8-2013

# Evaluating Economic and Environmental Impacts of Changing Herd Sire Genetics on Arkansas Cow-Calf Operations

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on Arkansas Cow-Calf Operations

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Agriculture Economics

By

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University of Arkansas
Bachelor of Science in Animal Science, 2011

August 2013
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

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**ABSTRACT**

This thesis is divided into four chapters. The first chapter explains the reasoning behind the thesis work. The second chapter describes the concept of and tutorial for the Forage Cow-Calf Calculator. The third chapter examines the ‘Bull Estimator’ section of the Forage Cow-Calf Calculator by modifying herd sire genetics and cattle prices to analyze their impact on farm profits and GHG emissions. The final chapter provides a brief summary, limitations and offers areas for future research.

## ACKNOWLEDGEMENTS

Foremost, I would like to express my gratitude to my thesis advisor and academic mentor, Dr. Michael Popp, for his support and guidance over the past two years.  I really appreciate all that you have done for me since my enrollment in graduate school.

Next, I would to thank Dr. Lanier Nalley and Dr. Ken Coffey for serving on my thesis committee and providing their support and expertise.

Lastly, I would to thank all of the faculty and staff of the Agricultural Economics Department at the University of Arkansas for their commitment to this program and its students.

## DEDICATION

This thesis is dedicated to my parents for their support over the past two years and throughout my life.  I would also like to dedicate this to the rest of my family for the support they have shown over the past few years.

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# Chapter 1

## I. Introduction

Arkansas cow-calf operators are currently faced with a dilemma. They are currently selling feeder calves that are bringing high prices, but also having increases in costs as many farm inputs are at similarly high prices. This situation is causing producers to wonder just what the economics of their operation looks like. Also, with ever increasing concern over climate change, cow-calf operators now may want to consider tracking the greenhouse gas (GHG) emissions of their operation as well. The Forage Cow-Calf Calculator combines farm economics with GHG emissions giving the producer one tool that allows them to see both the economic and environmental impacts for each sector of their operation.

Cow-calf operations are a crucial part of Arkansas agriculture. There are a variety of reasons why people have cow-calf operations; ranging from sole source of income, to supplemental source of income, to hobby farming. In 2010, across the state, cattle farming and ranching accounted for a total income of $45,047,392.61 (McGraw et al. 2012). The 2007 census of agriculture reported that there were a total of 25,361 cow-calf farms in Arkansas (NASS 2007). Comparing this to the total number of farms in Arkansas (49,346) it shows that around 51% of the farms have a cow-calf enterprise (NASS 2007). Of the 25,361 cow-calf farms approximately 79% had less than 50 cows (NASS 2007). Economically, Arkansas cow-calf farms were reported to have sales totaling $625,996,000 which represents approximately 8% of total reported sales for Arkansas agriculture (NASS 2007). Further, approximately 63% of total cow-calf sales came from farms that had annual sales of over $50,000 (NASS 2007). The Arkansas Beef Council reports on their website that, “about 97% of the beef cattle farms in Arkansas are family owned and operated (Arkansas Beef Council 2013).” Even though the majority of Arkansas cow-calf farms are small and family owned, the Arkansas Beef Council estimates that the total economic impact of the Arkansas beef industry is greater than $2 billion (Arkansas Beef Council 2013).

The struggle with weather and rising costs over recent years has shown the need of cow-calf operators for a tool to assist them in decision making. For Arkansas, many of the cow-calf budgets available to producers are outdated. A majority of the budgets are more than ten years old and hence were in need of updating not only in terms for price information and production practices but also in terms of mode of delivery (paper vs. interactive spreadsheet based).

The Forage Cow-Calf Calculator was thus developed to help Arkansas cow-calf operators better understand the economics of their operation and to assist them in decision making processes. Many other Universities and research centers have provided calculators that share a similar overall goal for producers in their state or region. Although these calculators are designed for a specific region or state, this does not mean that their usefulness is just limited to that particular area. It is important to remember that prices and costs given in these calculators are based on reported prices and costs for the specific area, but with calculators that allow you to enter in your own data or with a working knowledge of how revenue and costs are calculated, an operator in a different area is still able to use the calculator with effectiveness. Calculators designed by Oklahoma State University and the University of Missouri are being used by Arkansas Cow-Calf operators; however, these calculators do not always include management practices typical for Arkansas. One such calculator is “The Oklahoma Ranch Calculator” designed by Oklahoma State University (Lusby and Walker 2010). This calculator shows the economics for each section of a cow-calf operation; mature cows, yearling heifers, first calf heifers, and bulls. Another cow-calf calculator is the “Beef Cow Cost of Production Calculator” designed by the Agriculture Information Centre in Ontario, Canada (Handley et al. 2012). An interesting aspect of this calculator is that it looks at Risk Analysis for the operation. A third cow-calf calculator is the "Budgeting for Value: Missouri Cow-Calf Enterprise Calculator" designed by the University of Missouri (Dhuyvetter et al. 2013). This calculator breaks the operation's economics into two categories based on calving season; fall or spring. Users can look at default assumptions for the state of Missouri before entering data or making operational decisions. While these three calculators contain many useful aspects, they do not contain many of the aspects found in the Forage Cow-Calf Calculator. Forage production, default price information for the past year, most recent 5- and 10-year averages, GHG emissions, and genetics are some areas that are included in the Forage Cow-Calf Calculator, but are not included in these three calculators and many of the other available calculators. Other universities and research centers have developed calculators that assist with certain areas and aspects of cow-calf operations including fencing (Turner et al. 2005) , feeding (Lalman and Gill 1996), cow worth (Falconer and McGrann 2011), bull worth (McGrann and Waggoner 2012), and marketing (Lalman and Gill 2001). These calculators can be extremely helpful to producers with questions in these areas; however, they are not designed to act as a calculator for the entire operation.

The Forage Cow-Calf Calculator shows farm economics and environmental impacts for both a state bench mark farm and a user defined farm. The calculator contains separate tabs for many of the different aspects pertaining to a cow-calf operation. Summary tabs for economic returns along with a price sensitivity analysis and a GHG summary categorized by source and totaled by farm, per acre or per pound of beef sold allow a snapshot of the operation's performance. While it is impossible for the calculator to exactly define the myriad of different operational scenarios existing in Arkansas, the user can specify many operational details to provide a working model of their operation's performance for one year under the assumption that the operator wishes to maintain their herd size. Understanding the operation's economics will allow the user to make sounder decisions about ramifications of changing the herd size, cattle genetics, forage species and fertilizer application levels separately for hay and pasture, calving season, weaning age, stocking rate, harvesting of hay from pastures, equipment and building investment, cattle price levels and related areas. Understanding farm finances will give the operator a better understanding of their situation as they sit down with their lender. The calculator also provides the user with a better understanding of the environmental impacts of changes in production practices on their operation's GHG emissions. In summary, operators can use the information reported in the calculator to evaluate management decisions prior to making them to get a better understanding of their impact.

**Objectives**

Rather than stating testable hypotheses for this work, objectives are listed as the modeling framework used within did not allow for statistical analyses. Hence, the specific objectives of this thesis were to: i) highlight the conceptual underpinnings of the Forage Cow-Calf Calculator as shown in the calculator's user manual available at http://agribus.uark.edu/2910.php which is not printed herein due to figure style guideline limitations; ii) determine profitability difference as a result of herd sire selection away from a baseline of Angus sired calves from commercial white cows; iii) highlight what drives these profitability changes; iv) estimate the size of GHG emission reductions attainable with herd sire selection; v) analyze whether GHG mitigation motivated by changes in herd sire selection is profitable or not; vi) demonstrate how price factors and initial price levels (2012 vs. 5 yr and 10 yr average) affect profitability changes; and vii) showcase how robust genetics recommendations are when changing baseline herd genetics.

## Components of Thesis

This thesis is broken into several different chapters. This first chapter serves as an introduction to the thesis. The second chapter focuses on the ‘Bull Estimator’ section of the calculator by modifying and analyzing herd sire genetics changes on farm profits and GHG emissions. Finally, chapter three provides conclusions about the use of the Forage Cow calf Calculator with respect to cattle genetics, discusses potential limitations of the tool and as provides areas of interest for future research.

## References


Arkansas Beef Council. 2013. Available at http://www.arkansasbeef.org/arkansasbeeffacts.aspx. (accessed 25 April 2013).

Dhuyvetter, K., W. Tucker, E. Cole, and J. Horner. 2013. " Beef Cow/Calf, Projected Budget for Calves Sold in 2013, South Missouri.” University of Missouri Extension Service. Available at http://agebb.missouri.edu/mgt/budget/.

Falconer, L., and J. McGrann. 2011. "Cow Bid Price Estimate Calculator." Texas Agrilife Extension and Oklahoma State University. Available at http://www.scribd.com/doc/58907767/Cow-Bid-Price-Estimate-Calculator.

Handley, J, N. Noecker, and J. Molenhuis. 2012. "Beef Cow Cost of Production Calculator." Ontario Ministry of Agriculture, Food, and Rural Affairs. Available at http://www.omafra.gov.on.ca/english/busdev/bear2000/Budgets/livestock/cattle/cowcalf.xls.

Lalman, D., and D. Gill. 1996. "Cowculator 2.0." Oklahoma State University, Department of Animal Science. Available at http://beefextension.com/new site 2/cccalc.html.

Lalman, D., and D. Gill. 2001. "Oklahoma State University Preconditioning Value Calculator." Oklahoma State University, Department of Animal Science. Available at http://beefextension.com/new site 2/cccalc.html.

Lusby, K., and O. Walker. 2010. "Oklahoma Ranch Calculator." Oklahoma State University. Available at http://beefextension.com/new site 2/cccalc.html.

McGrann, J., and C. Waggoner. 2012. "Bull Investment Cost Analysis." Texas Agrilife Extension and Oklahoma State University. Available at http://beefextension.com/new site 2/cccalc.html.

McGraw, K., J. Popp, and W. Miller. 2012. “Economic Contribution of the Agricultural Sector to the Arkansas Economy in 2010.” Available at http://arkansasagnews.uark.edu/991.pdf.

National Agricultural Statistics Service (NASS). 2009. "2007 Census of Agriculture." Available at http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1, _Chapter_1_State_Level/Arkansas/.

Turner, L., J. Bicudo, and G. Rajput. 2013. "Fencing Cost Calculator." University of Kentucky, Department of Biosystems and Agricultural Engineering. Available at http://jokko.bae.uky.edu/ext/Livestock/Calculators/LivestockCalculator_FenceWovenBarbed.htm.

# Chapter 2

Economic and Greenhouse Gas Emission Repercussions of Changing Herd Sires:

Using a New Forage Cow Calf Calculator under Arkansas Conditions

By

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The authors are grateful for helpful suggestions from Ken Coffey, Johnny Gunsaulis, Jeremy Powell and Hayden Brown

## II. Economic and Greenhouse Gas Emission Repercussions of Changing Herd Sires: Using a New Forage Cow Calf Calculator under Arkansas Conditions


### ABSTRACT

This research looks at impacts of changing sires, and thus bull genetics, on cow-calf operations of varying land and herd sizes in the state of Arkansas. A 2012 Across-Breed EPD table, adjusted to the Angus breed, was used to estimate breed sire effects on birth weight and weaning weight of the herd's offspring (Kuehn and Thallman 2012a). Together with modified animal performance, the use of 2012 and most recent five- and ten- year Arkansas state average prices, allowed the evaluation of changing herd sires by accounting for breed type and hide color differences in prices. Using a spreadsheet tool that tracks operation-specific details of cow-calf operations, side by side comparisons of herd sire breed with respect to sale price, birth and weaning weight and attendant feed and birthing difficulty related costs could be translated to changes in net returns for the entire operation as well as on a per cow basis. From these breed related estimates of net returns, breakeven price premiums or discounts a producer would pay for the new bull compared to the existing bull could be determined. In addition to evaluating economic implications of bull genetics, the spreadsheet model also tracks the operation's greenhouse gas (GHG) emissions with changes in cattle weights and days on feed. The analysis thus highlights situations where herd sire selection could be both profitable and mitigate GHG emissions as opposed to only profitable or only GHG friendly. For analysis, a baseline farm was established. This baseline farm consisted of a medium-sized operation that had 60 hay acres, 180 pasture acres, 45 commercial white cows, and two Angus bulls. Given this baseline scenario, it is shown that an operator could have the greatest increase in profits and greatest decrease in GHG emissions by switching to a Simmental bull. Choice of bull genetics is highly dependent on the operation and the baseline breed of cows used for analysis. This result validates the concept of using a reasonably comprehensive model of a cow-calf operation for this type of analysis.

Keywords: Expected Progeny Differences, Breed, Sire, greenhouse gas emissions

Abbreviations: BW = Birth Weight, CWT = Hundredweight (100 lbs.), EPD = Expected Progeny Differences, GHG = Greenhouse Gas, WW = Weaning Weight, YW = Yearling Weight

## INTRODUCTION

Cow-calf operators have many breeds and cross-breeds to choose from when choosing herd sires for their operation. Normally, when operators are choosing herd sires, factors such as birth weight, weaning weight, and calf hide color are considered when making decisions related to genetics (Greiner 2005). For Arkansas cow-calf operators, bulls of black hide (Angus, Brangus, etc.) seem to be most popular noticing that nearly 53% of calves sold at Arkansas cattle auctions in 2010 possessed a black hide (Troxel and Barham 2012). However, given the increases in feed costs and droughts that have affected the state recently, many operators are starting to consider other factors such as heat tolerance, average daily gain, and days on feed in their bull purchasing decisions. To attain similar profits or to increase profits, operators need to take all these factors into consideration when comparing their existing bull to a potential new bull. If all of these factors are not considered, a bull with higher weaning weight (WW) could be purchased but lead to pricing discounts on large calves that eat more feed and are actually less profitable.

With constantly increasing concern over climate change, farmers are also considering their farms' environmental impact by tracking greenhouse gas (GHG) emissions as this metric is often proposed for potential climate change legislation. Some retailers also have sustainability efforts ongoing and want the supply chain to provide them with GHG emissions estimates. Therefore, some operators are looking at practices that minimize their use of tractors and other farm machinery and monitoring their fertilization practices; however, for many cow-calf farms, the cattle are the largest source of GHG emissions when considering carbon dioxide ($CO_2$) released via gases leaving the body, methane ($CH_4$) released through enteric fermentation, and the release of nitrous oxide ($N_20$) through the breakdown of manure and urine. There are many different cattle management strategies that operators can implement that are shown to decrease GHG emissions on cow-calf operations.

Most cow-calf operators know that their herd sire is one of the biggest contributors to their operation's overall profitability; however, many operators are unable to easily compute what they can afford to pay for a new herd sire. A tool that assists with the analysis of higher calf performance statistics versus higher genetics costs is thus desirable. Higher weaning weights may also modify feed requirements and different hide colors lead to varying premiums or discounts in the market place. When choosing a new herd sire, cow-calf operators many times also consider the impact of the bull on calving ease. On the one hand, if their cow herd is comprised largely of first time heifers and young cows or of a breed with smaller framed cows than the breed of the sire, bulls that sire calves with high birth weights need to be more carefully considered as this can potentially increase calving difficulty and calf dystocia resulting in greater death losses and/or veterinary charges. On the other hand, farms comprised mostly of older cows or of a large-framed breed will normally be less affected by increases in calf birth weight. Also, if all of a farm's cows are polled and the current bull is polled, then a switch to a horned bull could produce a large amount of calves with horns. This means that the farmer will have to either dehorn these calves or be willing to take the price discount that horned calves usually receive at sale time.

