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Factors Affecting Beef Cow-Herd Costs, Production, and Profits

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Cow-herd standardized performance analysis (SPA) data for Texas, Oklahoma, and New Mexico were used to determine economic factors affecting cow-herd costs, production, and profitability. Total cost was defined as the financial cost associated with raising a calf through the weaning stage; production, as pounds weaned per exposed female; and profits, as rate of return on assets. Variables affecting one or more performance measures included herd size; pounds of feed fed; real estate, machinery, and breeding-stock investments; calving percentage; death loss; and breeding-season length. Management variables were especially important for financial costs and profitability of the cow-herd operation.

Key Words: beef, cattle, costs, cow–calf, economics, production, profits, return on assets

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Economic performance of the beef cow–calf or cow-herd enterprise can be measured in alternative ways. Three interdependent measures chosen for this study were costs, production, and profitability. Ranch managers often focus on production measures and the means to increase production because production is the profit equation component directly affecting income from the enterprise. Ranch managers also need to emphasize cost management, another component of the profit equation. Ultimately, the major focus is with profitability of the cow–calf enterprise. While technology advances have contributed to increased production efficiency and reduced costs, profitability of cow–calf operations varies widely, as will be shown.

In recent years, considerable detailed data about the cow–calf enterprise have been generated from using a tool developed jointly by cattlemen, researchers, and extension specialists for cow–calf producers. Standardized performance analysis (SPA) combines both financial records and production records into a single analytical tool (McGrann; McGrann, Jones, and McCorkle). The SPA software utilizes enterprise accounting concepts, focusing on the cow–calf production process through weaning the calf.

The objective of this research was to utilize unique data from SPA to identify economic factors within a ranch manager's control that are important in determining economic performance, here measured by cost of production, pounds weaned per exposed female, and rate of return on assets. As such, this research contributes to a relatively sparse literature on factors affecting long-term competitiveness

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and profitability of the beef-cow enterprise. Results provide additional insight for the industry into factors that affect performance across many sizes and production conditions in the southern plains region.

Previous Research

SPA data from eight Northern Plains states (Montana, Wyoming, North and South Dakota, Nebraska, Kansas, Minnesota, and Iowa) were used by Dunn (2000) in one of the most extensive studies of cow–calf enterprises. Dunn used SPA data from 148 herds collected over the period 1991–1999. He divided the observations into three profit groups as measured by return on assets (ROA). The high-profit group was characterized as having lower than average investments, average or better production, lower than average expenses, and higher than average market values for calves.

Miller et al. used SPA data from 225 cow herds in Illinois and Iowa collected over the 1996–1999 period to identify specific factors influencing profitability, as measured by the return to unpaid labor and management per cow (RLM). Feed costs accounted for over half of the variation in RLM. Other important factors were depreciation and operating costs, value of calves sold, and production as measured by calf birth weight and weaning percentage.

Falconer, Parker, and McGrann used SPA data from Texas cow-herd enterprises for 1992–1998 to estimate a cost function for the cow–calf enterprise. Prices for feed and grazing, other operating costs, and total production (pounds weaned) significantly affected total cost of production for the 187 observations.

Economies of size are frequently thought to exist in cow-herd operations. To date, results are mixed. Dunn (2000) found that no measurement of enterprise size affected profitability. Miller et al. found significant, but modest, economies of size, mostly in the form of reduced feed and operating costs. Their results corresponded to a study of cow/calf cost of production by herd size and profitability groups in which Langemeier, McGrann, and Parker found economies of size, but with the size advantage existing only up to 1,000 head. Short reported that production of feed and purchase of feed accounted for more than half of the total cost of production and concluded that economies of size are a factor in cow/calf production.

A U.S. Department of Agriculture (USDA) survey of management practices associated with profitable cow–calf herds determined that producers who worked toward optimal production rather than maximum production showed positive returns and achieved them through better herd efficiency and cost containment. According to the USDA survey, the largest difference between individuals with negative and positive returns was in capital investment, primarily real estate. Their finding corresponded with that of Dunn (2000).

