Moderate versus Big Cows: Do Big Cows Carry Their Weight on the Ranch?

Damona Doye and David Lalman

Doye is Regents Professor and Sarkeys Distinguished Professor, Oklahoma State University

Department of Agricultural Economics, 529 Ag Hall, Stillwater, OK 74078

damona.doye@okstate.edu

Lalman is Professor, Oklahoma State University Department of Animal Science, 201C Animal

Science Building, Stillwater, OK 74078,

david.lalman@okstate.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Corpus Christi, TX, February 5-8, 2011

Efficiency in livestock production is important both at the farm and industry levels as the demand for protein increases in developing countries with improved incomes (USDA-ERS). While copious experiments have been published comparing biological efficiency of beef cows varying in genetic characteristics (breed, mature size, milk yield, etc.), literature is sparse comparing these factors in an economic efficiency context. Dickerson defines overall efficiency in livestock production as the ratio of total costs to total animal product (economic equivalents) from females and their progeny over a given period of time. He describes how biological variables influence costs per unit of product and how female production rates, body maintenance functions, genetics, reproduction rates, efficiency of growth, environment and management systems are interrelated. His list of major biological objectives to reduce production costs per unit of animal include greater total product value per female relative to metabolic body size; higher rate of reproduction to reduce breeding herd costs; more efficient lean growth to market live weight and earlier sexual maturity with minimum increase in mature size; combining female production and progeny lean meat production under intensive management.

Johnson, Dunn and Radakovich note that cow size has changed in recent years as a by-product of packing industry rewards for large framed cattle but that the increase in cow size may not be efficient in grass environments, depending on feed availability and cost. For a producer with a given set of resources, cow size should affect herd size. However, producers may not recognize a gradual increase in cow size over time nor adjust herd size to reflect this change. Questions remain about the impact of change in cow size both on profitability and the natural resource base. Cow size may affect ranch level profitability directly if stocking rate must be adjusted to maintain range conditions and if increased feed inputs are necessary to maintain reproductive efficiency. Similarly, the interrelationships of cow size, milk production (and

therefore, feed input costs) to calf weaning weight are also key elements in understanding the impact of these traits on ranch profitability. The impact of larger cow size on producer profitability when nutritional requirements are maintained as recommended has not been recently evaluated. Has long term selection for growth and milk production resulted in increased cow maintenance costs with only marginal improvements in calf weaning weights?

Literature Review

Biological versus economic efficiency

In revisiting beef cow efficiency, Jenkins and Ferrell (2002) question whether the biologically efficient cow is an economically efficient cow. However, relatively few analyses incorporate these two dimensions. A 1975 systems analysis of cow size using a deterministic linear programming (LP) model found small cows were more profitable in a pasture regime as the small cows produced more live weight and gross income (Long, Cartwright and Fitzhugh). Small cows were assumed to have the same milk production, fertility and mortality rates as medium and large cows. They noted at the time that additional study of possible genetic and environmental relationships between mature size and other characteristics such as milk yield, fertility, longevity and progeny growth were needed. Stokes et al found net returns to land, labor and management were highest for large, medium-milking cows, but variances were lower with decreased milking potential as well as increased cow size. Davis et al found that breed groups of moderate mature size and milk production were more profitable than more extreme types in northern range production systems. Differences were approximately $80 per cow exposed per year and $23,000 per year for ranches with 2,700 animal unit months of range forage. van Oijen reported that crossbred cows with low genetic potential for milk production were more

economically efficient per unit of weaned calves and per unit of carcass weight, compared to cows with moderate and high genetic potential for milk.

Effect of cow size on maintenance requirements and/or biological efficiency

Larger cows had maintenance requirements similar to smaller cows when milk potential was similar (Ferrell and Jenkins). Montano –Bermudez, Nielsen and Deutscher found substantial variation in maintenance requirement independent of output potential and suggested additional research is needed.