The 'Bull Estimator' tab in the Forage Cow-Calf Calculator developed by the University of Arkansas was created as an analytical framework to assist cow-calf operators in determining the answers to the above questions and considerations for their operation. The focus of the 'Bull Estimator' tab is to i) apply average genetic changes in offspring's birth weight (BW) and WW between two bull breeds on the basis of EPDs; ii) calculate and compare attendant price adjustment factors and anticipated birthing difficulty and GHG emissions changes; iii), assist in calculating breakeven purchase price; and iv) show the total profit impact for the operation when herd sires are changed. Breakeven purchase price is calculated based on weight changes, change of inputs needed, and sale price factors. A glimpse of how the 'Bull Estimator' is set up is shown in Figure 1.

The specific objectives of this paper were thus to: i) determine profitability difference as a result of herd sire selection away from a baseline of Angus sired calves from commercial white cows; ii) highlight what drives these profitability changes; iii) showcase the size of GHG emission reductions attainable with herd sire selection; iv) analyze whether GHG mitigation motivated by changes in herd sire selection is profitable or not; v) demonstrate how price factors and initial price levels (2012 vs. 5-yr and 10-yr average) affect profitability changes; and vi) showcase how robust genetics recommendations are when changing baseline herd genetics.

## MATERIALS AND METHODS

### *Across-Breed EPD Table*

An Across-Breed EPD table was used to calculate the genetic impact of sire selection on BW and WW. Table 1 shows the Across-Breed EPD values from the updated 2012 version created by Dr. Larry Kuehn and Dr. Mark Thallman of the U.S. Meat Animal Research Center (MARC) (Kuehn and Thallman 2012a). For within breed comparisons, EPD values are commonly used to track the quality of a bull visa vis the breed average; however, with an Across-Breed EPD table, comparisons can be made between two bulls of different breeds. Across-breed EPD values are the appropriate adjustments that are needed to equalize breed EPD values across all breeds. To equalize all breeds, one breed is established as the base breed. In the Across-Breed table used, all breeds were compared to the Angus breed. Further, having Across-Breed EPD values, comparisons can be made between two bulls of different breeds with or without known breed EPD values. The table used gave Across-Breed EPD values for BW, WW, yearling weight (YW), milk (MILK), marbling (MAR), ribeye are (REA), and fat thickness (FAT) (Kuehn and Thallman 2012a). It also reported a mixture of these values for 18 beef cattle breeds which were Angus, Beefmaster, Brahman, Brangus, Braunvieh, Charolais, Chiangus, Gelbvieh, Hereford, Limousin, Maine Anjou, Red Angus, Salers, Santa Gertrudis, Shorthorn, Simmental, South Devon, and Tarentaise (Kuehn and Thallman 2012a). In the 'Bull Estimator' tab, BW, WW and YW are shown but only EPD values related to BW and WW are actually used in the model when changing sire genetics as price information used in the calculator is limited to #3-700 calves and hence yearling weights, while of interest, are heavier than the range of price information available. Further, BW, WW, and YW are thought to be most important in calf performance for an operation typically selling their calves at weaning (Hammack 2008). These three EPD values were reported for all 18 breeds. For operators who know their existing bull's EPD values, the new bull's EPD values, or both, they can enter these numbers instead of accepting the default breed averages (Table 1) as reported by Kuehn and Thallman (2012c). Accuracy values for EPDs were not considered in this research since reported breed averages were used. Accuracy values show how accurate an EPD is for a certain trait and increases as the number of progeny increases. Natural service bulls many times have lower accuracy values than artificial insemination (AI) bulls as their number of progeny is lower. Either the breed average or user-specified EPD values are adjusted with the appropriate Across-Breed EPD values so that comparisons can be made. This is done by taking the potential bull's EPD for one trait, adjusting it with the appropriate Across-Breed EPD, and then subtracting it from the properly adjusted existing bull's EPD for the same trait. Hence, as an example, if comparing BW between an existing Angus bull and a new Simmental bull, take the Simmental's 0.7 breed average BW EPD adjust it by adding the Simmental Across-Breed BW EPD of 5.2, resulting in an adjusted 5.9 BW EPD. For the Angus bull one would follow the same process. Taking the Angus breed average 1.8 BW EPD and adjusting it with the Angus Across-Breed EPD BW of 0 gives a 1.8 adjusted BW EPD. Subtracting 1.8 from 5.9 implies that, on average, when bred to the same cows, the Simmental bull is expected to sire calves with birth weights that are 4.1 lbs. heavier than calves from the Angus bull. The same methods are used when comparing two bulls with known EPD values by using user-specified EPD values instead of the breed average EPD values. Comparisons can also be made when EPD values are known for only one bull; however, when comparing a bull with known EPD values to one with unknown EPD values there is a greater chance for discrepancies in the comparison as the bull with unknown EPD values could be considerably below or above their breed average. Similar discrepancies can also occur when comparing bulls with varying accuracy values. The process described above can also be applied to other performance statistics such as WW, YW, MILK, MAR, REA, FAT, etc.

*Price Adjustment Factors*

Price factors were developed for each of the three user choices for prices; 2012, 5-yr and 10-yr averages available in the Forage Cow-Calf Calculator and are summarized in Table 2. Price adjustment factors for 2010 were derived from "Phenotypic Expression and Management Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions" by Dr. T.R. Troxel and Dr. B.L. Barham (2012). To construct the five year average price factor to accompany the five year average cattle prices, price factors for 2005 were derived from "Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions in 2005," by

Dr. B.L. Barham and Dr. T.R. Troxel, and were averaged with the 2010 price factors (Barham and Troxel 2007). To construct a ten-year average price factor to accompany the ten-year average cattle prices, price factors for 2000 were derived from "Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions," by Dr. T.R. Troxel et al. (2002) and were averaged with the 2005 and 2010 price factors (Troxel et al. 2002). These price factors are also shown graphically in Figure 2.

These breed price indexes were developed using prices from 14 Arkansas livestock auctions to generate average prices for seven breeds, thirteen crossbreeds, and ten hide colors (Troxel and Barham 2012). Price adjustment factors are the reported, average annual hundredweight (CWT) price for a particular breed, crossbreed, or hide color divided by the reported overall average annual CWT price (Troxel and Barham 2012) of all weekly prices received for calves and yearlings over the course of the reported year and across the 14 different auctions. Since the reported prices in the papers are averages over the course of the reported year, possible effects of changes in price premiums or discounts by selling week, sale barn or weight class are not accounted for. Reported overall average prices for 2010, 2005, and 2000 were $108.58, $118.10, and $93.95 respectively. In the model, this price ratio by breed was used to adjust for hide color and other breed differences by multiplying it with the appropriate state average price for a particular weight class, gender and selling month as reported in the University of Arkansas Extension publication "Livestock Market News Roundup for 1990-2010 by Steve Cheney with updates for 2011 and 2012(Cheney 2011) in Figures 3 to 5. An average sale price for calves with the presence of horns was also reported in each of the papers (Troxel and Barham 2012; Barham and Troxel 2007; Troxel et al. 2002). An average price discount for the presence of horns was created on the basis of this reported price difference. For example, in 2010 the average selling price for calves with horns was 7.3% less than for calves without horns or a price ratio of 0.927 in Table 2. The discount for the presence of horns was applied by multiplying its price ratio with the breed adjusted price.

To determine which price factor most accurately represents the user's operation the user can specify a breed or composite breed for the majority of their cows in the 'Bull Estimator' tab in Figure 1 (A). The user may choose from the 18 bull breeds along with six commercial options to find the best match for their cow herd near the top right. The six commercial options are based upon the four major hide colors (black, red, yellow, and white), a spotted or striped hide, and an overall commercial herd that does not show a particular dominant hide color. Price factors for the overall commercial are derived from the average of the five other commercial options. Price factors for the spotted or striped commercial option will not change due to herd sire change because calves are assumed to still show spots or stripes. Price factors for the overall commercial option will not change due to herd sire change because there will still be a large amount of hide color variance. Based on the user's answers for both the cow breed (A) and the breed of bull in middle section (B) of Figure 1, price factors, adj. BW and WW as well as anticipated changes in calving difficulty were applied to relevant parameters in the rest of the model. Calving difficulty was increased by 2% for each added pound of birth weight (Ritchie and Anderson 1994). Cow and calf losses from dystocia increase as calving difficulty increases. The number of caesarian sections changes as calving difficulty changes and is determined by multiplying the number of heifers and cows bred by the anticipated percentage of calving difficulty and then multiplying that number by the anticipated percentage to need a C-section (McDermott et al. 1991). However, to properly capture calving problems the cow's effect needs to be considered. To capture the cow's effect, the BW value for cows was set at the same level as for that of the bull of the same breed. Therefore, an anticipated increase in calving difficulty would only be expected if the new bull's BW was higher than both the existing bull's BW and the cow's BW. Even after the calf is born, there may be lingering side effects from a difficult birth. "Calves that experience dystocia at birth are 13 times more likely to be born dead or die within the first 12 hours of life compared to calves with normal births, 2.5 times more likely to become ill, and 5 times more likely to die during the first 45 days of life (Cooke et al. 2008)." The model accounts for these breed effects by providing an anticipated change in calving difficulty (C) in Figure 1 and multiplying this increase in calving difficulty by 0.135 and 0.05 (McDermott et al. 1991) to modify calf and cow death loss percentages, respectively.

*Greenhouse Gas Emissions*

The three main gases emitted by cattle operations are $CO_2$, $CH_4$ and $N_2O$. In the Forage Cow-Calf calculator, cattle $CO_2$ emissions were estimated with a formula presented in the "Release of Methane and Carbon Dioxide in Dairy Cattle" by Kirchgessner et al (Kirchgessner et al. 1991). Methane and $N_2O$ emissions were estimated using IPCC tier II estimates for livestock emissions (IPCC 2007). All emissions were converted to their $CO_2$ equivalent to account for differences in global warming potential across the different gases. Greenhouse gas emissions from the decomposing of dead animals was not included in GHG calculations and neither were GHG emissions associated with supplemental feed purchased as both sources are expected to be minor especially when making comparisons across herd sire genetics. Emissions are reported in the 'Bull Estimator' tab as changes in GHG emissions per live weight sold in Figure 1 (F). For this measurement, net cattle emissions by the herd are divided by the total weight of all cattle sold from the operation including calves, cull cows, and cull bulls. Depending on replacement rate as affected by death losses from sire effects, some cow-calf operations sell more calves, on an annual basis, than cull cows and bulls combined. Therefore, in these instances calf weights can have a relatively large impact on GHG emissions. The interested reader is directed to Smith's (2013) dissertation for further details on GHG calculations in the Forage Cow-calf Calculator.

*Baseline*

To demonstrate the economic and GHG effects associated with the purchase of a new bull of different genetics than the original bull, a baseline farm was needed for making comparisons using the Forage Cow-Calf Calculator. This baseline was developed to reflect production choices of a typical Arkansas cow-calf operation. Given the large variation in operation types observed in Arkansas, a typical or statistically representative average farm is a difficult concept. Nonetheless the following represents the production parameter assumptions used for the baseline. Commodity prices were for 2012 cattle and fertilizer as well as 2012 for all other inputs (Table 3). The baseline farm was considered a medium-sized farm with 60 hay acres and 180 pasture acres. Fertilizer application on hay land involved 0.25 ton of lime, 100 lbs of ammonium nitrate (34-0-0) and two tons of poultry litter (3-2-3). Pasture land received the same level of lime and 0.5 ton of poultry litter by comparison. Forage composition by area for the pasture was set to 25% bermudagrass, 55% fescue, 10% orchardgrass, and 10% clover. Hay land was assumed to be comprised of 50% bermuda, 45% fescue and 5% clover. Continuous grazing on pasture resulted in an expected grazing efficiency of 50% such that half of forage growth 2" in height above the ground would be eaten by cattle with the remainder going unused due to bedding, trampling, presence of manure paddies, or not grazed due to palatability issues of mature forage. Cattle management practices assumed year-round calving with a resultant year round calf sale distribution at a weaning age of seven months. Both BW and WW were adjusted by typical breed performance estimates as reported by Kuehn and Thallman 2012b (Table 4). All other cattle management practices are shown in Table 5. Bagged corn was the supplemental feed provided when total digestible nutrient needs of the herd were not met on a month to month basis. Default values for equipment and building ownership charges for a medium-sized cattle operation were employed as shown in Table 6. The ‘Bull Estimator’ options were set as shown in Figure 1, except that all different bull breeds were compared to the Angus baseline.

*Baseline Genetics*

Baseline genetics are established by the user’s answer to cow herd composition and existing bull breed. The baseline genetics used in this paper consisted of a commercial white cow herd and average Angus bulls. A commercial white cow herd means that there is a variety of hide colors in the herd, but white is dominant. The Angus bulls are considered average because breed average EPD values were accepted. Calving difficulty, calf weaning weights, and price factors received are all factors affected by genetic change and are all factors that affect farm profitability. To determine whether the choice of baseline genetics had an impact on profit maximizing sire breed chosen, sensitivity analysis was performed by changing the baseline breed from Angus × commercial white by changing to each of the 23 other cow breed choices (as outlined in the Table 7).

*Breakeven Purchase Price*

The ‘Bull Estimator’ tab can also give users an idea of what they can afford to pay for a new bull holding profit levels constant by modifying the cell described as the ‘Cost of the New Bull(s) near the middle right in Figure 1 (D). The breakeven purchase price is calculated based on potential profit changes over the life of the bull by allowing for changes in BW and WW of calves sired, as well as anticipated changes in birthing difficulty and sale price changes associated with the genetics change. For example, higher WW would lead to greater feed intake and GHG emissions. A higher BW, as discussed above leads to potentially greater calving difficulty which could affect the number of calves sold as well as veterinary charges. The price paid for the existing bull is considered the bench mark amount for calculating a breakeven price for the new bull. If the breakeven purchase price, calculated as the purchase price where the operation's profitability is the same for the new as the old bull (E), is less than what was paid for the existing bull then the potential bull is less profitable than the existing bull and vice versa. If the operator pays less than the anticipated breakeven price then the level of profits are assumed to increase and vice versa.

In summary, breakeven prices were calculated by iteratively applying breed effects (A & B) at different purchase prices (D) until profitability per cow change (E) was zero between the old and new bull. Again, the baseline herd consisted of a cow herd with predominantly white color and was bred to an average Angus bull with an initial purchase price of $2,000 per head.

## RESULTS

### *Change in Dollar per Breeding Cow*

Given the baseline farm operation details outlined above, the Bull Estimator showed that that nine of the possible 17 different breeds are shown to increase farm profits when switching from an Angus bull (gray shaded column in Table 7). These nine breeds were Beefmaster, Gelbvieh, Hereford, Limousin, Red Angus, Salers, Santa Gertrudis, South Devon, and Tarentaise. These breeds were primarily more profitable because sale prices for a yellow hided calf were considerably greater than sale prices for a gray or white hided calf as would result with

Angus bred commercial white cows. A Tarentaise bull, that would sire yellow calves when bred to commercial white cows, was shown to be the most profitable with a change in $/cow of $18.76. The primary reason this breed was shown to be more profitable is due to the average increase in weaning weight and the changes in calf sale prices with this cross. In fact, given the baseline, a change from an Angus bull to a Tarentaise bull resulted in an increase of over $875 in receipts due to higher weaning weights and a price premium. Although farm receipts are increasing, all aspects of the change are not positive as Total Direct Costs increased by a little over $30 with a Tarentaise bull as sale barn expenses, feed costs, and veterinary costs all increased. The driver of profitability change in this scenario was thus on the revenue rather than the cost side.

For the other eight breeds (that led to lower or minor returns compared to Angus), one was considered to have only minor changes and seven are anticipated to decrease profitability. Of the seven breeds that were shown to make the operation less profitable a Brahman bull, on average, was shown to have the worst impact with a decrease in $/Cow of -$87.39. The main reasons for the considerable decrease in profits with a switch to a Brahman bull is due to the substantial increase in calving difficulty and price discounts for some Brahman crosses along with Brahman sired calves falling into a higher weight category. Similar switches to higher weight categories and attendant price discounts applied to Charolais and Simmental.