Research reported here extends previous research by using more refined independent variables to estimate their effects on three aspects of cow-herd enterprise performance. For example, specific variables are used for various types of investments, enterprise costs, and production measures. Additionally, previous studies modeled a single performance measure. Thus, this research provides insight into economic factors affecting two measures of performance that affect profit-equation components and a direct measure of profitability.

Data and Methods

Data needed for a SPA are organized into two main categories. First, financial data required includes cash operating costs, liabilities, cost and market value of assets, changes in inventories, and expenses associated with purchased feed, pasture rents, fuel, and veterinary services in the year calves are weaned. Records used in calculating financial costs include IRS tax schedules (especially Schedule F), depreciation schedules, loan payment schedules, beginning and ending fiscal-year balance sheets, and income statements.

Production data required includes cow and calf inventories, inventory reconciliation for exposed females (i.e., cow culling, sales, purchases, transfers, and deaths), feed and grazing acres, and feed used. For the production data, some records prior to the fiscal year are also necessary. Reproduction measures that are calculated include pregnancy percentage, pregnancy-loss percentage, calving percentage, calf-death loss, calf crop or weaning percentage, and female replacement rate, where all ratios are based on exposed females. Calving distribution information is a secondary SPA measure so data are not required, but data are included when available.

SPA data used in this study were compiled into a database by Texas A&M University from individual producer records for Oklahoma, Texas, and New Mexico cow herds from 1991 to 2001. Total herd-year observations numbered 394, with 63 from Oklahoma, 293 from Texas, and 38 from New Mexico.[1] Production systems vary widely across this geographic region, from arid, land-extensive operations, primarily in the western portion of the region, to more intensive operations based on improved forage in higher rainfall areas in the eastern portion.

The regional SPA database includes 119 variables in total, 66 production, and 53 financial (McGrann). Definitions and summary statistics for the 11 dependent and independent variables used in the analysis reported here are shown in Table 1. The wide range of values for nearly all variables indicates the diversity of cow-herd enterprises in the Southern Plains. Care was taken to verify seemingly high or low values in the data set.

Models Specified

Three models were specified, one each for costs, production, and profits. The three respective dependent variables were (1) cost—defined as economic pretax cost before non-calf revenue adjustment per hundredweight, (2) production—defined as pounds weaned per exposed female (lbs.), and (3) profit—defined as percent return on assets calculated on a cost basis. In the cost model, the dependent variable takes into account opportunity costs on owned assets and raised inputs. Cost on a per hundredweight basis is used to best relate production statistics with financial data. In the production model, the dependent variable represents the level of reproduction and production success within an operation, combining fertility, death-loss prevention, and weaning-weight performance into one variable. Return on assets can be argued to be the most appropriate measure of profitability (Oltmans, Klinefelter, and Frey; Dunn 2002) because it is a comprehensive measure of managerial efficiency of total assets in the enterprise. Thus, in the profit model, return on assets was chosen as a long-run measure of profitability. Table 2 shows the expected signs of variables in each model.

Beginning fiscal-year breeding-cow inventory (i.e., cow-herd size) was expected to be significant and have a negative relationship with costs and a positive relationship with production and profits if economies of size exist in cow–calf enterprises, as has been found in previous research (Langemeier, McGrann, and Parker; Miller et al.; Short). A squared term was included because economies of size are expected to have a nonlinear effect over the range of cow-herd sizes. It was recognized that economies may not exist in production because management may not be as intense in managing larger herds for optimal production performance.

Previous research verifies the importance of investments to profitability in the cow-herd enterprise (Dunn 2000; Miller et al.; USDA). Unlike previous research, total investment was divided into three independent variables in this study. The investment in real estate (valued on an adjusted cost base of land plus improvements) was expected to have a positive coefficient in the cost model. Anticipating the relationship in the production model is difficult. Real estate investments could contribute to increased or decreased production depending on how the land is managed. The real estate investment coefficient was hypothesized to have a negative sign in the profitability model if the return generated by ranch profits is less than the return generated by renting the land.

[1] One observation was one ranch herd for 1 year. Additionally, if a ranch had a fall calving herd and a spring calving herd, each was considered a separate observation.