Effect of genetic potential for milk on maintenance requirements and/or biological efficiency

Ferrell and Jenkins studied energy utilization by mature nonpregnant, nonlactating cows of different types and noted that cow types with higher milk production potential had higher maintenance requirements than cows with lower milk potential. Milk production has been estimated to explain 23% of the variation in maintenance requirements (Montano-Bermudez, Nielsen and Deuscher). Holloway and Butts found that Angus cows producing relatively large amounts of milk consumed more digestible DM, weaned heavier calves and were more efficient producers of milk and weaned calf on either fescue or fescue-legume pastures. Maintenance requirements were increased in breed crosses (Red Poll x Angus and Milking Shorthorn x Angus) selected for moderate and high milk yield, respectively (114 and 110 kcal / kg $BW^{0.75}$), compared to Hereford x Angus crossbred cows, intended to represent low milk yield (97 kcal / kg $BW^{0.75}$; van Oijen).

Interaction of cow size and milk yield on nutrient requirements and/or biological efficiency

Cartwright found that optimal milk production increased with size as well as calving season. Optimal milk production for spring and fall calving tended to occur at lower levels if calves were sold after finishing rather than at weaning. Jenkins and Ferrell (1994) found that feed

availability affected the ranking for breed mean efficiencies with breeds more moderate in growth and milk production potential faring better in environments with low feed availability. Holloway and Butts reported that large frame cows grazing fescue-legume pasture produced more milk and faster growing calves than did small frame cows but that smaller frame cows performed better on fescue. Olson et al found that optimum production efficiency favored cows of average or slightly greater size when level of nutrition was not limiting.

Effect of cow size on reproductive efficiency

Johnson, Dunn and Radakovich noted that reproduction is the single most important contributor to ranch efficiency and that the ability to reproduce in a given feed environment is related to the mature size of the cows. Jenkins and Ferrell state that "maximum efficiencies within breeds occurred at intake levels that did not limit reproduction of the cows, and provided sufficient energy for milk yields to meet the growth potential of the breed as expressed in the calf (2002, p. 7)". In limited feed environments, females with high maintenance energy requirements may also have difficulty maintaining an acceptable Body Condition Score (BCS) and rebreeding. Stewart and Martin reported a reduction in lifetime number of calves produced by -0.007 calves per kg of additional cow mature weight. For example, a 643 kg cow would produce one less calf over her productive lifetime compared to a 500 kg cow.

Buttram and Willham note that interactions between size and management are important as the differences in reproductive efficiency are accentuated under unfavorable conditions. They found small cows more efficient reproductively in terms of calving rate than larger cows when managed similarly (about 20% higher). Smaller cattle which mature at an earlier age and lighter weight may be preferred for heifers raised under less than optimal conditions and cycling at 14 to 15 months of age. They note that larger, later-maturing cows which require more feed and reach

4

puberty at heavier weights require an environment that allows them to reach their genetic potential for growth. Klosterman also suggests that larger, later-maturing cows may need a more intensive system of management. Other studies have also concluded that animals of greater genetic potential for productivity are less able to lower maintenance requirements in environments with reduced feed (Frisch and Vercoe; Taylor, Thiessen and Murray et al). However, Wagner et al, found no significant association between measures of mature cow size and efficiency of the pair at weaning.

Effect of cow size on weaning weight

Of the immature traits, weaning weight has the highest genetic correlation with mature cow weight. Urick et al. found that increases of cow unit weight (45.4 kg) resulted in small but positive calf weight increases (1.93 kg). Brown and Lalman found breed differences in calf gain on different types of forages, noting that pre-weaning performance is a function of animal genetics, environment and the interaction of genotype with environment. Stewart and Martin reported that increased mature cow weight was associated with increased calf weaning weight (0.132 kg/kg). Similarly, MacNeil found only slight improvement in calf weaning weight as mature cow weight increased. Beck et al found that increasing cow size can increase calf weaning weight but did not affect total production per hectare and reduced the weaning weight efficiency ratios.

Modeling cow/calf production systems for profitability analysis

Whole farm or ranch models developed for systems analysis are often developed with a specific emphasis in mind: enhance environmental analysis in determining the best feed mix to meet animal nutritional requirements (Rotz, Buckmaster and Comerford); simulate the biophysical processes of grazing systems in temperate southern Australia (Donnelly et al);

estimate economically optimal stocking rates for alternative economic parameters and alfalfa forage availability (Wachenheim et al); water, nutrient and pesticide management in a whole farm context (Ascough II et al); breeding and management questions relevant to cow-calf production systems in the Northern Great Plains and Rocky Mountain West (Tess and Kolstad). Research to identify the most profitable enterprises for a given resource base in a systems framework that incorporates forage production details and livestock nutritional requirements are scarce. May,Van Tassell, Smith and Waggoner used integer programming to examine optimal monthly feeding strategies and costs for March and May calving alternatives and to identify minimum cow feed costs with basin wild rye as a winter grazing option. Smith's mixed integer programming model used both quality and quantity measures of forage in matching seasonal forage production and livestock nutritional requirements to solve for optimal combinations of cow/calf and stocker enterprises on different resource bases.