*EPD*

Using the 2012 Across-Breed EPD table as well as breed average EPD values in conjunction with the baseline cow herd assumptions, Brahman, Charolais, Simmental, and Tarentaise would sire calves with heavier BW and WW than Angus bulls. Breeds shown to increase calving difficulty were Brahman, Charolais, and Shorthorn. Selecting different baseline breeds, especially the smaller framed Angus × Red Angus combination, resulted in greater BW and WW increases as well as greater change in anticipated calving difficulty with these results available from the authors upon request.

*Change in GHG Emissions*

The baseline farm had GHG emissions of 17.62 lbs. of $CO_2$ per pound of beef sold. A negative number reported for the change in GHG per live weight sold (F in Figure 1) shows a decrease in GHG emissions. Recall that changes in GHG per live weight sold was a result of weaning weight changes as well as modified cow and calf losses and differential feeding needs. Breeds of bulls that are shown to decrease GHG emissions per live weight sold compared to the baseline with an existing Angus herd sire were Simmental and Tarentaise. These bull breeds decreased GHG emissions in the baseline scenario because calf weaning weights increased without an increase in calving difficulty. Compared to the Angus breed, Simmental bulls decreased GHG emissions the most with a change of -0.62% and Brahman bulls increased GHG emissions the most with a change of +8.40%. The Brahman bull increased GHG emissions because the increase in calving difficulty led to more calf and cow losses decreasing the number of animals and amount of beef sold. This decrease in beef sold had a greater impact than the weaning weight increase experienced with the Brahman bull. Changes in GHG emissions for all 24 cow breeds are shown in Table 7. Given our baseline, results suggest that in only one of seventeen breeds GHG emissions could be reduced while also increasing returns (yellow shaded cells in Table 7). The best case scenario revealed a 0.17% reduction in GHG along with a 18.8% increase in returns for the baseline scenario (shaded in gray). The worst case scenario increased GHG by 8.4% and lowered returns by 87.6%. Similar results were observed using the different cow breeds shown in Table 7. This table shows that the greatest level of overall farm profits, given our base farm scenario, was obtained with Simmental cows and Angus bulls. The smallest level of GHG emissions, given our base farm scenario, was obtained with Charolais cows and Charolais bulls. Table 7 shows that out of the 79 times that either farm profits increased or GHG emissions decreased the two happened simultaneously 13% of the time. Paying attention to both the profitability and GHG signal, pending many plausible different farm situations, it is thus stipulated that sire selection leads to relatively minor GHG emissions changes but has considerable net return implications.

*Sensitivity Analysis to Prices Used and Baseline Genetics*

As mentioned before, price factors were calculated using hide color and breed price factors derived from 2010 reported prices (Troxel and Barham 2012). When compared to the 2010 overall average sale price; three breed sale prices, six crossbreed sale prices, and four hide color sale prices were higher than the overall reported average. When compared to the 2010 average sale price for gray hided calves (potential offspring from a commercial white cow and Angus bull) 17 of the possible 30 price factors were higher.

Breeds, crosses, and hide color prices change depending on whether prices are reported from the 2010, five year average, or ten year average price index. For example, in 2010 an Angus × Brahman cross received the average highest selling price; however, in 2005 and 2000 the average highest selling price was given to a Hereford × Charolais cross and a Hereford × ¼ Brahman cross, respectively. Changes in price levels and price premiums for hide color and breeds can change the level of profitability of a herd sire change. By holding the baseline production practices constant and changing only price and breed price factor choices simultaneously (2012, 5 Year Average, and 10 Year Average), Figure 6 shows the robustness of breed profitability over time. These trends show that both the greatest increase and decrease in profits were seen with 2012 prices and 2010 breed price factors. Breeds did not always have the same level of profits with the 5- and 10-year prices and price factors that was seen with 2012 prices and 2010 breed price factors. Many breeds had similar profit levels regardless of price level and breed price factors. Brahman bulls had the greatest variability in profit levels.

Results will also vary depending on the baseline genetics. The baseline genetics were commercial white cows with Angus bulls. Baseline profitability is established based on level of calving difficulty, prices received, established WW and amount of inputs required. All of these are dependent on baseline genetics. As baseline genetics change, the level of profitability from one bull to another will change. Although a bull breed may be more profitable than another bull in one baseline genetics scenario, it may be less profitable in another scenario. In fact, Table 7 shows that by changing the cow breed and beginning bull breed, the most profitable new bull breed changes. On the basis of profitability, Angus was the top breed for 15 of the 24 cow breeds. Beefmaster, Hereford, Charolais and Tarentaise were the other dominant breeds using 2012 prices and 2010 breed price factors as well as operational characteristics similar to that of the baseline reported within.

*Breakeven Purchase Price*

Using the baseline farm with a starting bull price of $2,000 per head, a list of breakeven purchase prices for each breed is shown in Figure 7. Ten bull breeds had a breakeven purchase price greater than $2,000 with Tarentaise having a breakeven price greater than $3,000. Brangus, Braunvieh , Chiangus, Limousin, and Simmental all had breakeven purchase prices below $2,000 but greater than $0. Brahman and Charolais bulls both had negative breakeven purchase prices. The breakeven purchase price for the Brahman bull was -$4,292; meaning that the operator would have to receive the bull for free and be paid $4,292 to receive the same level of profits as experienced with the Angus bull. As the established purchase price for the existing bull changes, the breakeven purchase price for the new bull will change as well.

**DISCUSSION**

The goal of this paper was to i) determine profitability difference as a result of herd sire selection away from a baseline of Angus sired calves from commercial white cows; ii) highlight what drives these profitability changes; iii) showcase the size of GHG emission reductions attainable with herd sire selection; iv) analyze whether GHG mitigation motivated by changes in herd sire selection is profitable or not; v) demonstrate how price factors and initial price levels (2012 vs. 5-yr and 10-yr average) affect profitability changes; and vi) showcase how robust genetics recommendations are when changing baseline herd genetics.

When examining the results given the assumptions of the baseline farm with Angus × commercial white calves, the greatest increase in farm profits occurred when switching to a Tarentaise bull. The profitability increase was mainly a result of price premiums rather than changes in cost. The switch also resulted in a reduction in GHG emissions. Modifying baseline genetics leads to different sire genetics recommendations as changes in calving difficulty and anticipated price premiums play differential roles on the basis of base breed. Applying the same switch to Tarentaise with a different base breed such as Angus × Limousin as opposed to Angus × commercial white was demonstrated to lead to negative profitability changes. Profitability changes using different cattle price levels were relatively consistent over time at least for the baseline farm considered in the analysis.

Limitations of this analysis are that price premiums based on average prices differentials by breed over the course of the entire year do not consider effects of sale month, sale location or weight category. Further, different pasture management, calving season, cattle weight and weaning age assumptions may also lead to different results than reported within. Price changes due to shifts in 100 lb weight categories are rather drastic in this analysis as well. Future research may consider adjusting cattle prices by weight at a smaller increment than 100 lbs. Feedlot performance of calves as might be revealed in YW EPD values is currently not considered. Neither is MAR, REA and FAT. The cow-calf operator using the Forage Cow-calf Calculator thus may wish to consult several tools prior to making a herd sire selection.

**REFERENCES**


Barham, B.L., and T.R. Troxel. 2007. “Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions in 2005.” *Journal of Animal Science* 85:3434-3441.

Cheney, S. 2011 "Livestock Market News Roundup 1990-2010." *Arkansas Livestock and Grain Market News Service*. Available at http://www.uaex.edu/Other_Areas/ publications/ PDF/ AG1270.pdf.

Cooke, R., A. Villarroel, and C. Estill. 2008. "Chapter 1. Introduction." *Calving School Handbook*: 2. Oregon State University, EOARC. Avaialable at http://beefcattle.ans.oregonstate.edu/html/publications/documents/CalvingSchoolHandbook_000.pdf.

Greiner, S. 2005. "Expected Progeny Differences (EPD’s) and Indexes." As presented in the Louisiana Beef Cattle Genetics Short Course. Available at http://www.lsuagcenter.com/NR/rdonlyres/2B74C4B9-5BCB-4394-B9FC-F9847AC0C77A/18896/EPDsIndexesLAMSALshortcourseNov053slidesperpageWNO.pdf.

Hammack, S. 2008. "EPD for Traditional Cow/Calf Producers." *Beef Cattle Penning*. 1. no. Winter.

Intergovernmental Panel on Climate Change (IPCC) 2007: Climate Change 2007: The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]

Kirchgessner, M., W. Windisch, H. L. Muller, and M. Kreuzer. 1991. “Release of methane and of carbon dioxide by dairy cattle.” *Agribiol. Res*. 44(2-3): 91-102.

Kuehn , L.A., and R.M. Thallman. 2012a. "Across-Breed EPD Tables for the Year 2012 Adjusted to Breed Differences for Birth Year of 2010." As presented at the 2012 Beef Improvement Federation Conference. Available at http://www.bifconference.com/bif2012/proceedings-pdf/11Kuehn-Thallman2.pdf

Kuehn , L.A., and R.M. Thallman. 2012b. "Breed of Sire Means for 2010-Born Animals Under Conditions Similar toUSMARC." *MARC Releases 2012 Across-Breed EPD Table*. As presented in the May 3, 2012 BEEF Magazine article. Available at http://beefmagazine.com/selection-tools/marc-releases-2012-across-breed-epd-table.

Kuehn, L.A., and R.M. Thallman. 2012c. “Mean EPDs reported by different breeds.” In: *Proceedings of the Beef Improvement Federation 44th Annual Research Symposium & Meeting*. p. 147-151.

McDermott, J.J., D.M. Alves, N.G. Anderson, and S. W. Martin. 1991. "Measures of herd health and productivity in Ontario cow-calf herds." *The Canadian Veterinarian Journal* 32:7: 413-20.

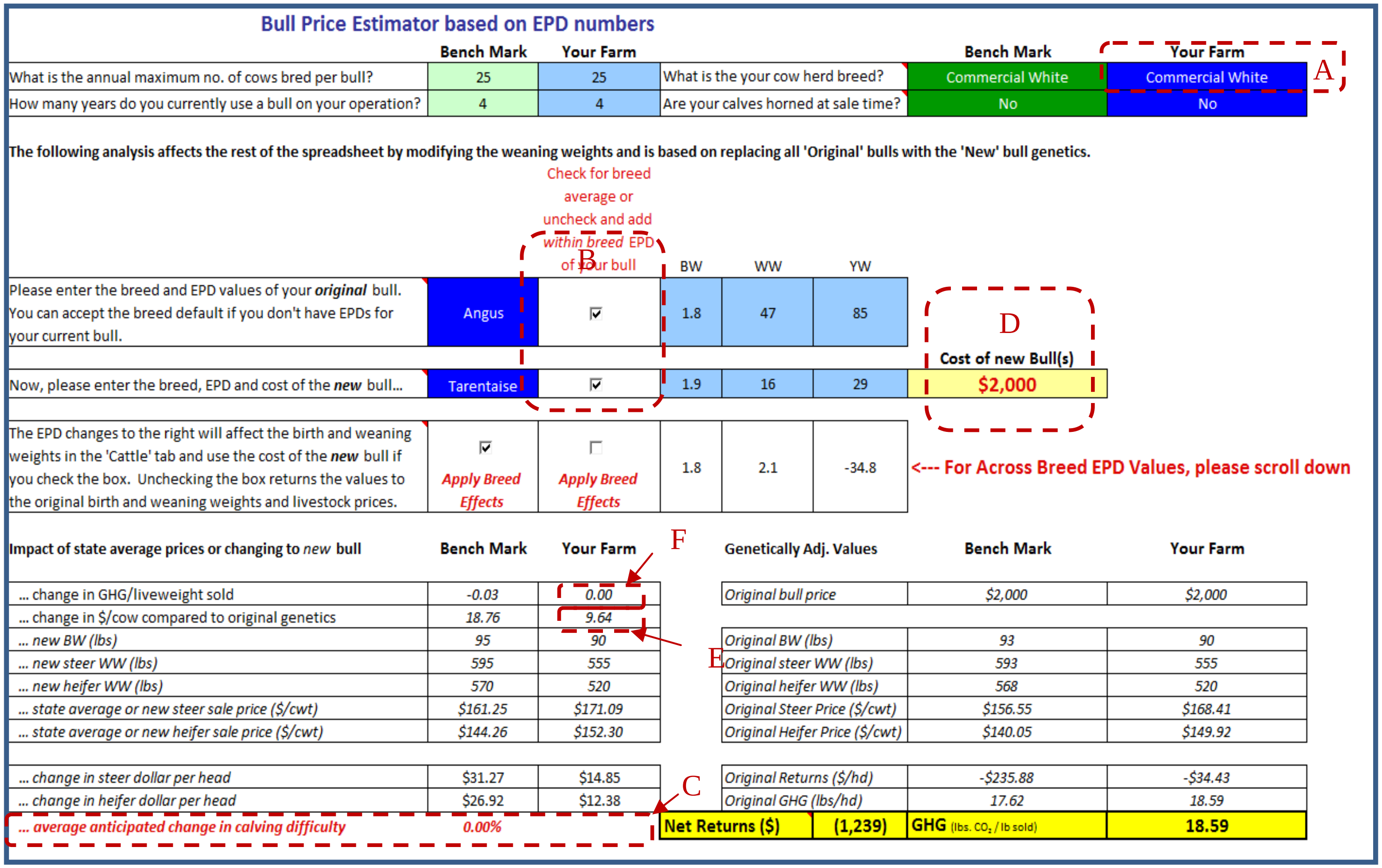
Ritchie, H.D., and P.T. Anderson. 1994. "Calving Difficulty in Beef Cattle: Part 1." *Beef Cattle Handbook* : 1-4. Available at http://www.iowabeefcenter.org/Beef%20Cattle%20Handbook/Calving_Difficulty-1.pdf.

Smith, S. A. 2013. “Modeling Greenhouse Gas Emissions and Net Return Implications for Cow-Calf Producers In The Ozark Highlands”. Unpublished dissertation. Environmental Dynamics. University of Arkansas.

Troxel, T R., and B L. Barham. 2012. "Phenotypic Expression and Management Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions." *Professional Animal Scientist* 28:64-72.

Troxel, T.R., M.S. Gadberry, S. Cline, J. Foley, G. Ford, D. Urell, and R. Wiedower. 2002. “Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions.” *Professional Animal Scientist* 15:227-236.

