-500lbs	412	463	717	254	98	2.61
500-600lbs	439	546	807	260	101	2.59
600-700lbs	438	639	919	280	106	2.63

Table 3. Summary Statistics for the Feedlot Data (Decatur County Feed Yard, Oberlin, KS) (2006-2008)

Number of Animals	Average Starting Weight (lbs)	Average Ending Weight (lbs)	Average Weight Gained (lbs)	Average Days on Feedlot	Average Daily Gain (lbs)	Average Feed Cost ($/lb)	Average Quality Score[1]	Average Gross Revenue ($/lb)
Animals from pasture								
146	699	1288	591	176	3.29	0.62	0.85	1174.78
76	793	1353	560	171	3.24	0.66	0.71	1232.59
44	890	1425	535	161	3.29	0.76	0.60	1267.44
Animals directly put into Feedlot								
136	556	1202	644	191	3.36	0.61	1.16	1077.05
158	649	1248	601	182	3.24	0.61	0.93	1132.57
130	749	1321	574	172	3.28	0.64	0.77	1206.76

[1] Calculated as ratio of weight gained in Feedlot to starting weight

Table 4. Regression Results for the Weight Gained at the Pasture

Variable	Coefficient Estimates for Starting Weight Range		
	400-500 lbs	**500-600lbs**	**600-700lbs**
# of Animals	419	439	438
Intercept	64163.94 (6997.75)	65514.08 (6998.28)	63545.72 (14657.83)
Year	-32.03 (3.50)	-32.66 (3.50)	-31.81 (7.30)
Days on Pasture	3.13 (0.28)	2.84 (0.27)	2.98 (0.57)
Starting Weight	1.17 (0.16)	1.07 (0.24)	1.43 (0.24)
R^2	42.00%	40.00%	49.30%

Figures in parentheses are the standard errors,

Table 5. Regression Results for the Weight Gained at the Feedlot

Dependent Variable	Pasture and Feedlot			Feedlot only		
	Starting Weight Range					
	700-800lbs	**800-900lbs**	**900-1000lbs**	**550-650lbs**	**650-750lbs**	**750-850lbs**
# of animals	146	76	44	136	158	130
Intercept	267.42 (191.44)	551.39 (194.8)	764.78 (152.32)	69.02 (172.19)	366.21 (172.43)	771.62 (195.44)
Days on Pasture	1.61 (0.26)	0.98 (0.29)	0.11 (0.41)	1.74 (0.27)	2.37 (0.23)	1.16 (0.27)
Starting Weight	1.05 (0.25)	0.80 (0.24)	0.72 (0.14)	1.44 (0.29)	0.70 (0.25)	0.47 (0.24)
R^2	24.5	23.5	41.8	31.1	40.7	13.8

Table 6. Returns on Investment (ROI) for 100 Cattle under Different Starting Weights and Different Feeding Options

	PASTURE AND FEEDLOT			FEEDLOT ONLY		
Weight Range (lbs)	**400-500**	**500-600**	**600-700**	**500-600**	**600-700**	**700-800**
Animal Purchase						
Number of Animals	100.00	100.00	100.00	100.00	100.00	100.00
Purchase Price ($/lb)	1.26	1.14	1.05	1.14	1.05	0.99
Avg. Purchase Weight (lb)	450.00	550.00	650.00	550.00	650.00	750.00
Total Purchase Cost ($)	56,600	62,480	68,406	62,480	68,406	74,412
Pasture Costs						
Avg. St. Weight (lb)	441.00	539.00	637.00	NA	NA	NA
Transport Costs ($)	862.89	1,054.64	1,246.39	NA	NA	NA
Days on Pasture	100.00	95.00	90.00	NA	NA	NA
Average Ending Wt (lbs)	708.95	800.54	884.40	NA	NA	NA
Contract Price ($/lb)	0.30	0.30	0.30	NA	NA	NA
Contract Payments ($)	8039	7846	7422	NA	NA	NA
Feedlot Costs						
Starting Wt	694.77	784.52	866.71	539.00	637.00	735.00
Transport Costs	5,506.60	6,217.97	6,869.38	4,271.99	5,048.72	5,825.44
Days on Feedlot	220.00	190.00	160.00	220.00	200.00	180.00
Average Ending Wt (lbs)	1,358.53	1,378.86	1,409.23	1,222.47	1,284.68	1,335.79
Feed costs ($/lb)	0.66	0.71	0.80	0.64	0.63	0.67
Quality	0.96	0.76	0.63	1.27	1.02	0.82
Total feed cost ($)	43,643	42,076	43,437	43,810	41,096	40,297
Profit and Loss						
Predicted Sale Price ($)	1,226.01	1,251.79	1,294.08	1,122.95	1,147.34	1,193.61
Simulated Sale Price ($)	1,236.24	1,262.24	1,304.89	1,132.32	1,156.92	1,203.58
Total costs ($)	114,651	119,675	127,381	110,562	114,550	120,535
Total Sales ($)	123,624	126,224	130,489	113,232	115,692	120,358
Profits ($)	8,973	6,550	3,108	2,670	1,141	-177
ROI	**7.83**	**5.47**	**2.44**	**2.42**	**1.00**	**-0.15**