We provide an updated analysis of the economics of cow size assuming the goal is to optimize beef production on a given forage base with a marketing endpoint for calves at weaning. Specifically, we

1. Evaluate differences in costs and returns for two cow sizes for alternative pasture systems using budgeting tools and

2. For a given forage resource base, identify profit-maximizing combinations of livestock enterprises for two cow sizes when forage quality and availability by month are considered.

Data and Methods

An Oklahoma State University (OSU) software tool, CowCulator, identifies beef cow nutritional requirements using animal criteria such as cow weight, body condition, stage of production and breed and performance predictions based on National Research Council

6

recommendations (Lalman). Once the cow's forage plus supplemental nutritional needs are identified, costs and returns under alternative pasture systems and cow sizes can be calculated. OSU enterprise budget software is used to analyze returns for the expected economic environment and management practices (Sahs and Doye). CowCulator with enterprise budgets are employed to analyze maintenance costs and net returns of alternative production systems: two cow sizes that we refer to as moderate (1,100 lb. cow) and big (1,400 lb. cow) and two different pasture systems, native and improved pasture. The native pasture system is 1,000 acres of native pasture while the improved pasture is 160 acres of fescue plus 160 acres of Bermuda. The pasture cost equals the rental rate of $12 per acre for native pasture, $22 per acre for fescue and $17 per acre for Bermuda (Doye and Sahs) or the opportunity cost of not renting out owned land. Improved pasture requires $70 per acre for fertilizer, the assumed cost of 150 pounds of N needed to replace forage harvested (Redfearn et al). In the native pasture system, hay is valued at $65/ton whereas higher quality improved pasture hay is valued at $75/ton. Initially, we assume that the calving percent is 87% and calf death loss is 3% regardless of cow size or pasture system. Calf and cull cow prices are based on historical average, seasonal prices for 2005-2009.

The base case of 100 moderate cows plus 4 bulls is the number of breeding females that can normally be stocked on 1,000 acres of native pasture in Oklahoma. The improved pasture scenario is designed to meet the 100 cow, moderate-size base case. Stocking rate is adjusted based on estimated pasture productivity and cow size to achieve approximately equal grazing pressure in each scenario or system. When cows are bigger, fewer can be maintained on the same acreage; hence, the big cow herd is 76 breeding females and 3 bulls in both pasture systems. Budget assumptions for production parameters with differences between moderate and big cows are summarized in Table 1. Bigger cows wean bigger calves with a lower calf price per pound.

Initially, average weaning weight as a percent of cow weight is assumed to be 45% for both cow sizes. Thus, in this base scenario, the 300 lb of additional cow weight on big cows is assumed to be equally as productive as the first 1,100 lb of cow weight. We also evaluate scenarios where the additional mature cow weight is assumed to be less productive. The amount of hay fed is an indication of the assumed differences in daily dry matter intake based on mature weight. Labor hours per head are based on Kansas Farm Management Association data and differ by herd size.

In the native pasture system, the stocking rate is conservative to minimize the need for hay feeding. Even so, thirty days of prairie hay feeding is assumed for each class of cattle to account for extreme weather conditions or low forage availability in late winter. Dormant tall grass prairie (native) forage and prairie hay contain only 2 to 5% crude protein compared to a requirement in cows and heifers ranging from 8 to 11% of diet dry matter. Therefore, this system requires a greater amount of supplemental protein, either 20% or 38% commercial range cube products. Larger cows and heifers require slightly more supplemental protein and energy compared to more moderate sized cows (Table 1).

Weather permitting, fescue and properly managed stockpiled, fertilized Bermuda pasture should contain higher protein concentration during fall and late-winter/early-spring. Accordingly, less supplemental protein should be required during these times. Thus, the supplementation period for the improved pasture system is shortened to match the hay feeding period. Even though the improved forage system should require less supplementation, the nutrient concentration of these forages decline more rapidly and to a greater extent during winter, effectively requiring a longer hay feeding period (75 d). Due to higher protein concentration of Bermuda and fescue standing forage and hay, 38% range cubes are not used in the improved forage system.