**Figure** 1. Screen shot of the Bull Estimator spreadsheet tab.



Bull Price Estimator based on EPD numbers

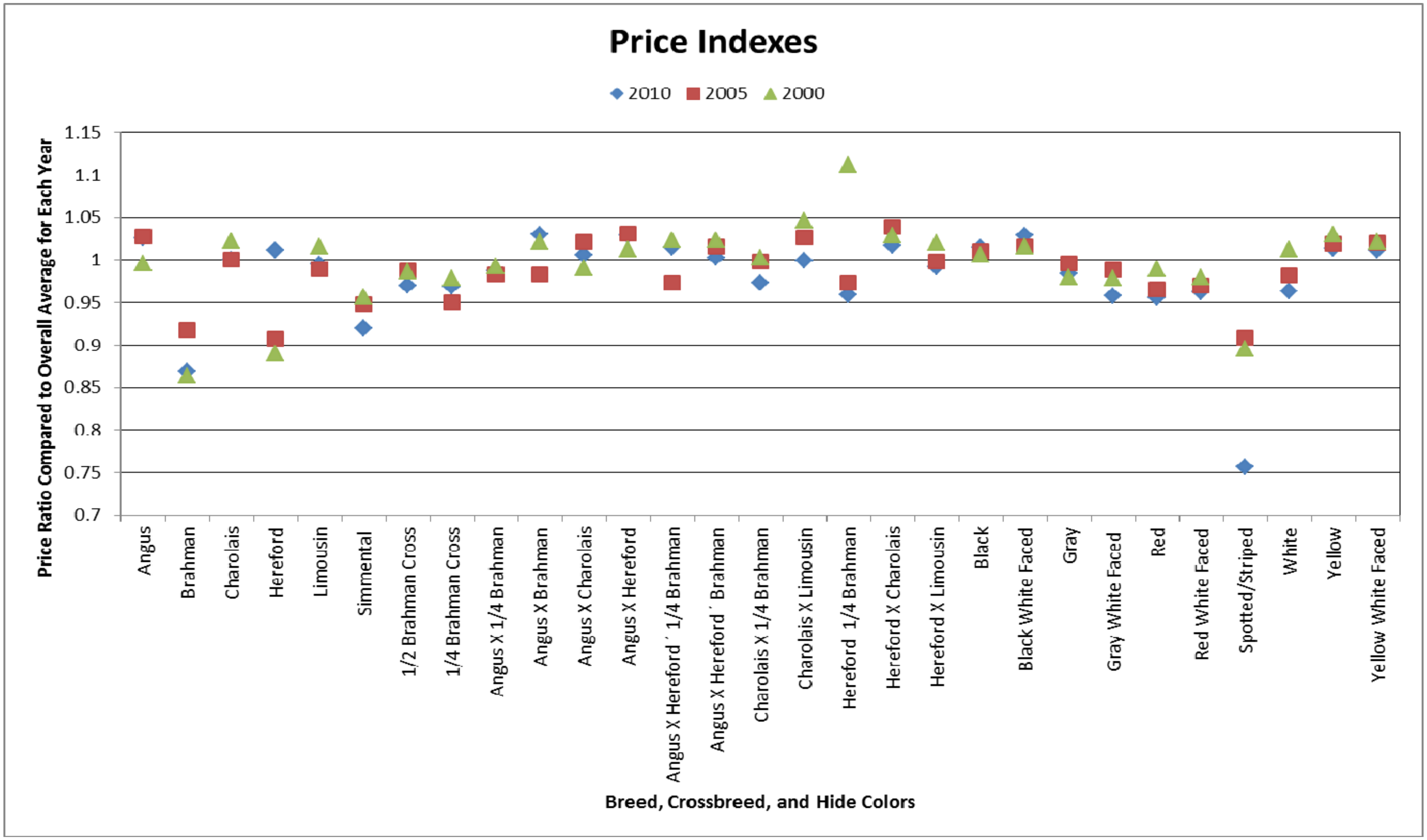
| | Bench Mark | Your Farm | | Bench Mark | Your Farm |
|---|---|---|---|---|---|
| What is the annual maximum no. of cows bred per bull? | 25 | 25 | What is the your cow herd breed? | Commercial White | Commercial White |
| How many years do you currently use a bull on your operation? | 4 | 4 | Are your calves horned at sale time? | No | No |

**The following analysis affects the rest of the spreadsheet by modifying the weaning weights and is based on replacing all 'Original' bulls with the 'New' bull genetics.**

| | | Check for breed average or uncheck and add *within breed* EPD of your bull | BW | WW | YW | |
|---|---|---|---|---|---|---|
| Please enter the breed and EPD values of your ***original*** bull. You can accept the breed default if you don't have EPDs for your current bull. | Angus | ☑ | 1.8 | 47 | 85 | **Cost of new Bull(s)** |
| Now, please enter the breed, EPD and cost of the ***new*** bull... | Tarentaise | ☑ | 1.9 | 16 | 29 | **$2,000** |
| The EPD changes to the right will affect the birth and weaning weights in the 'Cattle' tab and use the cost of the ***new*** bull if you check the box. Unchecking the box returns the values to the original birth and weaning weights and livestock prices. | ☑ *Apply Breed Effects* | ☐ *Apply Breed Effects* | 1.8 | 2.1 | -34.8 | **<--- For Across Breed EPD Values, please scroll down** |

| **Impact of state average prices or changing to *new* bull** | **Bench Mark** | **Your Farm** | **Genetically Adj. Values** | **Bench Mark** | **Your Farm** |
|---|---|---|---|---|---|
| ... change in GHG/liveweight sold | *-0.03* | *0.00* | *Original bull price* | *$2,000* | *$2,000* |
| ... change in $/cow compared to original genetics | *18.76* | *9.64* | | | |
| *... new BW (lbs)* | *95* | *90* | *Original BW (lbs)* | *93* | *90* |
| *... new steer WW (lbs)* | *595* | *555* | *Original steer WW (lbs)* | *593* | *555* |
| *... new heifer WW (lbs)* | *570* | *520* | *Original heifer WW (lbs)* | *568* | *520* |
| *... state average or new steer sale price ($/cwt)* | *$161.25* | *$171.09* | *Original Steer Price ($/cwt)* | *$156.55* | *$168.41* |
| *... state average or new heifer sale price ($/cwt)* | *$144.26* | *$152.30* | *Original Heifer Price ($/cwt)* | *$140.05* | *$149.92* |
| *... change in steer dollar per head* | $31.27 | $14.85 | *Original Returns ($/hd)* | *-$235.88* | *-$34.43* |
| *... change in heifer dollar per head* | $26.92 | $12.38 | *Original GHG (lbs/hd)* | *17.62* | *18.59* |
| *... average anticipated change in calving difficulty* | *0.00%* | | **Net Returns ($)** | **(1,239)** | **GHG** (lbs. $CO_2$ / lb sold) **18.59** |

**Figure 2**. Price Indexes for 2010, 2005, and 2000 .

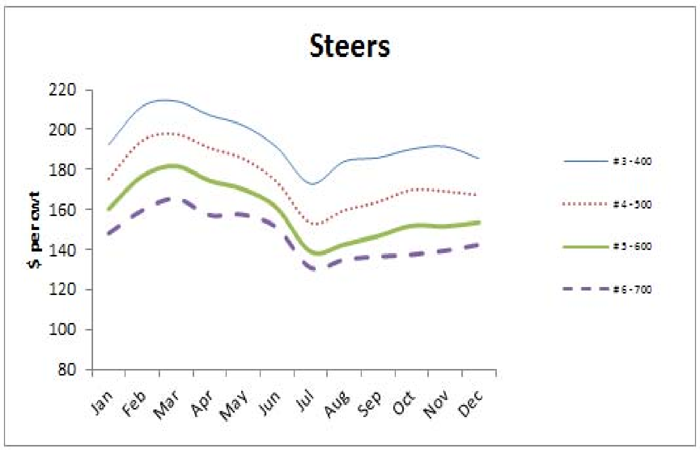


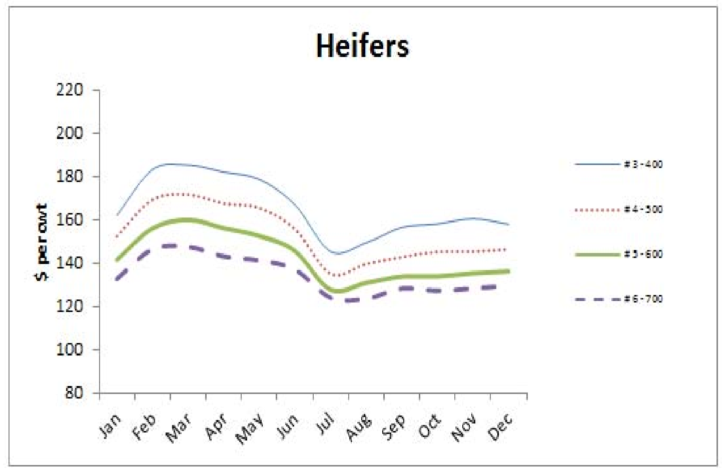

Source: Troxel and Barham 2012, Barham and Troxel 2007, and Troxel et al. 2002. See Table 2 for price ratios.

**Figure 3**. Reported Monthly Prices for Arkansas by Animal type and weight for 2012.

## Monthly and Annual Cattle Prices in $/cwt -- Average of All Arkansas Markets

| | Please pick Marketing Year or Avg. | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Annual |
| Steers | Medium and Large 1 (3-400 lb.) | 192.40 | 211.51 | 214.11 | 207.13 | 201.97 | 191.04 | 172.78 | 184.02 | 185.86 | 190.08 | 191.48 | 185.56 | 193.99 |
| | Medium and Large 1 (4-500 lb.) | 175.35 | 194.43 | 197.61 | 190.75 | 185.38 | 173.71 | 153.22 | 159.54 | 163.66 | 169.80 | 169.01 | 167.13 | 174.96 |
| | Medium and Large 1 (5-600 lb.) | 160.20 | 176.66 | 181.68 | 174.35 | 170.06 | 160.69 | 138.88 | 142.42 | 146.65 | 151.87 | 151.53 | 153.48 | 159.04 |
| | Medium and Large 1 (6-700 lb.) | 147.98 | 159.51 | 165.37 | 157.13 | 157.33 | 150.81 | 130.78 | 134.87 | 136.42 | 137.35 | 139.33 | 142.32 | 146.60 |
| Heifers | Medium and Large 1 (3-400 lb.) | 161.84 | 182.91 | 185.02 | 181.87 | 178.51 | 166.79 | 145.16 | 149.18 | 156.26 | 157.87 | 160.29 | 157.74 | 165.28 |
| | Medium and Large 1 (4-500 lb.) | 152.23 | 169.03 | 171.46 | 167.36 | 165.30 | 155.59 | 134.90 | 139.43 | 142.59 | 145.04 | 145.13 | 146.20 | 152.85 |
| | Medium and Large 1 (5-600 lb.) | 141.35 | 155.83 | 159.84 | 155.96 | 152.35 | 145.42 | 127.53 | 130.68 | 133.58 | 133.70 | 135.11 | 136.03 | 142.28 |
| | Medium and Large 1 (6-700 lb.) | 132.54 | 146.19 | 147.35 | 142.86 | 141.06 | 136.86 | 123.81 | 123.34 | 128.05 | 127.05 | 128.09 | 129.31 | 133.87 |
| Cows | Breaking Utility and Commercial (75-80% Lean) | 71.20 | 83.00 | 84.75 | 85.00 | 83.50 | 77.25 | 71.60 | 72.75 | 73.75 | 71.40 | 71.00 | 71.00 | 76.35 |
| Bulls | Yield Grade 1-2 (1,000 - 2,100 lbs) | 83.60 | 93.25 | 93.75 | 99.40 | 103.75 | 98.00 | 91.50 | 91.75 | 91.25 | 87.80 | 87.00 | 86.33 | 92.28 |



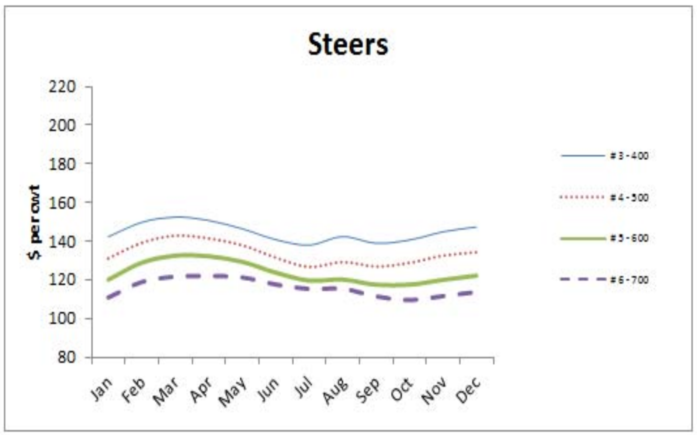



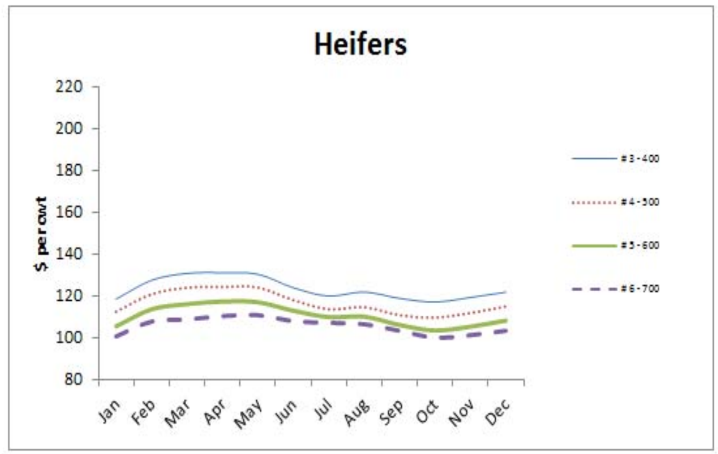

Source: United States Department of Agriculture, Agricultural Market Service. Arkansas Livestock Sale Prices for 2012 as reported by Steve Cheney, Little Rock, AR.

**Figure 4**. Reported Monthly Prices for 2008-2012.

## Monthly and Annual Cattle Prices in $/cwt -- Average of All Arkansas Markets

| | Please pick Marketing Year or Avg. | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Past 5 Year Avg. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Annual |
| Steers | Medium and Large 1 (3-400 lb.) | 142.19 | 149.66 | 152.40 | 150.63 | 146.34 | 140.74 | 137.90 | 142.31 | 138.85 | 140.52 | 144.78 | 147.25 | 144.47 |
| | Medium and Large 1 (4-500 lb.) | 130.99 | 139.10 | 142.80 | 141.38 | 137.85 | 131.45 | 126.61 | 129.20 | 126.84 | 128.74 | 132.47 | 134.24 | 133.47 |
| | Medium and Large 1 (5-600 lb.) | 119.98 | 128.81 | 132.48 | 132.14 | 129.27 | 123.69 | 119.59 | 120.11 | 117.44 | 117.43 | 119.93 | 122.11 | 123.58 |
| | Medium and Large 1 (6-700 lb.) | 110.78 | 118.79 | 121.64 | 121.92 | 121.20 | 117.55 | 115.24 | 115.31 | 111.39 | 109.46 | 111.56 | 113.67 | 115.71 |
| Heifers | Medium and Large 1 (3-400 lb.) | 118.22 | 127.19 | 130.53 | 130.85 | 130.13 | 123.70 | 119.70 | 121.64 | 118.54 | 116.87 | 118.99 | 121.55 | 123.16 |
| | Medium and Large 1 (4-500 lb.) | 112.21 | 120.53 | 123.68 | 124.05 | 123.80 | 117.75 | 113.38 | 114.39 | 110.54 | 109.40 | 111.60 | 114.74 | 116.34 |
| | Medium and Large 1 (5-600 lb.) | 105.24 | 113.35 | 115.84 | 117.08 | 116.74 | 112.70 | 109.63 | 109.85 | 105.88 | 103.24 | 105.07 | 107.97 | 110.21 |
| | Medium and Large 1 (6-700 lb.) | 100.44 | 107.48 | 108.48 | 110.13 | 110.57 | 107.71 | 106.90 | 106.21 | 103.05 | 99.84 | 101.00 | 103.12 | 105.41 |
| Cows | Breaking Utility and Commercial (75-80% Lean) | 53.51 | 59.98 | 60.73 | 63.05 | 63.00 | 60.00 | 58.02 | 57.98 | 55.31 | 53.63 | 52.92 | 54.60 | 57.73 |
| Bulls | Yield Grade 1-2 (1,000 - 2,100 lbs) | 64.99 | 70.65 | 72.03 | 75.06 | 77.25 | 74.46 | 72.86 | 72.57 | 69.46 | 66.50 | 65.43 | 66.68 | 70.66 |



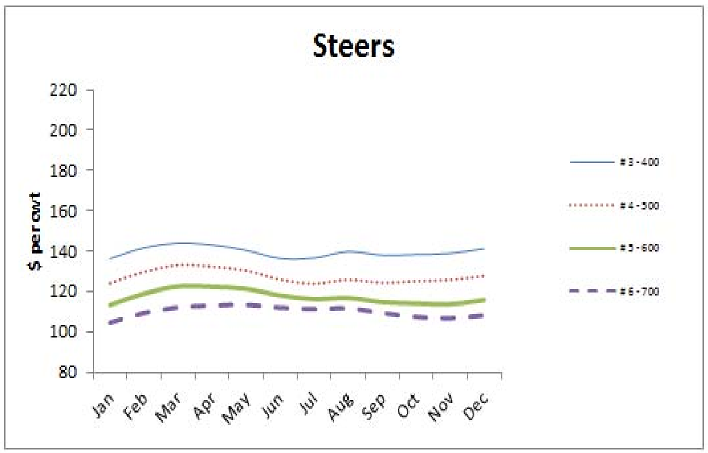



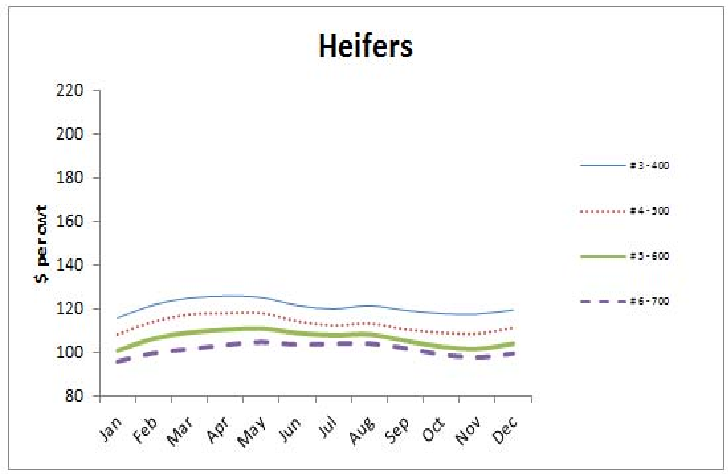

Source: United States Department of Agriculture, Agricultural Market Service. Arkansas Livestock Sale Prices for 2012 as reported by Steve Cheney, Little Rock, AR.