Table 7. Estimates of First and Second Degree Stochastic Dominance

First Degree Dominance (FDD)						
	20 cents	**30 cents**	**40 cents**	**50 cents**	**60 cents**	**Feedlot**
20 cents FDD				FDD	FDD	
30 cents FDD						
40 cents FDD					FDD	
50 cents FDD					FDD	
60 cents FDD						
Feedlot FDD					FDD	
Second Degree Dominance (SDD)						
	20 cents	**30 cents**	**40 cents**	**50 cents**	**60 cents**	**Feedlot**
20 cents SDD		30 cents	40 cents	50 cents	60 cents	Feedlot
30 cents SDD			40 cents	50 cents	60 cents	Feedlot
40 cents SDD				50 cents	60 cents	Feedlot
50 cents SDD					60 cents	
60 cents SDD						
Feedlot SDD				50 cents	60 cents	

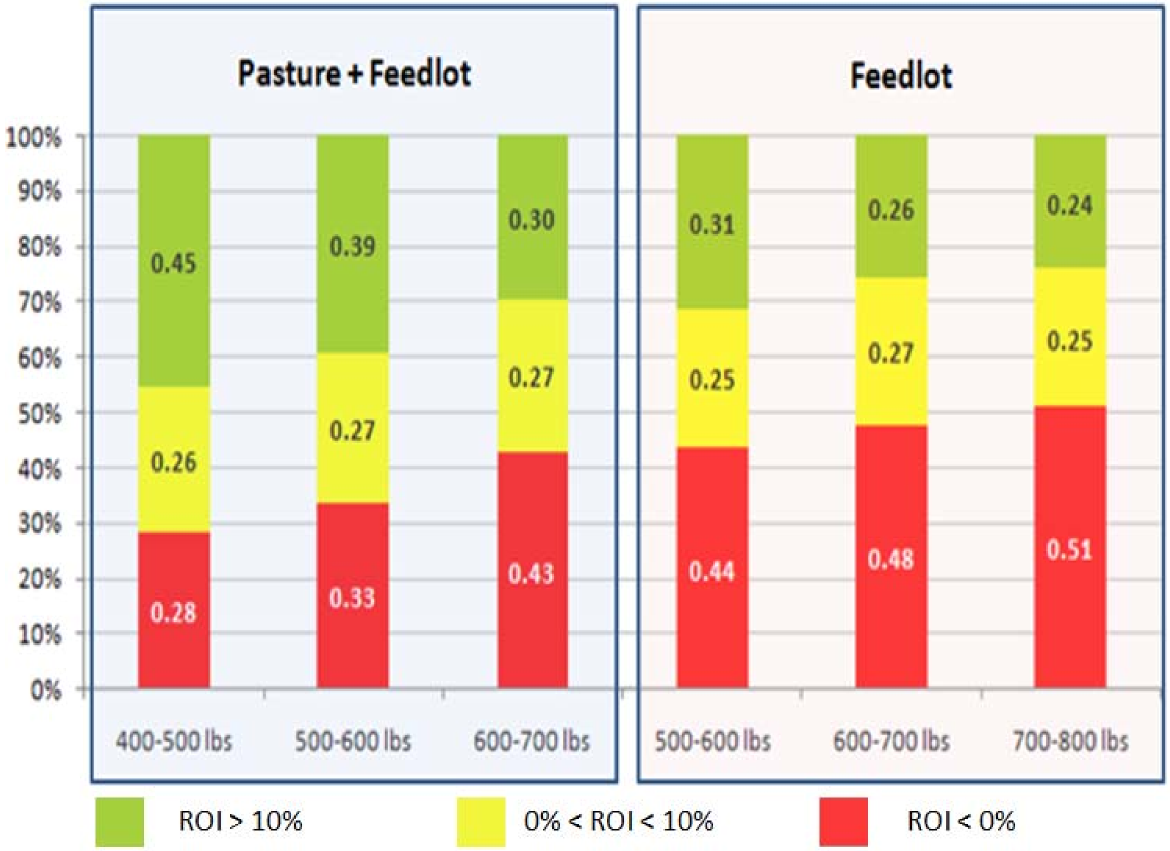

Figure 1. Stoplight Chart Comparing Return on Investments under Different Starting Weights and Feeding Options.

The red shaded area in each bar represents the probability of a negative Return on Investment (ROI). The green area represents the probability of an ROI>10%. The yellow area would be the probability that the ROI lies between 0% and 10%.

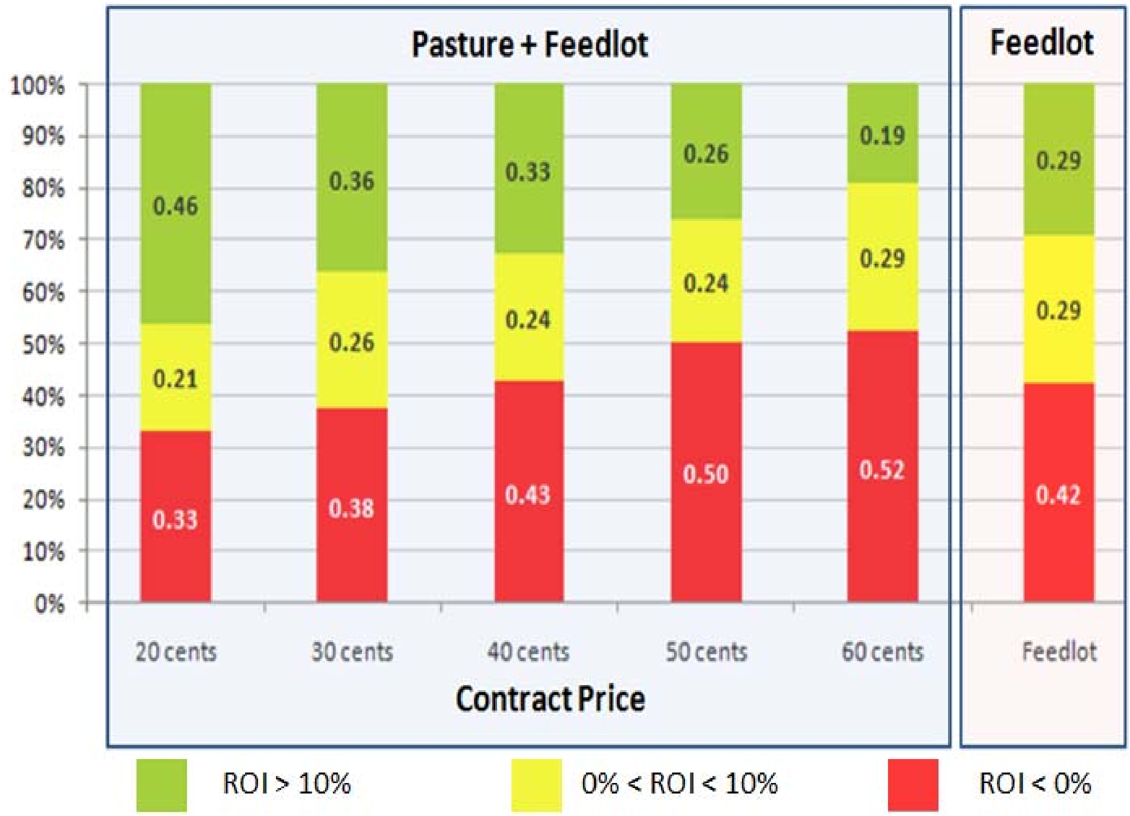

Figure 2. Stoplight Chart Comparing Return on Investments under Different Contract Pricing and Feeding Options