8

Budget Analysis Results

Table 2 summarizes the results of the budget calculations. The big cows wean more pounds when the calving percentages and death losses are the same, so despite the lower price per pound, the big cows generate more calf income. And, though the price per pound is the same for culls from both moderate and big cow herds, the big cows also generate a bit more cull female income. If we focus only on revenue generated, the big cows have an advantage of about $86 per cow, which seems substantial. However, the income advantage is eliminated by the nutritional expenses associated with maintaining the large cow size. The big cow's nutrition costs are almost $89 per head higher on native pasture and $256 per head higher in the improved pasture system. Higher levels of operating expenses lead to higher operating interest charges. In addition, some fixed costs such as those for machinery and equipment, fencing and labor are spread over fewer big cows so costs per head are slightly higher. For example, producers will have a charge for a portion of a pickup and trailer for the cow herd regardless of number of head in that herd, so dividing the fixed costs by the total number of head yields a higher per cow cost. Total income and expenses for the ranch, focusing on the returns to the land base rather than income and expenses per head range from a loss of $1,710 for moderate cows on native pasture to a loss of $21,831 for big cows on improved pasture.

While the penalty for having bigger cows may not seem large, the base case assumes that reproductive rates are the same and that calf weaning weights are the same proportion of cow body weight. Some preliminary data suggests that the assumptions of equal calving percentages and weaned calf weight proportional to cow body weight may overestimate what is realized with big cows (Mourer et al; Dobbs, Brown and Lalman). Table 3 shows per cow costs and returns with what may be more accurate calving percentages and weaning weights. Clearly, if weaning

weight is only 12.5 pounds more per 100 pound increase in cow body weight and the calving rate

is 80 percent rather than 87 percent, the potential losses per head are large for big cows. More

work is needed to determine if there should be a reproductive and/or calf weaning weight

discount for the larger mature cow size.

Ranch Optimization Linear Programming Model

Animal unit months have traditionally been used to define the carrying capacity of

pasture. But, the quantity produced and quality of different forages vary significantly over a year

and different cow sizes place different demands on forages, for example. Thus, a model able to

incorporate seasonality of inputs and outputs and solve for optimal solutions under different

conditions may offer different insights. The modeling framework of Smith was adapted to

incorporate the previously described scenarios to determine the optimal use of forage resources

in cow/calf production for moderate and big cows under different scenarios.

The linear programming (LP) tableau is built in Microsoft Excel and refers to other

worksheets containing data, formulas for calculations, and user-entered information regarding

resources and preferences. As the tableau exceeds the limits for the standard Excel Solver,

Premium Solver Platfrom from Frontline Systems is used. Production activities may include

cow-calf, stocker, crop and forage enterprises. For this research, the activities are restricted to

cow-calf and forage enterprises as previously described. The user specifies the total number of

owned acres by land type, the minimum and maximum number of acres of crop and forage

enterprises, and the expected annual production per acre for each forage. Monthly labor

requirements, operating capital, and total costs (excluding labor, feed, and capital costs) for all

forage, crop, and livestock enterprises are specified along with general farm information, such as

starting operating capital, maximum capital that can be borrowed, annual percentage rate on the

borrowed capital, monthly labor hours available from the owner/operator, and the wage rate for hired labor. If labor is a limiting factor in any month, additional labor may be hired up to a user-specified limit. In our modeling, we assume that all labor is hired and that all capital is borrowed.

Cow-calf nutrient requirements are a function of average body weight of cows in the herd, average body condition score for cows, average cow milk production, average expected calf birth weight, expected percent calf crop, and expected calf weaning weights (National Research Council). Cow-calf nutritional requirements are calculated for various stages of the reproductive cycle (first 180 days, following 90 days, and last 90 days). Maximum dry matter intake (DMI) of cows is set to 2.5 percent and minimum consumption to 1.5 percent of body weight. For every pound of DM used by the animals, associated pounds of crude protein (CP) and total digestible nutrients (TDN) are also used. Here, moderate cows are assumed to have 77 pound calves, large cows, 98 pound calves. Expected average milk production for moderate cows is 15 pounds and for large cows, 19 pounds.