**Figure 5**. Reported Monthly Prices for 2003-2012.

## Monthly and Annual Cattle Prices in $/cwt -- Average of All Arkansas Markets

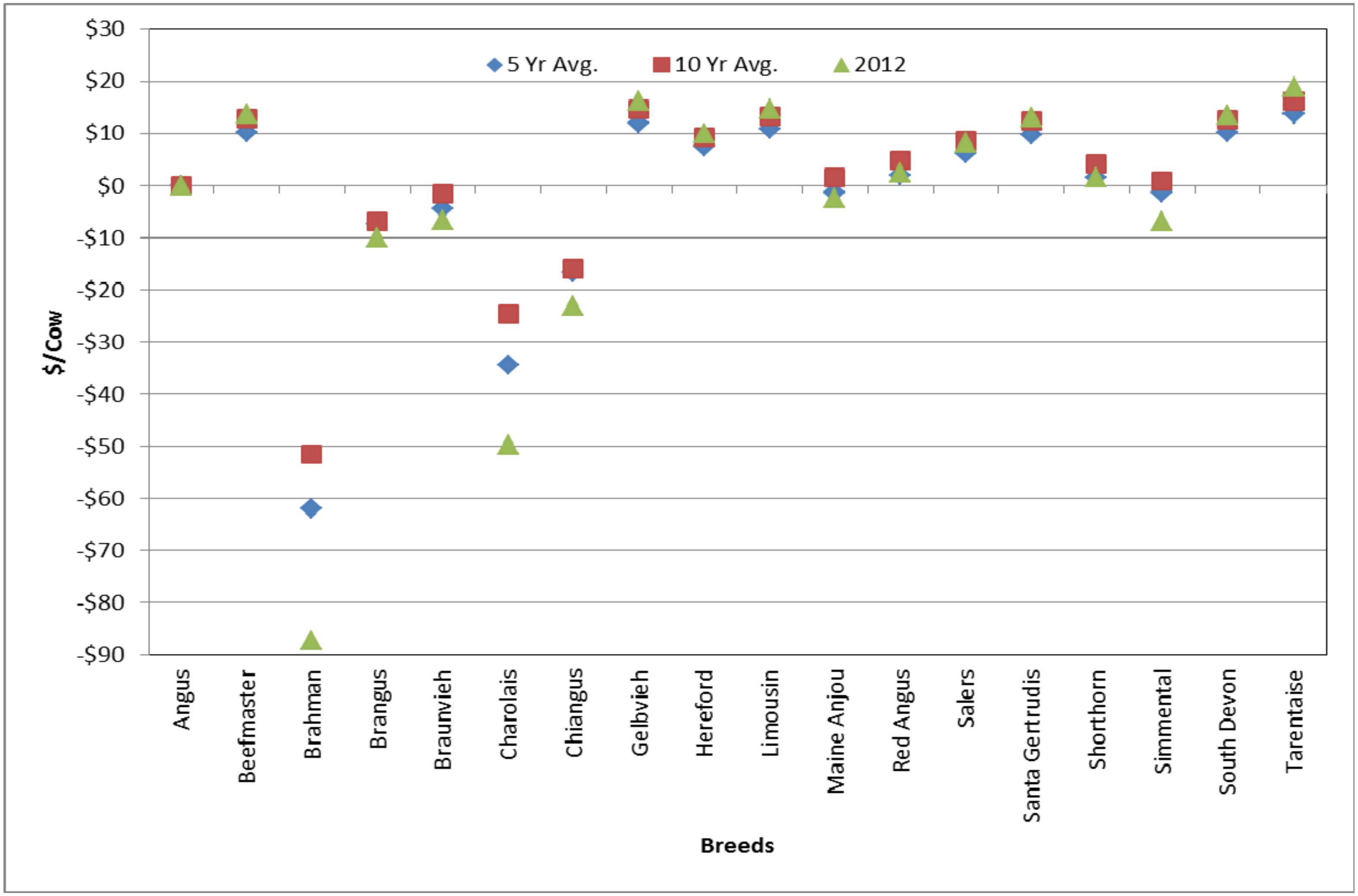
| | Please pick Marketing Year or Avg. | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Past 10 Year Avg. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Annual |
| Steers | Medium and Large 1 (3-400 lb.) | 136.31 | 141.50 | 143.92 | 142.97 | 140.34 | 136.39 | 136.61 | 139.70 | 137.98 | 138.27 | 138.85 | 141.07 | 139.49 |
| Steers | Medium and Large 1 (4-500 lb.) | 124.06 | 129.65 | 133.06 | 132.33 | 130.37 | 125.88 | 123.84 | 125.76 | 124.28 | 125.09 | 125.72 | 127.63 | 127.31 |
| Steers | Medium and Large 1 (5-600 lb.) | 113.19 | 118.87 | 122.53 | 122.32 | 121.27 | 117.98 | 116.15 | 116.68 | 114.65 | 113.98 | 113.62 | 115.70 | 117.24 |
| Steers | Medium and Large 1 (6-700 lb.) | 104.48 | 109.24 | 112.02 | 112.89 | 113.36 | 111.90 | 111.18 | 111.54 | 109.22 | 107.33 | 106.64 | 108.10 | 109.83 |
| Heifers | Medium and Large 1 (3-400 lb.) | 115.52 | 121.50 | 124.71 | 125.59 | 124.99 | 121.34 | 119.75 | 121.24 | 119.09 | 117.59 | 117.33 | 119.24 | 120.66 |
| Heifers | Medium and Large 1 (4-500 lb.) | 107.97 | 113.89 | 117.11 | 117.70 | 117.76 | 114.09 | 112.13 | 113.05 | 110.33 | 108.82 | 108.34 | 111.07 | 112.69 |
| Heifers | Medium and Large 1 (5-600 lb.) | 100.62 | 106.08 | 108.87 | 110.10 | 110.71 | 108.65 | 107.60 | 108.01 | 105.15 | 102.42 | 101.45 | 103.77 | 106.12 |
| Heifers | Medium and Large 1 (6-700 lb.) | 95.61 | 99.44 | 101.32 | 103.17 | 104.52 | 103.35 | 103.75 | 103.80 | 101.73 | 98.84 | 97.53 | 99.20 | 101.02 |
| Cows | Breaking Utility and Commercial (75-80% Lean) | 48.82 | 53.36 | 53.49 | 55.33 | 55.91 | 54.19 | 53.63 | 53.12 | 51.27 | 49.71 | 49.20 | 50.32 | 52.36 |
| Bulls | Yield Grade 1-2 (1,000 - 2,100 lbs) | 60.43 | 64.30 | 65.19 | 67.18 | 68.88 | 67.62 | 67.31 | 67.20 | 64.24 | 61.68 | 60.96 | 61.57 | 64.71 |



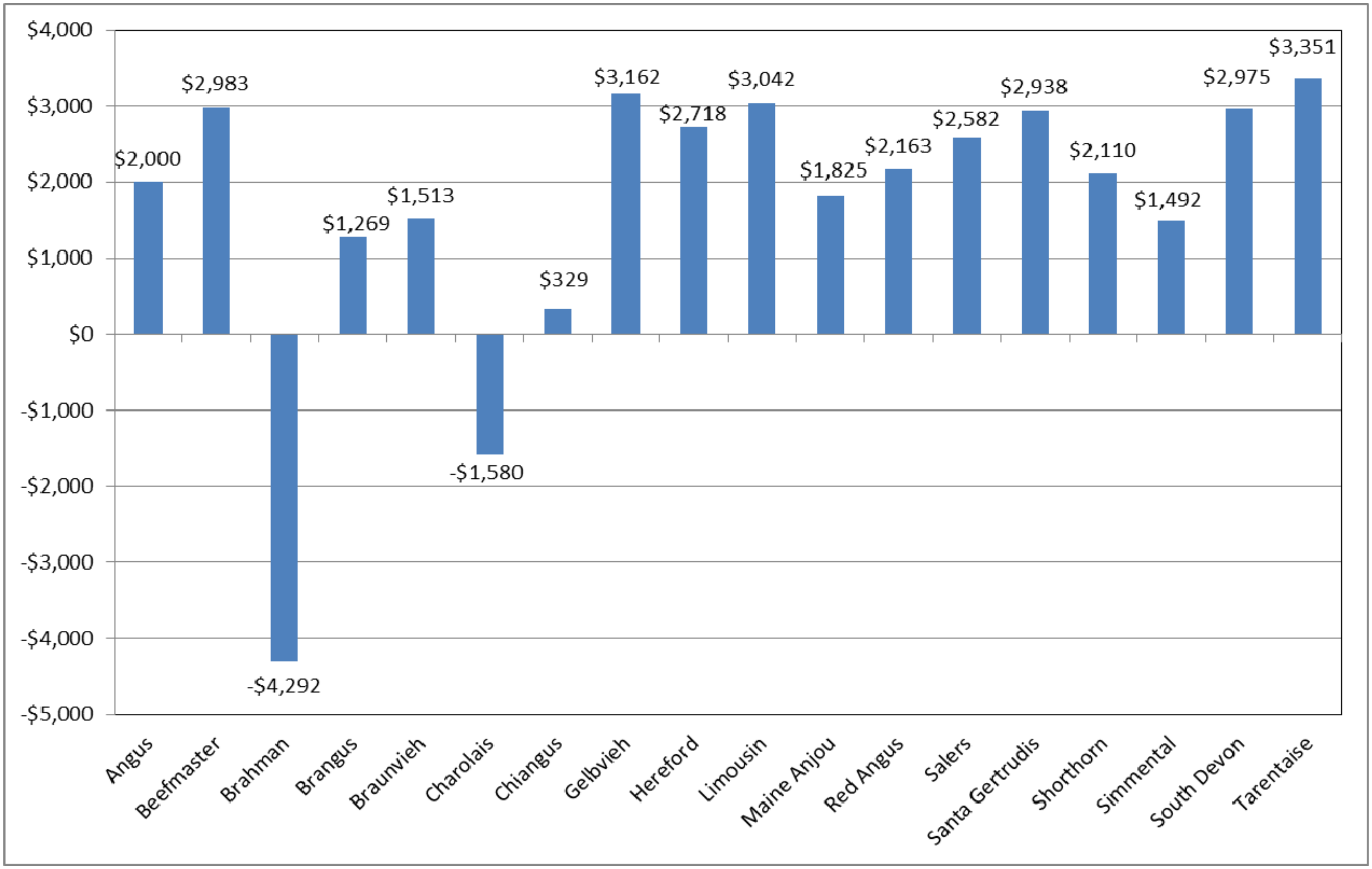

Source: United States Department of Agriculture, Agricultural Market Service. Arkansas Livestock Sale Prices for 2012 as reported by Steve Cheney, Little Rock, AR.

**Figure 6**. Profitability Changes as Pricing Changes from Baseline Scenario




Profitability changes to the base farm scenario with only changing price and price factor year

**Figure 7**. Breakeven Purchase Price for New Bull




Breakeven purchase prices for new bulls given the base scenario. Existing bull was purchased for $2,000

**Table 1.** MARC Across-Breed and Breed Average EPD Table for 2012

| **Breed** | **BW (lbs.)** | **WW (lbs.)** | **YW (lbs.)** | **MILK (lbs. of WW)** | **MARBLING (Marbling Score)** | **RIBEYE AREA (square inches)** | **FAT THICKNESS (inches)** | **BW (lbs.)** | **WW (lbs.)** | **YW (lbs.)** |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Adjusted To Angus* | | | | | | | *Breed Average* | | |
| Angus | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 1.8 | 47 | 85 |
| Beefmaster | 6.7 | 35.3 | 32.5 | 7.8 | -- | -- | -- | 0.3 | 8 | 13 |
| Brahman | 11.1 | 42.5 | 4.8 | 22.4 | -- | -- | -- | 1.7 | 15 | 24 |
| Brangus | 3.7 | 13.0 | 13.5 | 6.8 | -- | -- | -- | 0.7 | 23 | 42 |
| Braunvieh | 1.2 | -19.2 | -38.5 | -0.4 | -0.67 | 0.23 | -0.095 | 2.8 | 41 | 64 |
| Charolais | 8.6 | 40.1 | 46.8 | 5.7 | -0.46 | 0.92 | -0.222 | 0.6 | 24 | 43 |
| Chiangus | 3.3 | -14.9 | -31.3 | -- | -0.42 | 0.40 | -0.157 | 2 | 37 | 69 |
| Gelbvieh | 4.0 | 5.7 | -13.5 | 13.6 | -- | -- | -- | 1.2 | 40 | 75 |
| Hereford | 2.7 | -2.8 | -20.1 | -16.7 | -0.34 | -0.11 | -0.053 | 3.6 | 44 | 73 |
| Limousin | 3.8 | -0.9 | -34.7 | -9.2 | -0.70 | 1.07 | -- | 1.5 | 45 | 83 |
| Maine Anjou | 4.1 | -13.0 | -34.5 | -4.7 | -0.79 | 0.88 | -0.210 | 1.7 | 39 | 78 |
| Red Angus | 2.4 | -0.6 | -12.0 | -3.1 | 0.03 | -0.10 | -0.034 | -0.1 | 32 | 60 |
| Salers | 1.8 | -3.1 | -14.3 | 2.4 | -0.11 | 0.75 | -0.210 | 1.8 | 41 | 79 |
| Santa Gertrudis | 7.4 | 37.7 | 33.9 | -- | -0.67 | -0.19 | -0.115 | 0.6 | 5 | 7 |
| Shorthorn | 6.0 | 15.7 | 39.4 | 17.9 | -0.14 | 0.17 | -0.148 | 2.4 | 15 | 24 |
| Simmental | 5.2 | 24.9 | 22.4 | 19.8 | -0.55 | 0.92 | -0.215 | 0.7 | 31 | 56 |
| South Devon | 4.2 | 3.2 | -6.3 | -2.3 | 0.05 | 0.15 | -0.111 | 2.6 | 40 | 76 |
| Tarentaise | 1.7 | 33.1 | 21.2 | 23.4 | -- | -- | -- | 1.9 | 16 | 29 |

Sources: Kuehn and Thallman 2012a and c.