Table 1. SPA Variable Summary Statistics

Independent Variable	Calculation	Unit	Mean	Std. Dev.	Minimum	Maximum	*N*
Economic pretax cost before noncalf revenue adjustment per cow	(Total pretax costs/lbs. of weaned calf production per breeding cow) × 100	$	412	160	138	1,717	394
Pounds weaned per exposed female	Total pounds of calf weaned/total number of females exposed	Pounds	430	80	195	638	394
Percent return on assets (cost basis)	((Accrual-adjusted net enterprise income from operations + total interest expenses − family living withdrawals/average total enterprise assets) × 100	%	1.12	10.05	−45.08	48.54	394
Beginning fiscal-year breeding-cow inventory	Number of breeding females at beginning of fiscal year	Cows	711	1,754	10	13,884	394
Real estate improvements (cost basis)	Average asset value/number of breeding cows	$	1,547	2,208	0	16,230	394
Machinery and equipment (cost basis)	Average asset value/number of breeding cows	$	174	307	0	3,264	394
Livestock (cost basis)	Average asset value/number of breeding cows	$	653	300	0	1,910	394
Pounds of raised/purchased feed per breeding cow	Total pounds of raised and/or purchased feed fed/number of breeding females	Pounds	1,675	1,561	0	7,610	394
Calving percentage	(Number of calves born/number of exposed females) × 100	%	85.8	9.3	49.3	104	382
Calving death loss based on exposed females	Number of calves which died/number of exposed females	%	3.5	3.5	0	23	384
Length of breeding season	Number of days from beginning to end of breeding season	Days	133	77	11	365	394

Note: Data constructed from standardized performance analysis data in Oklahoma, Texas, and New Mexico from 1991 to 2001.

Table 2. Expected Parameter Estimate Signs

Variable	Estimated Pretax Cost per Cow	Pounds Weaned per Exposed Females	Percentage Returns on Assets
Beginning fiscal-year breeding-cow inventory	−	−	+
Investment in real estate–land and improvements	+	?	−
Investment in machinery and equipment	+	?	−
Investment in livestock	+	+	+
Pounds of raised/purchased feed fed per breeding cow	|	|	
Calving percentage	−	+	+
Calving death loss based on exposed females	+	−	−
Length of breeding season	−	−	−

The anticipated effects from the investment in machinery and equipment (valued on an adjusted cost basis) is similar to that for real estate. Machinery and equipment investments were expected to increase costs and have a positive coefficient sign in the cost model. Larger investments in machinery, equipment, and vehicles translate into higher operating costs for repairs, fuel and lube, depreciation, and taxes plus interest on the investment. Machinery and equipment investments could contribute to increased or decreased production depending on where the investments are and how they contribute to the cow-herd operation. Investment in machinery and equipment was anticipated to have a negative sign in the profit model, indicating that, as the investment in machinery and equipment increases, profits decrease.

The coefficient sign on the variable for investment in breeding livestock (a base value reflecting cost of raising the animals) was expected to be positive. Larger breeding-stock investments also translate into higher operating costs. The effect of breeding-stock investments on production could have mixed results. Ideally, investment in better quality breeding stock with increased reproductive rates would increase pounds weaned per cow. However, if increased investments are not clearly related to enhanced production, the anticipated relationship may not result. A positive sign was anticipated in the profit model, again assuming wise investment in breeding stock increased productivity and profitability. However, overzealous investment in breeding stock without a commensurate increase in production may detract from profitability.

Previous research found feed costs to be the largest expense in the cow-herd enterprise (Falconer, Parker, and McGrann; Miller et al.). Grazing is typically the most cost-effective means of meeting beef cows' nutritional needs. Hence, low-cost systems would be expected to use little purchased or raised feed that has been mechanically harvested, stored, and hauled. Hence, the coefficient for pounds of raised/purchased feed per breeding cow (feed costs) in the cost model was expected to be positive because more pounds fed increases costs. In the production model, the coefficient was expected to be positive. Increased feeding may increase total pounds weaned as a result of higher weaning weights or better condition of cows or bulls, leading to better reproductive rates. Feed costs were also expected to have a negative sign in the profitability model, indicating that, as feed costs increase, profit decreases if the benefits of feeding relative to grazing do not outweigh the added costs.