Forage quality is characterized by TDN, CP and DM with the quantity produced and quality of different forages varying significantly during a year. Monthly averages of forage TDN, CP and DM are incorporated in the model. Stockpiled forage decreases in available quality and quantity over time. As a research base to document expected degradation or loss of forages is lacking, expert opinions were used as default values. The default value for month-to-month degradation is 90 percent during the non-growing months for each forage. Forage can also be harvested for hay in summer months if not used by the animals.

A limitation of the model is that an animal's DMI should be a function of TDN concentration in the diet. However, because the model selects forages to meet livestock DM requirements and the TDN values vary by forage type and by month, the TDN concentration of

11

the diet is unknown before the model has been run. If the CP or TDN is a limiting factor for the

animal's nutrition in any month, supplemental 20% or 38% range cubes are purchased.

In this application of the model, farm income is generated from the sale of hay or calves.

The calf crop is assumed to be half bull calves and half heifers. An output worksheet

summarizes the number of cows, the number of head of steer and heifers calves sold, and

supplemental hay and feed purchases by month. A labor summary table shows the number of

labor hours used and/or purchased plus total cost of hired labor. Total capital required, own

capital provided, operating capital borrowed, and interest on capital are also tabulated. Finally,

monthly sales and expenses are given along with net returns to land, overhead, own labor and

capital.

Ranch Optimization Model Results

The LP model identifies the combination of resources that maximizes returns to overhead

and fixed costs given specified constraints and represents what might be considered a steady-

state solution. The parameters used in the model (cow weights, calf prices, forage cost of

production, etc.) match those used in the budgeting exercise. We also restrict hay feeding to 30

tons per month from January through March. All labor is hired at $10 per hour. Table 4 reports

the results, which indicate that in theory more livestock could be produced on the forage base

than was used in the conservative budgeting exercise. For moderate cows, 30 more head could be

maintained on native pasture and 46 more on improved pasture and for big cows, 25 more could

be stocked on native pasture and 36 more on improved pasture. The higher stocking rate

contributes to a $12,000 to $23,000 higher value for the net returns to land, management and

overhead before taxes as compared to the returns above operating cost in the budgeting exercise.

Improved pasture scenarios require greater monthly capital. The hay constraint is limiting in all

scenarios except the big cows on improved pasture; many more cubes are fed in native pasture scenarios.

Summary and Conclusions

CowCulator and budget analysis of moderate (1,100 lb.) and big (1,400 lb.) cows on two pasture systems (native range, improved pasture) document that because the big cows wean more pounds, they generate significantly more calf income (despite the lower price per pound). As the price per pound is the same for culls from both moderate and big cow herds, the big cows also generate a bit more cull female income. However, the big cow's nutrition costs are also higher. Higher levels of expenses prior to calf/cull sales also lead to higher operating interest charges. In addition, some fixed costs such as those for machinery, equipment, fencing and labor are spread over fewer head on a specified land base; thus, fixed costs per head for large cows are also slightly higher. The net effect is that the increase in total costs associated with big cows leads to a decrease in returns above all costs. Using historical calf and cull prices with current expense levels, no system is profitable but the native pasture scenarios lose much less money. If weaning weight is only 12.5 pounds more per 100 pound increase in cow body weight and the calving rate is 80 percent rather than 87 percent, the potential losses per head are large for big cows. Linear programming results confirm that moderate sized cows on native pasture offer the greatest returns to land, management and overhead.

In the short run, failure to match livestock enterprises to the forage resources may not cause highly visible negative outcomes. However, in the longer run, forage may be overgrazed causing long-term damage or cow performance may be hindered. While forage can be supplemented to meet cattle's nutritional needs, this can be costly. Higher costs of production lead to higher levels of financial risk. And, having bigger cows can make an operation more

vulnerable in times of drought as more feed must be bought or more pasture found to maintain the cow.

References

Ascough II, J.C., M.J.Shaffer, D.L. Hoag, G.S. McMaster, G.H. Dunn, L.R. Ahuja and M.A. Weltz. "GPFarm: An Integrated Decision Support System for Sustainable Great Plains Agriculture." Sustaining the Global Farm. Selected paper. 10th International Soil Conservation Organization Meeting. Purdue University and the USDA-ARS National Soil Erosion Research Laboratory. 2001. P. 951-960.