**Table 2**. Price Indexes of Breed and Hide Color Effects Relative to State Average Prices for Feeder Cattle in 2000, 2005, and 2010.

| | **Breed to State Average Price Ratio** | | | **Breeds & Cross Breeds Price Ratio was Applied to** |
|---|---|---|---|---|
| **Breed by Year** | **2010** | **2005** | **2000** | |
| Angus | 1.026 | 1.028 | 0.996 | A** |
| Brahman | 0.869 | 0.917 | 0.864 | B |
| Charolais | 1.001 | 1.000 | 1.022 | C |
| Hereford | 1.011 | 0.908 | 0.890 | H |
| Limousin | 0.995 | 0.990 | 1.016 | L |
| Simmental | 0.920 | 0.948 | 0.957 | S |
| 1/2 Brahman Cross | 0.970 | 0.987 | 0.986 | B × AO, Br × Br |
| 1/4 Brahman Cross | 0.969 | 0.950 | 0.979 | Br × AO |
| Angus × 1/4 Brahman | 0.987 | 0.983 | 0.993 | A × Br |
| Angus × Brahman | 1.030 | 0.983 | 1.021 | A × B |
| Angus × Charolais | 1.006 | 1.021 | 0.991 | A × C |
| Angus × Hereford | 1.029 | 1.031 | 1.013 | A X H |
| Angus × Hereford × 1/4 B | 1.015 | 0.973 | 1.024* | A × Be |
| Angus × Hereford × B | 1.003 | 1.016 | 1.024 | B × Be |
| Charolais × Limousin | 0.999 | 1.027 | 1.046 | C × L |
| Hereford × 1/4 Brahman | 0.959 | 0.973 | 1.112 | H × Be |
| Hereford × Charolais | 1.017 | 1.039 | 1.029 | H × C |
| Hereford × Limousin | 0.992 | 0.998 | 1.020 | H × L |
| Black | 1.015 | 1.010 | 1.006 | A × AO, Br × AO, Ch × AO |
| Black White Faced | 1.029 | 1.016 | 1.016 | A × H or S, Br × H or S, Ch × H or S |
| Gray | 0.984 | 0.996 | 0.980 | A × CW, Br × C or CW, Ch × C or CW |
| Red | 0.956 | 0.965 | 0.990 | Be, Bv, G, L, M, R, Sa, Sg, Sh, Sd, T, CR |
| Red White Faced | 0.962 | 0.970 | 0.980 | H × AR, S × AR |
| Spotted/Striped | 0.757 | 0.909 | 0.895 | Sp × AO |
| White | 0.963 | 0.982 | 1.013 | C × CY or CW |
| Yellow | 1.014 | 1.019 | 1.030 | C × AR |
| Yellow White Faced | 1.011 | 1.020 | 1.021 | C × H or S |
| Horned Cattle | 0.927 | 0.969 | 0.984 | |

* The exact price was not reported for the given year so the closest substitute of Angus × Herford × Brahman was used.

** A = Angus, B = Brahman, C = Charolais, H = Hereford, L = Limousin, S = Simmental, Br = Brangus, Be = Beefmaster, Ch = Chiangus, CW = Commercial White, Bv = Braunvieh, G = Gelbvieh, M = Maine Anjou, R = Red Angus, Sa = Salers, Sg = Santa Gertrudis, Sh = Shorthorn, Sd = South Devon, T = Tarentaise, CR = Commercial Red, AR = All in red hide group, Sp = Spotted/Striped, Commercial Yellow, AO = All Other

Sources: Troxel and Barham 2012, Barham and Troxel 2007, Troxel et al. 2002.

**Table 3.** Highlights of Inputs Tab

| Item and Description | Unit | 2012 | Item and Description | Unit | 2012 |
|---|---|---|---|---|---|
| **LIVESTOCK** | | | **FENCING** | | |
| 3 - 400 lb. Steers* | $/cwt | $193.99 | Barbed Wire (double strand) | 1/4 mile | $63 |
| 4 - 500 lb. Steers* | $/cwt | $174.96 | Electric Wire | 3/4 mile | $100 |
| 5 - 600 lb. Steers* | $/cwt | $159.04 | Corner/Brace - Pipe | 1 | $250 |
| 6 - 700 lb. Steers* | $/cwt | $146.60 | Corner/Brace - Wooden | 1 | $100 |
| 3 - 400 lb. Heifers* | $/cwt | $165.28 | T-post (6 ft) | 1 | $4.00 |
| 4 - 500 lb. Heifers* | $/cwt | $152.85 | Electric Fence posts | 1 | $2.50 |
| 5 - 600 lb. Heifers* | $/cwt | $142.28 | Insulators for T-posts | 1 | $0.25 |
| 6 - 700 lb. Heifers* | $/cwt | $133.87 | Charger | 1 | $250 |
| Cull Cow** | $/cwt | $76.35 | Gates | 1 | $50 |
| Purchase Price of Breeding Bull | $/hd | $2,000 | Farm Pond | 1 | $1,500 |
| Cull Bull*** | $/cwt | $92.28 | Watering Tank**** | 1 | $1,250 |

* Medium and Large Fram No. 1
** 75-80% Lean Breaking Utility
*** Yield Grade 1-2, 1,000 to 2,100 lbs.
**** 50% cost share

**Table 3.** Highlights of inputs Tab (cont'd).

| **FEED** | | | **INTEREST, TAX & INSURANCE RATES** | | |
|---|---|---|---|---|---|
| Hay delivered -- 4' x 5' or 800 lbs | $/bale | $45.00 | Capital Recovery Rate | % per annum | 5.00% |
| Corn | $/lb | $0.15 | Operating Interest | % per annum | 6.00% |
| Salt & Minerals (50 lb bag) | $/bag | $20.00 | Property Tax Rate | % per annum | 0.50% |
| **FERTILIZER** | | | Insurance Rate | % per annum | 0.80% |
| Lime | $/ton | $30.00 | **FUEL USE & OTHER MISCELLANEOUS** | | |
| Ammonium Nitrate (34-0-0) | $/ton | $506.00 | Fuel per acre for mowing, raking and staging | gal/acre | 4.5 |
| Diammonium Phosphate (18-46-0) | $/ton | $726.00 | Custom pasture/hay establishment | $/acre | $14 |
| Potash (0-0-60) | $/ton | $647.00 | Fuel per day for feeding | gal per day | 0.64 |
| Poultry Litter (3-2-3) | $/ton | $36.00 | Fuel per day for checking cattle | gal per day | 1 |
| Application cost per acre | $/acre | $6.00 | Twine per bale | $ per bale | $1.00 |
| **OTHER** | | | Cost for Farm Vehicle | $/month | $45.00 |
| Beef Checkoff | $/hd | $1.00 | **VETERINARY CHARGES** | | |
| Insurance & Yardage | $/hd | $1.75 | Prolapse | Service chg. ($/hd) | $75 |
| Sales Comission | % of sales | 3.50% | C-section | Service chg. ($/hd) | $225 |
| Diesel Fuel | $/gal | $3.50 | Sick treatments | Avg. drug chg. ($/hd) | $15 |
| Custom charge for winter annuals | $/acre | $0.00 | Bull Soundness | Service chg. ($/hd) | $30 |

**Table 4**. Breed of Sire Means for 2010-Born Animals Under USMARC Conditions.

| Breed | Birth Weight (lbs.) | Weaning Weight (lbs.)* | Breed | Birth Weight (lbs.) | Weaning Weight (lbs.)* |
|---|---|---|---|---|---|
| Angus | 89.8 | 582.0 | Gelbvieh | 93.3 | 580.8 |
| Hereford | 94.3 | 576.2 | Limousin | 93.3 | 579.5 |
| Red Angus | 90.3 | 566.3 | Maine-Anjou | 93.8 | 561.4 |
| Shorthorn | 96.3 | 565.7 | Salers | 91.6 | 573.2 |
| South Devon | 94.8 | 578.7 | Simmental | 93.9 | 590.7 |
| Beefmaster | 95.0 | 578.3 | Tarentaise | 91.6 | 584.1 |
| Brahman | 100.8 | 592.2 | Commercial** | 93.9 | 576.2 |
| Brangus | 92.4 | 571.0 | Commercial Black** | 92.6 | 573.0 |
| Santa Gertrudis | 96.0 | 577.7 | Commercial Red** | 93.7 | 576.1 |
| Braunvieh | 92.1 | 556.7 | Commercial White** | 96.1 | 578.0 |
| Charolais | 97.2 | 599.3 | Commercial Yellow** | 94.3 | 577.3 |
| Chiangus | 93.2 | 556.9 | Commercial Spotted** | 94.8 | 581.5 |

* A 25 lb. spread was applied to the steer and heifer weights (12.5 lbs. above and below the average respectively).

** Weights were not reported in original document and are an average of all breeds that fit into the specific group.

Source: Kuehn and Thallman 2012b.

**Table 5**. Highlights of Cattle Management Practices.

| **Description** | | **Herd Size and Description** | |
|---|---|---|---|
| Days on Hay & Supplements | 152 | Cows | 38 |
| Days on Pasture | 213 | Young Cows | 7 |
| Breeding failures | 14% | Cow herd size | 45 |
| Cow death losses | 1.00% | Replacement | 7 |
| Calf death losses | 3.00% | Herd Sires | 2 |
| Avg. culling age of cows | 7.83 | Male calves sold | 19 |
| Avg. number of calves over life of cow | 6 | Female calves sold (you buy replacements if negative) | 12 |
| Weight of mature cow in lbs | 1,250 | Cull cows | 7 |
| Weight of young cow (at first calf) in lbs | 1,000 | No. of years between bull purchases | 2 |
| Weaning age in months | 7 | Cow death losses | 0 |
| Avg. age of replacements at first breeding | 15 | Calf death losses | 2 |
| Avg. birth weight in lbs | 93 | Hay Waste with feeding & storage | 20% |
| Avg. steer weaning weight in lbs | 593 | **Hay sold** | |
| Avg. heifer weaning weight in lbs | 568 | hay produced minus hay needed (lbs) | 10,960 |
| Avg. herd sire weight in lbs | 2,000 | Number of 800 lb. round bales (including harvest from pasture if any) | 15 |
| Calving Season | Year round | Pasture acres per cow | 4 |

**Table 6.** Ownership charges for Equipment, Buildings and Livestock for a Medium-Sized Farm in Arkansas, 2012.

| **Description** | **List Price** | **Years of Useful Life** | **Salvage Value** | **Annual Capital Recovery** | **Repair and Maint.** | **Taxes** | **Insurance** |
|---|---|---|---|---|---|---|---|
| Hay Barn (1,000 sqft.) | $5,000 | 20 | $800 | $377 | $100 | $25 | $40 |
| Shed (800 sqft.) | $4,000 | 20 | $750 | $298 | $80 | $20 | $32 |
| 50-75 hp Tractor | $30,000 | 10 | $10,000 | $3,090 | $750 | $150 | $240 |
| Disk Mower | $8,000 | 7 | $4,000 | $891 | $400 | $40 | $64 |
| Hay Baler | $20,000 | 10 | $7,500 | $1,994 | $200 | $100 | $160 |
| Hay Rake | $4,000 | 10 | $750 | $458 | $80 | $20 | $32 |
| Stock Trailer | $3,500 | 10 | $1,500 | $334 | $70 | $18 | $28 |
| Hay Wagon | $3,000 | 10 | $500 | $349 | $60 | $15 | $24 |
| Brush Mower | $8,000 | 10 | $800 | $972 | $200 | $40 | $64 |
| Corral and Chute | $3,500 | 10 | $1,000 | $374 | $53 | $18 | $28 |
| Miscellaneous Items | $2,000 | 10 | $0 | $259 | $100 | $10 | $16 |
| Fencing & Watering | $24,144 | 20 | $0 | $1,937 | $121 | na | $193 |
| **Total** | | | | **$11,334** | **$2,213** | **$455** | **$921** |

| **Livestock** | **Market Value** |
|---|---|
| Cows ($850) | $32,300 |
| Young Cows ($1,000) | $7,000 |
| Replacements ($900) | $6,300 |
| Herdsires (set in Inputs) | $4,000 |
| Annual Opportunity Cost of Capital Employed (5% of Total Investment in Breeding Stock) | **$2,480** |

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus*.

| Cow Breed | Angus | | Beefmaster | | Brahman | | Brangus | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $125.38 | 17.59 | $117.97 | 17.62 | $101.37 | 17.54 | $97.38 | 17.69 |
| Change From Baseline | NR* ($/hd) | GHG** (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$66.55 | 9.66% | -$36.66 | 0.40% | ***$12.11*** | 0.40% | -$9.13 | 5.54% |
| Brahman | -$74.77 | 5.29% | -$101.58 | 5.51% | -$83.58 | ***-0.80%*** | -$55.13 | 5.37% |
| Brangus | -$54.77 | 6.25% | -$10.50 | 1.02% | -$14.15 | 0.91% | ***$14.45*** | 0.96% |
| Braunvieh | -$51.29 | 7.45% | -$49.88 | 2.10% | -$27.29 | 2.11% | -$33.25 | 2.09% |
| Charolais | -$82.52 | 4.89% | -$38.41 | 3.75% | -$18.26 | ***-1.31%*** | -$59.35 | 7.74% |
| Chiangus | -$85.23 | 11.60% | -$23.93 | 2.04% | -$27.00 | 2.11% | -$6.58 | 2.04% |
| Gelbvieh | -$64.19 | 9.44% | -$36.48 | 0.17% | -$5.91 | 0.17% | ***$15.15*** | 0.11% |
| Hereford | -$61.08 | 9.89% | -$37.14 | 0.57% | -$15.30 | 0.57% | -$43.77 | 5.77% |
| Limousin | -$65.74 | 9.61% | -$38.04 | 0.34% | -$7.04 | 0.29% | ***$13.50*** | 0.23% |
| Maine Anjou | -$81.46 | 11.20% | -$53.88 | 1.87% | -$23.15 | 1.77% | -$25.16 | 7.07% |
| Red Angus | -$20.53 | 1.36% | -$49.50 | 1.36% | -$18.69 | 1.25% | ***$2.15*** | 1.19% |
| Salers | -$36.45 | 6.08% | -$44.07 | 0.85% | -$12.27 | 0.74% | ***$7.97*** | 0.79% |
| Santa Gertrudis | -$66.79 | 6.65% | -$39.40 | 0.40% | -$8.43 | 0.46% | -$69.65 | 9.72% |
| Shorthorn | -$76.26 | 7.67% | -$71.93 | 6.81% | -$19.40 | 1.37% | -$54.73 | 10.85% |
| Simmental | -$77.17 | 8.53% | -$53.39 | ***-0.62%*** | -$26.62 | ***-0.68%*** | ***$11.33*** | 4.35% |
| South Devon | -$66.60 | 9.66% | -$38.92 | 0.40% | -$7.93 | 0.40% | -$9.18 | 5.54% |
| Tarentaise | -$25.78 | 5.00% | -$34.05 | ***-0.17%*** | -$32.11 | ***-0.17%*** | ***$18.67*** | ***-0.17%*** |

* Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.

** GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.

*** Italics denote times when either NR increase or GHG emissions decrease

**** Shading denotes when NR increase and GHG emissions decrease simultaneously

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus* (cont'd).

| Cow Breed | Braunvieh | | Charolais | | Chiangus | | Gelbvieh | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $106.49 | 17.81 | $90.96 | 17.5 | $107.52 | 17.8 | $119.04 | 17.61 |
| Change From Baseline | NR* ($/hd) | GHG** (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$92.41 | 9.71% | -$3.44 | 0.40% | -$25.62 | 5.62% | -$60.69 | 5.62% |
| Brahman | -$70.52 | 5.33% | -$67.42 | 8.34% | -$46.37 | 5.34% | -$100.89 | 5.45% |
| Brangus | -$10.48 | 0.79% | ***$0.82*** | 0.86% | -$36.28 | 0.79% | -$11.39 | 1.02% |
| Braunvieh | -$41.37 | 2.13% | ***$11.47*** | 2.06% | -$24.28 | 2.08% | -$58.08 | 2.04% |
| Charolais | -$41.77 | 7.75% | ***$11.49*** | ***-1.31%*** | -$59.28 | 7.81% | -$73.72 | 7.84% |
| Chiangus | -$45.67 | 7.58% | -$5.27 | 2.06% | -$23.98 | 2.08% | -$23.98 | 2.04% |
| Gelbvieh | -$57.54 | 5.39% | ***$3.02*** | 0.11% | -$1.35 | 0.11% | -$36.59 | 0.11% |
| Hereford | -$58.26 | 5.78% | ***$31.86*** | 0.57% | ***$2.88*** | 0.45% | -$37.24 | 0.51% |
| Limousin | -$59.09 | 5.56% | -$6.98 | 0.29% | -$3.01 | 0.28% | -$38.15 | 0.28% |
| Maine Anjou | -$74.90 | 7.19% | ***$15.80*** | 1.77% | -$19.94 | 1.74% | -$53.99 | 1.82% |
| Red Angus | -$48.82 | 1.24% | ***$20.50*** | 1.26% | -$15.24 | 1.24% | -$49.62 | 1.36% |
| Salers | -$42.50 | 0.62% | ***$27.21*** | 0.69% | -$8.52 | 0.62% | -$44.18 | 0.85% |
| Santa Gertrudis | -$92.95 | 9.77% | ***$30.80*** | 0.46% | -$60.94 | 9.78% | -$94.58 | 9.82% |
| Shorthorn | -$102.10 | 10.78% | ***$19.75*** | 1.37% | -$71.65 | 10.84% | -$104.61 | 10.96% |
| Simmental | -$44.77 | 4.44% | ***$10.64*** | ***-0.69%*** | ***$8.31*** | ***-0.73%*** | -$53.52 | ***-0.62%*** |
| South Devon | -$92.50 | 9.71% | ***$31.32*** | 0.40% | -$25.67 | 5.62% | -$61.68 | 5.62% |
| Tarentaise | -$33.37 | ***-0.17%*** | ***$6.36*** | ***-0.17%*** | ***$1.28*** | ***-0.17%*** | -$34.17 | ***-0.17%*** |

* Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.

** GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.

*** Italics denote times when either NR increase or GHG emissions decrease

**** Shading denotes when NR increase and GHG emissions decrease simultaneously

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus* (cont'd).

| Cow Breed | Hereford | | Limousin | | Maine Anjou | | Red Angus | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $104.95 | 17.48 | $118.01 | 17.62 | $109.73 | 17.75 | $111.81 | 17.72 |
| Change From Baseline | NR[*] ($/hd) | GHG[**] (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$11.66 | 0.29% | -$60.62 | 5.62% | -$60.13 | 5.63% | -$92.25 | 9.65% |
| Brahman | -$85.69 | 5.43% | -$100.70 | 5.45% | -$71.09 | 5.41% | -$70.44 | 5.25% |
| Brangus | -$20.03 | 0.86% | -$10.49 | 1.02% | -$9.61 | 0.96% | -$32.21 | 6.09% |
| Braunvieh | -$31.48 | 2.12% | -$58.01 | 2.10% | -$56.65 | 2.08% | -$78.46 | 7.51% |
| Charolais | -$49.39 | 7.78% | -$81.16 | 7.83% | -$71.32 | 7.77% | -$71.17 | 4.80% |
| Chiangus | ***$7.58*** | 2.06% | -$23.98 | 2.04% | -$23.09 | 2.08% | -$78.52 | 11.68% |
| Gelbvieh | -$39.64 | 0.11% | -$36.53 | 0.17% | -$36.05 | 0.11% | -$90.96 | 9.48% |
| Hereford | ***$14.81*** | 0.57% | -$19.44 | 0.51% | -$35.87 | 0.51% | -$90.72 | 9.88% |
| Limousin | -$23.88 | 0.23% | -$14.99 | 0.34% | -$36.72 | 0.28% | -$92.42 | 9.59% |
| Maine Anjou | -$28.26 | 1.77% | -$53.93 | 1.82% | -$53.45 | 1.75% | -$107.12 | 11.23% |
| Red Angus | -$22.95 | 1.26% | -$49.55 | 1.36% | -$48.18 | 1.18% | -$48.29 | 1.19% |
| Salers | -$17.47 | 0.69% | -$44.12 | 0.85% | -$42.75 | 0.79% | -$64.60 | 6.09% |
| Santa Gertrudis | -$34.55 | 5.61% | -$94.45 | 9.82% | -$59.82 | 5.63% | -$91.26 | 6.60% |
| Shorthorn | -$45.40 | 6.64% | -$104.48 | 10.95% | -$70.59 | 6.76% | -$100.07 | 7.45% |
| Simmental | -$31.03 | ***-0.69%*** | -$53.41 | ***-0.62%*** | -$22.35 | ***-0.79%*** | -$79.02 | 8.41% |
| South Devon | -$41.97 | 0.34% | -$60.72 | 5.62% | -$37.59 | 0.28% | -$92.34 | 9.65% |
| Tarentaise | -$36.47 | ***-0.17%*** | -$34.10 | ***-0.17%*** | -$32.73 | ***-0.17%*** | -$54.60 | 5.02% |

[*] Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.

[**] GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.

[***] Italics denote times when either NR increase or GHG emissions decrease

[****] Shading denotes when NR increase and GHG emissions decrease simultaneously

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus* (cont'd).

| Cow Breed | Salers | | Santa Gertrudis | | Shorthorn | | Simmental | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $114.91 | 17.67 | $116.97 | 17.65 | $110.76 | 17.74 | $131.63 | 17.54 |
| Change From Baseline | NR* ($/hd) | GHG** (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$93.52 | 9.68% | -$38.81 | 0.34% | -$37.56 | 0.34% | -$42.88 | 0.29% |
| Brahman | -$98.78 | 5.32% | -$101.70 | 8.39% | -$72.15 | 8.40% | -$110.15 | 5.47% |
| Brangus | -$10.48 | 0.91% | -$10.49 | 0.96% | -$10.49 | 0.96% | -$10.66 | 0.97% |
| Braunvieh | -$57.83 | 2.09% | -$57.95 | 2.10% | -$56.71 | 2.09% | -$62.17 | 2.05% |
| Charolais | -$71.88 | 7.70% | -$38.39 | 3.74% | -$15.40 | ***-1.35%*** | -$84.04 | 7.87% |
| Chiangus | -$45.69 | 7.53% | -$23.98 | 2.04% | -$23.09 | 2.09% | -$23.45 | 2.17% |
| Gelbvieh | -$58.10 | 5.38% | -$36.47 | 0.17% | -$36.11 | 0.11% | -$41.42 | 0.11% |
| Hereford | -$91.97 | 9.90% | -$37.14 | 0.51% | -$35.93 | 0.51% | -$44.94 | 0.51% |
| Limousin | -$59.65 | 5.49% | -$38.02 | 0.28% | -$37.67 | 0.28% | -$42.98 | 0.29% |
| Maine Anjou | -$75.46 | 7.07% | -$53.87 | 1.81% | -$53.51 | 1.69% | -$58.95 | 1.82% |
| Red Angus | -$49.37 | 1.19% | -$49.49 | 1.30% | -$48.24 | 1.18% | -$54.53 | 1.37% |
| Salers | -$43.04 | 0.79% | -$44.05 | 0.79% | -$42.81 | 0.79% | -$48.17 | 0.86% |
| Santa Gertrudis | -$94.06 | 9.73% | -$39.40 | 0.40% | -$38.15 | 0.39% | -$65.23 | 5.70% |
| Shorthorn | -$103.21 | 10.87% | -$50.19 | 1.42% | -$48.94 | 1.41% | -$76.08 | 6.73% |
| Simmental | -$45.27 | 4.47% | -$53.31 | ***-0.68%*** | -$23.29 | ***-0.79%*** | -$86.50 | ***-0.63%*** |
| South Devon | -$93.62 | 9.73% | -$38.91 | 0.34% | -$37.66 | 0.34% | -$42.97 | 0.29% |
| Tarentaise | -$33.03 | ***-0.17%*** | -$33.15 | ***-0.23%*** | -$32.79 | ***-0.17%*** | -$67.80 | -0.06% |

* Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.
** GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.
*** Italics denote times when either NR increase or GHG emissions decrease
**** Shading denotes when NR increase and GHG emissions decrease simultaneously

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus* (cont'd).

| Cow Breed | South Devon | | Tarentaise | | Commercial | | Commercial Black | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $118.01 | 17.62 | $120.23 | 17.58 | $87.26 | 17.65 | $114.91 | 17.67 |
| Change From Baseline | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$38.87 | 0.40% | -$93.38 | 9.67% | -$25.41 | 5.61% | -$60.89 | 9.68% |
| Brahman | -$101.60 | 5.51% | -$100.35 | 5.40% | -$73.40 | 5.38% | -$75.46 | 5.32% |
| Brangus | -$10.49 | 1.02% | -$10.49 | 0.97% | -$9.93 | 0.96% | -$10.49 | 0.91% |
| Braunvieh | -$58.01 | 2.10% | -$57.31 | 2.05% | -$23.00 | 2.10% | -$24.28 | 2.09% |
| Charolais | -$38.44 | 3.75% | -$73.04 | 7.74% | -$69.80 | 7.82% | -$87.80 | 7.70% |
| Chiangus | -$23.98 | 2.04% | -$44.81 | 7.45% | -$22.71 | 2.04% | -$45.69 | 7.53% |
| Gelbvieh | -$36.53 | 0.17% | -$58.47 | 5.29% | -$1.29 | 0.11% | -$23.11 | 5.38% |
| Hereford | -$37.19 | 0.57% | -$92.68 | 9.95% | -$5.71 | 0.51% | -$19.64 | 5.77% |
| Limousin | -$38.09 | 0.34% | -$59.13 | 5.46% | -$2.86 | 0.28% | -$24.76 | 5.49% |
| Maine Anjou | -$53.93 | 1.87% | -$75.84 | 7.22% | -$18.87 | 1.64% | -$41.66 | 7.07% |
| Red Angus | -$49.55 | 1.36% | -$48.85 | 1.37% | -$14.44 | 1.19% | -$15.24 | 1.19% |
| Salers | -$44.12 | 0.85% | -$43.41 | 0.85% | -$8.95 | 0.79% | -$8.53 | 0.79% |
| Santa Gertrudis | -$61.21 | 5.73% | -$93.92 | 9.73% | -$25.99 | 5.61% | -$61.46 | 9.73% |
| Shorthorn | -$71.98 | 6.81% | -$103.95 | 10.86% | -$36.87 | 6.74% | -$71.29 | 10.87% |
| Simmental | -$53.42 | ***-0.62%*** | -$74.15 | 4.44% | -$21.95 | ***-0.68%*** | -$5.15 | 4.47% |
| South Devon | -$38.97 | 0.40% | -$93.47 | 9.73% | -$3.74 | 0.34% | -$60.99 | 9.73% |
| Tarentaise | -$34.10 | ***-0.17%*** | -$33.39 | ***-0.17%*** | ***$2.06*** | ***-0.23%*** | ***$2.17*** | ***-0.17%*** |

* Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.

** GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.

*** Italics denote times when either NR increase or GHG emissions decrease

**** Shading denotes when NR increase and GHG emissions decrease simultaneously

**Table 7**. Profitability and GHG Change as Base Cow Breed Changes *ceteris paribus* (cont'd).

| Cow Breed | Commercial Red | | Commercial Spotted | | Commercial White | | Commercial Yellow | |
|---|---|---|---|---|---|---|---|---|
| Baseline With Angus Bull | $116.97 | 17.65 | -$34.14 | 17.61 | $99.77 | 17.62 | $116.97 | 17.65 |
| Change From Baseline | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) | NR ($/hd) | GHG (% Change) |
| Angus | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| Beefmaster | -$60.57 | 5.61% | -$2.87 | 0.40% | ***$13.65*** | 0.40% | -$38.81 | 0.34% |
| Brahman | -$107.90 | 5.38% | -$59.11 | 5.51% | -$87.39 | 8.40% | -$77.79 | 5.38% |
| Brangus | -$10.50 | 0.96% | -$8.50 | 1.02% | -$10.15 | 1.02% | -$10.50 | 0.96% |
| Braunvieh | -$57.96 | 2.10% | -$17.68 | 2.04% | -$6.76 | 2.10% | -$57.96 | 2.10% |
| Charolais | -$73.03 | 7.82% | -$34.24 | 3.75% | -$49.72 | 3.80% | -$100.59 | 7.82% |
| Chiangus | -$23.99 | 2.04% | -$17.46 | 2.04% | -$23.20 | 2.04% | -$23.99 | 2.04% |
| Gelbvieh | -$36.47 | 0.11% | -$1.01 | 0.11% | ***$16.13*** | 0.17% | -$2.12 | 0.11% |
| Hereford | -$37.14 | 0.51% | -$4.49 | 0.57% | ***$9.97*** | 0.57% | -$8.28 | 0.51% |
| Limousin | -$38.03 | 0.28% | -$2.25 | 0.28% | ***$14.48*** | 0.34% | -$38.03 | 0.28% |
| Maine Anjou | -$53.87 | 1.64% | -$14.45 | 1.87% | -$2.43 | 1.87% | -$53.87 | 1.64% |
| Red Angus | -$49.49 | 1.19% | -$11.16 | 1.36% | ***$2.27*** | 1.36% | -$49.49 | 1.19% |
| Salers | -$44.06 | 0.79% | -$7.03 | 0.85% | ***$8.08*** | 0.85% | -$44.06 | 0.79% |
| Santa Gertrudis | -$61.14 | 5.61% | -$25.99 | 5.68% | ***$13.02*** | 0.45% | -$61.15 | 5.61% |
| Shorthorn | -$104.37 | 10.93% | -$33.45 | 6.81% | ***$1.53*** | 1.48% | -$71.92 | 6.74% |
| Simmental | -$53.32 | ***-0.68%*** | -$17.57 | ***-0.62%*** | -$7.06 | ***-0.62%*** | -$25.22 | ***-0.68%*** |
| South Devon | -$38.90 | 0.34% | -$2.95 | 0.40% | ***$13.55*** | 0.40% | -$38.91 | 0.34% |
| Tarentaise | -$33.15 | ***-0.23%*** | ***$0.73*** | ***-0.17%*** | ***$18.76*** | ***-0.17%*** | -$33.15 | ***-0.23%*** |

* Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs.