The red shaded area in each bar represents the probability of a negative Return on Investment (ROI). The green area represents the probability of an ROI>10%. The yellow area would be the probability that the ROI lies between 0% and 10%.

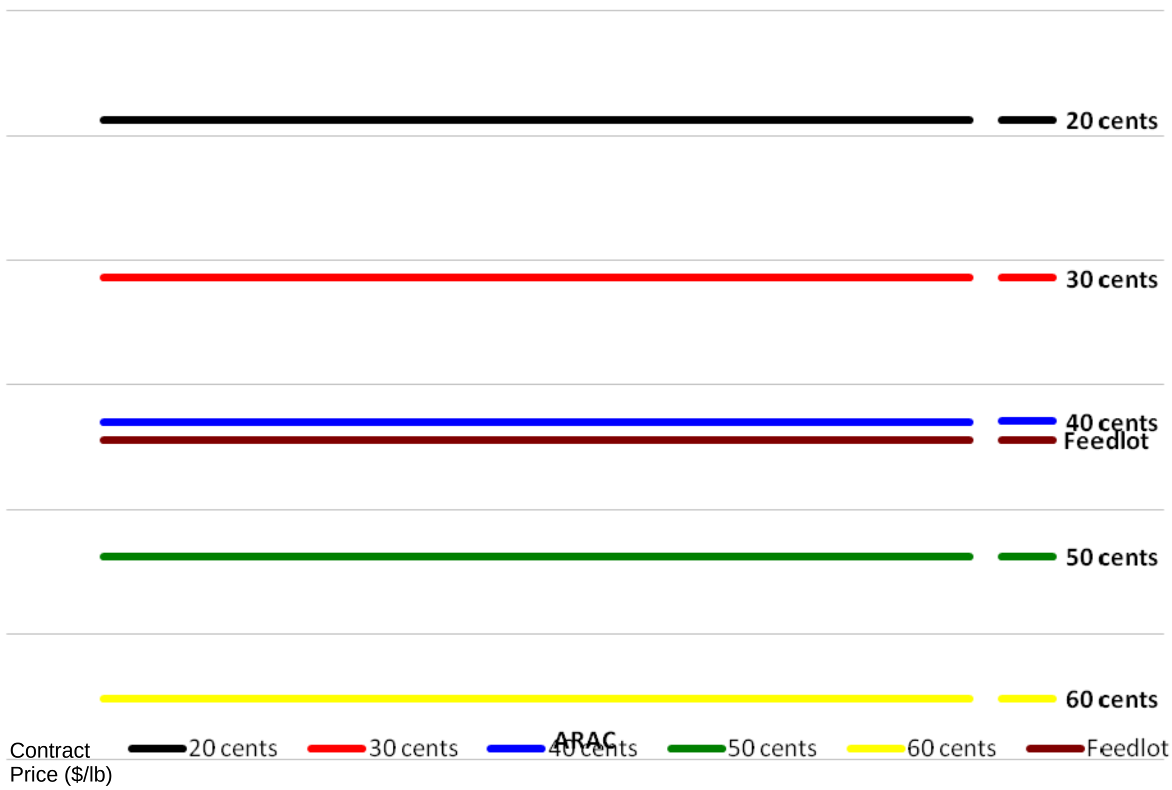

Figure 3. Stochastic Efficiency With Respect to a Function (SERF) Assuming a Negative Exponential Utility Function.

Stochastic efficiency with respect to a function (SERF) is another technique used to order risky alternatives using their certainty equivalents (CE) for alternative absolute risk aversion coefficients (ARACs) where CE is the amount accepted in lieu of a higher but uncertain amount.