Beck, P., B. Stewart, H. Gray, J. Smith, and S. Gadberry. "Effect of Cow-Size and Stocking Rate During Summer Grazing on Calf Growth and Cow Herd Efficiency." *J Anim Sci* 88, E-supplement 3 (2010). Southern Sectional Abstracts. No. 53.

Brown, M.A. and D.L. Lalman. "Preweaning Performance of Calves from Bonsmara, Brangus, Charolais, Gelbvieh, Hereford, and Romosinuano Sires Bred to Brangus Cows Managed on Native Rangeland or Improved Forages." *The Professional Animal Scientist* 24(2008*)*:67-75.

Buttram, S.T. and R.L. Willham. "Size and Management Effects on Reproduction in First-, Second-, and Third-Parity Cows." *J Anim Sci* 67 (1989):2191-2196.

Cartwright, T. C. "Size as a Component of Beef Production Efficiency: Cow-Calf Production." *J Anim Sci* 48 (1979):974-980.

Davis, K. C., M. W. Tess, D. D. Kress, D. E. Doornbos and D. C. Anderson. "Life Cycle Evaluation of Five Biological Types of Beef Cattle in a Cow-Calf Range Production System:II. Biological and Economic Performance." *J Anim Sci* 72 (1994):2591-2598.

Dickerson, G. "Efficiency of Animal Production-Molding the Biological Components." *J Anim Sci* 30 (1970):849-859.

Dobbs, C., M.A. Brown, and D.L. Lalman. "The Relationship of Cow Size and Calf Birth Weight to Calf Weaning Weight in a Commercial Brangus Cow/calf Operation. G. "Efficiency of Animal Production-Molding the Biological Components." *J Anim Sci* 89 e-Suppl.3(2011) in print.

Donnelly, J.R., M. Freer, L. Salmon, A.D. Moore, R.J. Simpson, H. Dove, T.P. Bolger. "Evolution of the GRAZPLAN Decision Support Tools and Adoption by the Grazing Industry in Temperate Australia." Elsevier Agricultural Systems. March 2002.

Doye, D. and R. Sahs. "Oklahoma Pasture Rental Rates: 2010-11." Oklahoma Cooperative Extension Service. CR-216. November 2010.

Ferrell, C. L. and T. G. Jenkins. "Energy Utilization by Mature, Nonpregnant, Nonlactating Cows of Different Types." *J Anim Sci* 58 (1984):234-243.

Frisch, J.E. and H.E. Vercoe. "Food Intake, Eating Rate, Weight Gains, Metablokc Rate and Efficiency of Feed Utilization in Bos taurus and Bos indicus Crossbred Cattle." *Animal Production* 25(1977):343.

Hollaway, J. W. and W.T. Butts, Jr. "Influence of Cow Frame Size and Fatness on Seasonal Patterns of Forage Intake, Performance and Efficiency of an Angus Cow-Calf Pairs Grazing Fescue-Legume or Fescue Pastures." *J Anim Sci* 59 (1984):1411-1422.

Holloway, J. W. and W.T. Butts, Jr. "Phenotype x Nutritional Environment Interactions in Forage Intake and Efficiency of Angus Cows Grazing Fescue-Legume or Fescue Pastures." *J Anim Sci* 56 (1983):960-971.

Jenkins, T.G. and C.L. Ferrell. "Beef Cow Efficiency-Revisited." Beef Improvement Federation Annual Research Symposium and Annual Meeting Proceedings. 2002.

Jenkins, T.G. and C.L. Ferrell. "Productivity Through Weaning of Nine Breeds of Cattle Under Varying Quantities of Dietary Energy. Initial Estimates." *J Anim Sci* 72(1994):2787.

Johnson, J.J., B.H. Dunn, and J.D. Radakovich. "Understanding Cow Size and Efficiency." Beef Improvement Federation 42nd Annual Research Symposium and Annual Meeting Proceedings. 2010. pp. 62-70.

Klosterman, E.W. "Beef Cattle Size for Maximum Efficiency." *J Anim Sci* 34(1972):875.

Lalman, D. "CowCulator". http://www.beefextension.com/new%20site%202/cccalc.html , September 13, 2010.

Lalman, D.L., C.P. McMurphy, G.L. Mourer, A.J. Secten, G.E. Selk, and D.R. Stein. "Matching the Cow to Forage Resources." *J Anim Sci* 88, E-supplement 3 (2010) Midwest Sectional Abstract No. 50.