Previous research found production measures important in determining profitability. Selected production measures affect costs directly, as well as impact an overall productivity measure of the cow–calf enterprise. Calving percentage could be interpreted as a proxy for management skills related to breeding, gestation, and calving and, if significant in the cost and profit models, would indicate a direct relationship between production skills and fi-

Table 3. Regression Results

	Estimated Pretax Cost per Cow	Pounds Weaned per Exposed Females	Percent Return on Assets
Beginning fiscal-year breeding-cow inventory	−0.00634*	0.0008677	0.00157**
	(−3.87)	(0.16)	(1.69)
Beginning fiscal-year breeding-cow inventory squared	3.708054E − 7*	1.188102E − 7	−1.02275E − 7
	(2.87)	(0.26)	(−1.32)
Investment in real estate	0.00377*	−0.00166	−0.000319
	(4.59)	(−1.22)	(−1.41)
Investment in machinery and equipment	2.61997*	−0.21401	−0.05661
	(6.00)	(−0.87)	(−1.37)
Investment in livestock	0.01244*	0.02676*	−0.00256
	(2.27)	(2.65)	(−1.52)
Pounds of raised/purchased feed per breeding cow	0.00253*	−0.00186	−0.00066194**
	(2.05)	(−0.90)	(−1.92)
Calving percentage	−1.50949*	6.21239*	0.26965*
	(−6.60)	(18.46)	(4.80)
Calving death loss based on exposed females	1.39183*	−6.31090*	−0.10497
	(3.08)	(−6.98)	(−0.70)
Length of breeding season	0.04707**	−0.15824*	−0.01026
	(1.96)	(−4.03)	(−1.57)
R^2	0.3094	0.4998	0.1101

nancial acumen. The coefficient sign for the calving percentage was expected to be negative in the cost model; as the calving percentage increases, costs decrease. Clearly, a positive relationship was expected between calving percentage and pounds weaned, the overall measure of productivity used here. A positive relationship would be expected between calving percentage and profits, given the expected negative effect on costs and the positive effect on production.

Calving death loss based on exposed females also can be interpreted as another proxy for production-management skills, especially related to calving and calf management to weaning. In the cost model, this variable was expected to be positive if calving mortality is accompanied by increased morbidity, resulting in higher veterinary and related costs. Calving-death loss was expected to negatively affect pounds weaned because higher death loss reduces the number of calves marketed and increased sickness adversely affects the weight of calves marketed. Higher death loss similarly was anticipated to negatively affect profits.

Length of breeding season is an indicator of management intensity. Longer breeding seasons result in a lack of uniformity of weaned calves and potentially lower prices as calves are sold in smaller, uneven lots. A shorter, more-intensive calving season typically better utilizes labor, decreases death loss, and increases calf health. A shorter breeding-season length was expected to reduce costs, increase productivity, and contribute to enhanced profitability.

Results and Discussion

Models were estimated by weighted generalized least squares after using Harvey's procedure to correct for heteroskedasticity (SAS Institute). Regression results are presented in Table 3. Given the considerable variability in each dependent variable (as was noted in Table 1), none of the models explained a particularly high proportion of the variation in the dependent variables. This was especially true for the profit equation.

General results are summarized first. All independent variables were significant in the cost model. The four significant variables in the production model could be argued to reflect management of the cow-herd enterprise. While one was an investment variable, the investment in breeding stock may reflect the ability to invest in breeding stock that increases productivity of the cow herd. The other three variables clearly represent cow-herd management, i.e., calving percentage, calving death loss, and breeding-season length. Results for the profit model were less consistent. The three significant variables (i.e., herd size, feed costs, and calving percentage) affect both income and cost components of the profit equation.

Turning to specific variables, herd size (beginning fiscal-year breeding-cow inventory) was significant in two of the three models, cost and profit. Results for the cost model indicated economies of size exist in the beef cow-herd enterprise. This is consistent with previous research (Langemeier, McGrann, and Parker; Miller et al.; Short). Both herd size and its squared term indicated cost per unit declined at a decreasing rate as herd size increased. Herd size was not significant in the production model. Thus, herd size can positively affect production costs but may not improve productivity *per se*. However, herd size was found to affect profit (return on assets), but the quadratic term was not significant. Larger herds may affect return on assets through lower per-unit costs or through marketing larger numbers of weaned calves.