** GHG is measured in lbs of $CO_2$ per pound of liveweight sold. Change is shown as a percent change.

*** Italics denote times when either NR increase or GHG emissions decrease

**** Shading denotes when NR increase and GHG emissions decrease simultaneously

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University of Arkansas System

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M E M O

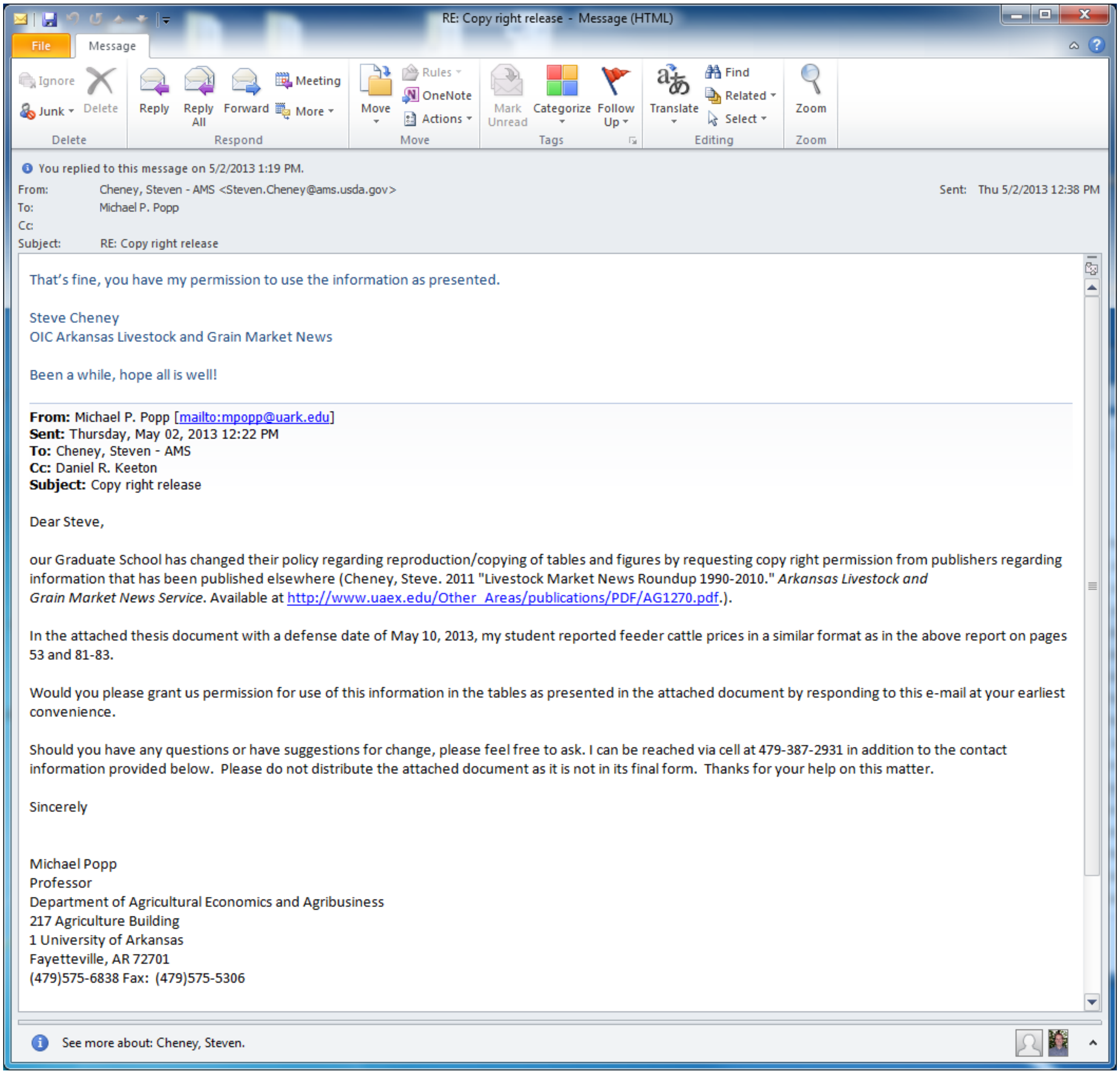
From: Michael Popp

To: Graduate School

Date: May 16, 2013

Subject: Daniel Keeton M.Sc Thesis

This memorandum is to certify that Daniel R. Keeton has performed at least 51% of the work associated with work entitled “Evaluating Economic and Environmental Impacts of Changing Herd Sire Genetics on Arkansas Cow-calf Operations”. Should you have any questions, please feel free to contact me at 479-575-6838 or mpopp@uark.edu.



RE: Copy right release - Message (HTML)

You replied to this message on 5/2/2013 1:19 PM.

From: Cheney, Steven - AMS <Steven.Cheney@ams.usda.gov>
Sent: Thu 5/2/2013 12:38 PM
To: Michael P. Popp
Cc:
Subject: RE: Copy right release

That's fine, you have my permission to use the information as presented.

Steve Cheney
OIC Arkansas Livestock and Grain Market News

Been a while, hope all is well!

**From:** Michael P. Popp [mailto:mpopp@uark.edu]
**Sent:** Thursday, May 02, 2013 12:22 PM
**To:** Cheney, Steven - AMS
**Cc:** Daniel R. Keeton
**Subject:** Copy right release

Dear Steve,

our Graduate School has changed their policy regarding reproduction/copying of tables and figures by requesting copy right permission from publishers regarding information that has been published elsewhere (Cheney, Steve. 2011 "Livestock Market News Roundup 1990-2010." *Arkansas Livestock and Grain Market News Service*. Available at http://www.uaex.edu/Other_Areas/publications/PDF/AG1270.pdf.).

In the attached thesis document with a defense date of May 10, 2013, my student reported feeder cattle prices in a similar format as in the above report on pages 53 and 81-83.

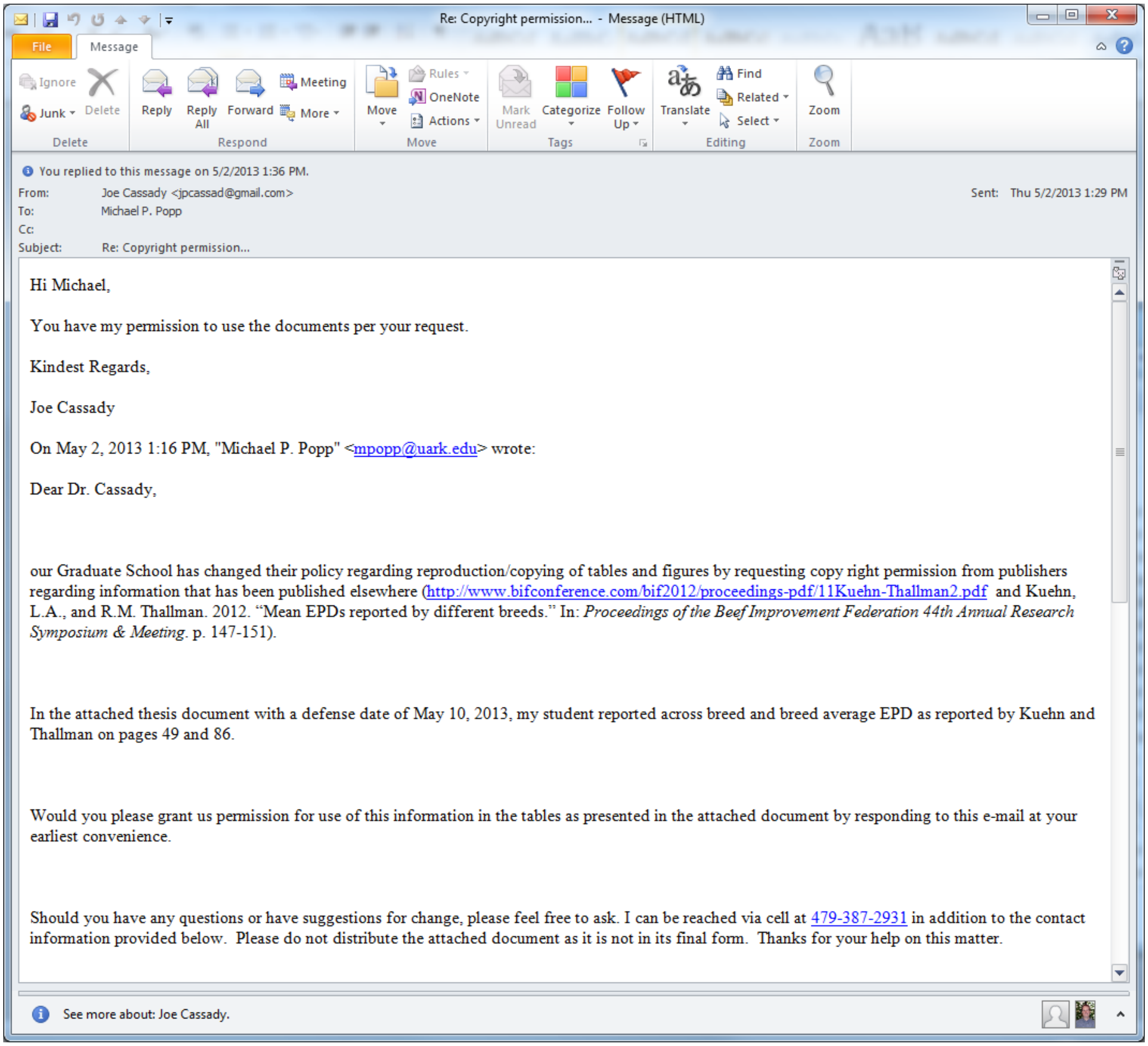
Would you please grant us permission for use of this information in the tables as presented in the attached document by responding to this e-mail at your earliest convenience.

Should you have any questions or have suggestions for change, please feel free to ask. I can be reached via cell at 479-387-2931 in addition to the contact information provided below. Please do not distribute the attached document as it is not in its final form. Thanks for your help on this matter.

Sincerely

Michael Popp
Professor
Department of Agricultural Economics and Agribusiness
217 Agriculture Building
1 University of Arkansas
Fayetteville, AR 72701
(479)575-6838 Fax: (479)575-5306

See more about: Cheney, Steven.



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From: Joe Cassady <jpcassad@gmail.com>
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Cc:
Subject: Re: Copyright permission...

Hi Michael,

You have my permission to use the documents per your request.

Kindest Regards,

Joe Cassady

On May 2, 2013 1:16 PM, "Michael P. Popp" <mpopp@uark.edu> wrote:

Dear Dr. Cassady,

our Graduate School has changed their policy regarding reproduction/copying of tables and figures by requesting copy right permission from publishers regarding information that has been published elsewhere (http://www.bifconference.com/bif2012/proceedings-pdf/11Kuehn-Thallman2.pdf and Kuehn, L.A., and R.M. Thallman. 2012. "Mean EPDs reported by different breeds." In: *Proceedings of the Beef Improvement Federation 44th Annual Research Symposium & Meeting*. p. 147-151).

In the attached thesis document with a defense date of May 10, 2013, my student reported across breed and breed average EPD as reported by Kuehn and Thallman on pages 49 and 86.

Would you please grant us permission for use of this information in the tables as presented in the attached document by responding to this e-mail at your earliest convenience.

Should you have any questions or have suggestions for change, please feel free to ask. I can be reached via cell at 479-387-2931 in addition to the contact information provided below. Please do not distribute the attached document as it is not in its final form. Thanks for your help on this matter.

See more about: Joe Cassady.

# Chapter 3

## III. Conclusion

### Introduction

Based on information gathered within, Arkansas cow-calf operators were in need of a tool that would allow them the opportunity to analyze economic and environmental ramifications of modifying production practices prior to implementing them. Given the variation in operational characteristics, recommendations for improving estimated profitability and environmental impact will differ from farm to farm. This thesis highlighted the effects of herd sire selection on a medium-sized operation.

The Forage Cow-Calf Calculator was developed to assist Arkansas cow-calf operators in understanding both the economic and GHG aspects of their operation and how management practices impact these areas. The 'Bull Estimator' is part of the Forage Cow-Calf calculator and allows operators to see what kind of profitability and GHG changes might occur from a potential herd sire change. Comparisons between potential bulls and existing bulls can be made by comparing expected breeding scenarios. Breeding scenarios are chosen by the user. The user can choose from 24 different cow breeds and 18 different bull breeds. Bull genetics, breeding difficulty, changes in calf sale prices, changes in input requirements, and bull purchase price all effect potential changes in profitability and GHG emissions. Profitability changes are shown in dollar change per breeding cow ($/cow) and GHG changes are shown in change in GHG per pound of live weight sold (GHG/live weight sold).

Results change as operation size, management practices, and existing genetics change. It is also important to remember that while the Bull Estimator may show one bull breed to be more profitable than another or to reduce emissions compared to another; this does not necessarily mean that the same result will be true across other cow breeds. A weak association between bull breeds that were more profitable and bulls that decreased GHG emissions was found but GHG ramifications were small (less than 1%).

**Limitations**

Since cow-calf operations can vary so much in their operational characteristics, even with the complexities captured in the Forage Cow-calf calculator, it is still difficult for user's to fully define their operation using that tool. Also, this calculator may not be able to give effective results for purebred operators and operators marketing to niche markets. Calculator results are dependent upon values, costs, and practices entered or chosen by the user. Ideally, calculator parameters and questions would be tailored to more effectively capture each individual user of the calculator but this would be quite costly. Furthermore, the calculator does not distinguish between hobby, part-time, and full-time operators. Input costs and management practices associated with the calculator are specifically designed for Arkansas cow-calf producers; therefore, producers in other states may get skewed results.

Calculated sale prices are based on studies by Cheney *et al.*, Barham *et al.*, and Troxel *et al.* Cheney *et al*. reports average sale prices for the state of Arkansas. The reported averages were used for this thesis as the author did not have access to the data for the calculation of coefficients from regression analysis. Further, there may not be sufficient observations for the different breeds and crossbreeds to arrive at coefficient estimates for sale barn, by sale weight by location effects, for example. Hence, regional and breed specific prices are not captured by this study. Also, sale prices are reported as an average for a hundred pound weight category. In reality, variations in prices can occur within hundred pound weight categories. All calves are also considered to be average; therefore, no premium can be associated with higher quality calves or calves with different frame scores or muscling and no discount can be associated with lower quality calves in an automated fashion. Barham *et al*. and Troxel *et al.* (2002, 2007, and 2012) report average sale prices for certain breeds, crossbreeds, and hide colors. Once again, reported prices are only averages and do not provide for sale time, fill differences, quality, or sale location adjustments. For purebred prices both bull and cows had to have been from the same breed and that breed needed to have a reported price but Barham *et al*. and Troxel *et al.* do not report all purebred prices. Crossbreed prices were applied when a certain breeding interaction had a reported crossbred price. No preference was given to the breed of the bull or cow. Purebreds that did not have a purebred price and crosses that did not have a crossbreed price were given a hide color price. As hide color can vary within a breed (for example in the shorthorn) the hide color price thought to best represent the average of the breed was used. If the user was to establish cow breed and bull breed, in the new bull row, on the Bull Estimator and applied the changes to 'Your Farm' then reported prices for the 'Your Farm' budget would change from overall Arkansas averages to interaction specific Arkansas averages. When combining these studies a good estimate of what a particular operation's calves are bringing at sale can be provided, but the only way to provide an exact amount is by the user directly inputting prices received. In general, application of breed effects on prices is a difficult subject.

**Further Research**

Further research is needed in adding alternative marketing strategies to the calculator as this is another important aspect that cow-calf operators need to look at when considering potential changes in sire genetics. Examples of alternative marketing strategies include retained ownership of calves, organic/grass fed beef, veal, replacement heifers, and purebred programs.

Annual updates will need to be made to the calculator as new research will change the reported data.

Expected Progeny Difference (EPD) values used in the Bull Estimator include BW, WW, and YW. The Across Breed EPD table used also contains EPD values related to carcass quality. However, it does not report these values for each breed in the chart so carcass EPD values were omitted. Adding carcass EPD values to the calculator will provide a better understanding of calf quality and assist the calculator in determining the most accurate prices received for calves sold.