Long, C. R., T. C. Cartwright and H .A. Fitzhugh, Jr. "Systems Analysis of Sources of Genetic and Environmental Variation in Efficiency of Beef Production: Cow Size and Herd Management." *J Anim Sci* 40(1975):409-420.

MacNeil, M.D. "Genetic Evaluation of the Ratio of Calf Weaning Weight to Cow Weight." *J Anim Sci* 83(2005): 794-802.

May, Gary J., Larry W. Van Tassell, Michael A. Smith and James W. Waggoner. "Profitability of Establishing Basin Wildrye for Winter Grazing." Selected Paper. Western Agricultural Economics Association Annual Meetings. Fargo, North Dakota. July 11-14, 1999.

Montano-Bermudez, M.K. Nielsen, and G.H. Deutscher. "Energy Requirements for Maintenance of Crossbred Beef Cattle with Different Genetic Potential for Milk." *J Anim Sci* 68(1990): 2279-2288.

Mourer, G.L., C.P. McMurphy, E. Devuyst, and D.L. Lalman. "Relationship of Cow Size to Calf Weaning Weight in a Commercial Cow/calf Operation in the Southern Great Plains." *J Anim Sci* 88 e-Suppl. 2 (2010): 771.

Olson, L.W., D.E. Peschel, W.H. Paulson and J.J. Rutledge. "Effects of Cow Size on Cow Productivity and on Calf Growth, Postweaning Growth Efficiency and Carcass Traits." *J Anim Sci (*1982):704-712.

Redfearn, D., B. Arnall, H. Zhang, C. Rice. "Fertilizing Bermudagrass Hay and Pasture." Oklahoma Cooperative Extension Service PSS-2263. April 2010.

Rotz, C.A., D.R. Buckmaster and J.W. Comerford. "A Beef Herd Model for Simulating Feed Intake, Animal Performance and Manure Excretion in Farm Systems." *J Anim Sci* 83(2005):231-242.

Sahs, R. and D. Doye. "OSU Enterprise Budget Software." [www.agecon.okstate.edu/budgets. Accessed September 2010](www.agecon.okstate.edu/budgets).

Smith, K. E. "Optimizing Forage Programs for Oklahoma Beef Production." MS. Thesis, Oklahoma State University. December, 1999.

Stewart, T. S. and T.G. Martin. "Mature Weight, Maturation Rate, Maternal Performance and Their Interrelationships in Purebred and Crossbred Cows of Angus and Milking Shorthorn Parentage." *J Anim Sci* 52(1981): 51-56.

Stokes, K. W., C. R. Shumway, P. E. Doren, W. O. Ajayi, T. C. Nelsen and T. C. Cartwright. "Economic Effects of Alternative Beef Cow Size and Milking Potential in Cow-Calf Operations. " *J Anim Sci* 62(1986):1154-1163.

Taylor, St.C.S., R.B. Thiessen and J. Murray. "Inter-breed Relationship of Maintenance Efficiency to Milk Yield in Cattle." Animal Production. (1986)43:37.

Tess, M. W. and B. W. Kolstad. "Simulation of Cow-Calf Production Systems in a Range Environment: II. Model Evaluation." *J Anim Sci* 78(2000):1170-1180.

Urick, J. J., B. W. Knapp, J. S. Brinks, O. F. Pahnish and T. M. Riley. "Relationships Between Cow Weights and Calf Weaning Weights in Angus, Charolais and Hereford Breeds." *J Anim Sci* 33(1971):343-348.

USDA-ERS. "Agricultural Baseline Projections: Global Agricultural Trade, 2010-2019." http://www.ers.usda.gov/briefing/baseline/trade.htm Accessed January 11, 2011.

van Oijen, M., M. Montano-Bermudez, and M. K. Nielsen. "Economical and Biological Efficiencies of Beef Cattle Differing in Level of Milk Production." *J Anim Sci* 71(1993): 44-50

Wachenheim, C.J., J.R. Black, M.L. Schelegal and S.R. Rust. "Economics of Alternative Stocking Densities for Direct-Seeded Central Michigan Alfalfa Pastures." Department of Agricultural Economics. Michigan State University. Staff Paper 99-40. July 1999.