Investment in real estate, machinery and equipment, and in breeding stock was positively related to per-unit costs. Their importance was consistent with Dunn (2000), Miller et al., and USDA. The coefficient sign on the three investment variables (real estate, machinery and equipment, and breeding stock) suggest that, as investments increased, cost per unit also increased.

Owning land, machinery and equipment, and simply investing more for breeding stock did not reduce costs. Leasing land may be less costly than land ownership in providing forage for a cow–calf operation. However, with real estate investments, the decision to own land may be influenced more by personal goals of producers, such as wealth accumulation and asset growth, than the expected contribution to enterprise profitability. Machinery and equipment ownership contributed to increased costs without commensurately increasing either pro duction or profits. Results suggest producers should carefully consider machinery ownership, perhaps substituting custom work, to minimize costs. Investment in breeding livestock significantly increased per-unit costs but also increased production. Perhaps producers with high levels of investments in breeding livestock have higher quality livestock and wean more pounds per cow. However, breeding-stock investment did not significantly affect cow-herd profitability, suggesting the increased gain in production may be insufficient to offset the increased costs and significantly affect profits. None of the three investment variables were significant in the profit model.

Pounds of feed fed were significant in both the cost model and the profit model, thus corresponding to previous research (Dunn 2000; Falconer, Parker, and McGrann; Miller et al.). As pounds of feed fed increased, per-unit costs increased. However, while pounds of feed fed affected costs, it did not improve production. Perhaps to be significant, feed must be strategically fed to increase conception and/or weaning weights. In the profit model, amount of feed fed was inversely related to profit and increased feeding was associated with lower profits. Results indicate producers who are feeding more raised and harvested or purchased feed have higher costs, no higher productivity, and lower profits.

Productivity measures affected costs, overall production, and profits. Calving percentage, clearly a variable within the purview of management, was the only variable significant in all three models. Increased calving percentage decreased per-unit costs, increased production, and increased profits. This finding reinforces the importance of high levels of reproduction to achieve enterprise success and contribute to long-term sustainability. Because of the significance of calving percentage in all three models, it can be concluded that better management to increase live, healthy calves is an important strategy to improve enterprise performance, i.e., decrease costs, increase production, and improve profitability.

Higher calving death loss increased per-unit costs and reduced production but did not significantly affect profitability. Again, these results emphasize the importance of management of the cow herd. Effective management to reduce calving losses has a synergistic effect in conjunction with investing in technology to decrease costs and increase production.

Length of the breeding season, like calving percentage and calving death loss, is directly affected and is an indicator of management skills and intensity. Length of the breeding season, like calving death loss, affected costs and production, but not profit. Longer breeding seasons increased costs and decreased production, as expected. Findings support recommendations to target a shorter breeding season.

Summary and Conclusions

Cow/calf SPA data were used to analyze cow/calf operations and how costs, production, and profitability were affected by management-related variables. Three models were estimated. All variables were significant in the cost model. Variables associated with increasing costs were investments in real estate, machinery, equipment, and livestock; pounds of feed fed; and calf death loss. Costs per hundredweight were negatively related to herd size, calving percentage, and length of the breeding season. Thus, production and financial management both contribute significantly in explaining total costs. It was also shown that economies of size increased at a decreasing rate.

Pounds weaned per exposed female were significantly affected by four factors. Investment in livestock and higher calving percentages had positive impacts on pounds weaned, while death losses and longer breeding seasons had negative impacts.

For the percent-return-on-assets model, three variables had a significant effect. Herd size and calving percentage increased the return on assets, while an increase in pounds of feed fed decreased return on assets. The significant coefficient on herd size and nonsignificant coefficient on the quadratic herd-size term indicate very modest economies-of-size effects on return on assets.

Overall results with SPA data provide additional insight into cow–calf operations. In particular, results evidence the importance of management in the cow–calf enterprise, both directly on physical production and on financial management.

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