Wagner, W. R., J. S. Brinks, J. J. Urick, O. F. Pahnish and G. v. Richardson. "A Comparision of Crossbred and Straightbred Cow-Calf Pairs. II. Biological Efficiency of the Cow-Calf Unit." *J Anim Sci* 58(1984):1160-1170.

Table 1. Key differences in production parameters for moderate versus big cows

	Moderate Cows		Big Cows	
Production differences				
Cow weight	1,100		1,400	
Bull weight	1,750		2,400	
Weaned heifer weight	480		615	
Weaned heifer price ($/cwt)	110.37		102.08	
Weaned steer weight	510		645	
Weaned steer price ($/cwt)	115.7		109.44	
Herd size: breeding females	100		76	
Supplementation (lb/hd/day) for cows	Native Pasture	Improved Pasture	Native Pasture	Improved Pasture
Protein fed: 38% cubes	1.5 #, 150 d	2 #, 150 d	2 #, 150 d	
Hay: Prairie	24 #, 30 d		31 #, 30 d	
Hay: Bermuda		24 #, 75 d		31 #, 75 d
Minerals	.12 lb/hd/day		.16 lb/hd /day	
Labor	5.65 hours/head		7.59 hours/head	

Table 2. Budget results

	Native Pasture		Improved Pasture	
($ per breeding female)	Moderate Cows	Big Cows	Moderate Cows	Big Cows
Income items				
Calf income	313.59	372.76	313.59	372.76
Cull cow income	103.99	130.61	103.99	130.61
Gross income	**417.58**	**503.37**	**417.58**	**503.37**
Expense items				
Pasture	120.00	157.89	286.40	376.84
Hay	24.51	41.69	40.84	92.74
Protein	40.54	70.93	14.36	18.83
Minerals	13.14	17.52	13.14	17.52
Nutrition subtotal	*199.14*	*288.03*	*354.74*	*505.95*
Vet	8.15	8.41	8.15	8.41
Marketing	7.68	7.61	7.68	7.61
Fuel, lube repairs	24.09	31.69	24.09	31.69
Labor	56.50	75.90	56.50	75.90
Operating interest	14.01	19.77	22.18	31.21
Total operating costs	*309.57*	*431.41*	*465.18*	*660.77*
Returns above op. costs	**108.01**	**71.96**	**-55.76**	**-157.40**
Fixed costs	125.11	129.85	125.11	129.85
Total costs	*434.68*	*561.26*	*598.45*	*770.79*
Returns above all costs	**-17.10**	**-57.89**	**-180.87**	**-287.25**
Returns above all costs to the land base ($)	**-1,710**	**-4,400**	**-18,087**	**-21,831**

Table 3. Returns to big cows on native pasture with different assumptions on calving rate and weaning weight ($ per breeding female)

	Base case	Lower calving rate (80%)	Lower weaning weight at 12.5# more per 100 lb. increase in cow weight	Lower weaning weight at 12.5# more per 100 lb. increase in cow weight & 80% calving
Gross income	503.37	458.09	461.47	421.83
Total operating cost	431.41	Same	Same	Same
Returns above operating cost	71.96	26.68	30.06	-9.58
Fixed costs	129.85	Same	Same	Same
Total costs	561.26	Same	Same	Same
Returns above all costs	**-57.89**	**-103.17**	**-99.79**	**-139.43**

Table 4. Profit-Maximizing Solutions to Model Runs

	Native Pasture		Improved Pasture	
	Moderate Cows	Big Cows	Moderate Cows	Big Cows
Net returns to land, management and overhead before taxes	$24,466	$21,193	$15,928	$12,188
Sales	$61,176	$56,300	$68,593	$62,535
Expenses	$36,710	$35,107	$52,665	$50,347
Number of cows	130	101	146	112
Annual labor requirements	818	844	898	917
Maximum monthly capital	$20,435	$19,210	$29,663	29,436
Bermuda hay fed	77.9 tons	75.8 tons	64.9 tons	55.3 tons
Prairie hay fed	12.1 tons	14.2 tons	25.1 tons	26.9 tons
Total hay fed	90 tons	90 tons	90 tons	82.2 tons
20% cubes fed	8.0 tons	None	None	None
38% cubes fed	5.8 tons	7.3 tons	4.0 tons	None
Total cubes fed	13.8 tons	7.3 tons	4.0 tons	None