Cow-Calf Operations in the Southeastern United States: An Analysis of Farm Characteristics and Production Risks

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Introduction

Beef cattle production in the southeastern United States differs in size, practice, and production type from other U.S. regions. These differences are explained in part by climate, primary land use for crops, and forage availability. Operator demographics show similarities to other regions but key operation statistics, such as herd size and makeup, importance of cattle income to total household income, management practices, and calf weaning weights, distinguish the Southeast.

Cattle production in the southeastern U.S. is typically a cow-calf operation where 70% of all calves produced in the region are sold at weaning (McBride and Mathews, 2011). Cow-calf operations dominate in the Southeast because the climate and forage availability make this type of beef cattle operation more ideal. Additionally, when compared to regions of the United States where beef cattle operations are larger and more diverse (for example, the Great Plains), agricultural land in the southeast is largely comprised of dense forest or row crop production (Ball, Hoveland and Lacefield, 1996). Therefore, the availability of pasture land in the Southeast for cattle production has typically been small areas of less productive land that lend well to grasses for grazing and hay. These aspects led McBride and Mathews (2011) to classify cow-calf producers as "residual user(s)" of land (p. iii), limiting or fragmenting cattle operations into smaller operations due to the opportunity cost associated with crop production or recreational activities.

The result of this limited acreage is that most operations in the Southeast are small, often requiring income from off-farm sources. For instance, the National Animal Health Monitoring System (NAHMS) study, *Beef 2007-08*, reports that 94.7% of operations in the U.S. with less than 50 head primarily rely on outside income (USDA, APHIS, 2008). In contrast, 65% of large scale operations, those with 200 head or more, list their cow-calf operation as the primary source of their income (USDA, APHIS, 2008). Typically, cow-calf production does not require the level of intense management compared to other beef operations, thus making it more manageable for those with limited time and labor, particularly for smaller operations.

Cow-calf operations in the southeastern United States are typically small, both in the number of head maintained and the number of acres managed, relative to the other regions. McBride and Mathews (2011) report that the Southeast[1] had an average of 59 head per farm and operated only 453 acres per farm using data from the 2008 Agricultural Resource Management Survey (ARMS). The regional differences in cattle production practices and operating environments create a unique set of challenges for each region in the United States. Thus research that is particular to each region is often necessary and lends significance to this work. Given that southeastern cattle operations are small they are managed under different sets of production practices.

[1] Defined in their research as: Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, Tennessee, and Virginia

Previous research has provided insight regarding the make-up of the cattle industry across varying sizes and locations. However, as the cattle industry adapts to the changes in factors of production, the data collected for past research becomes less representative of current industry dynamics. For example, a beef cattle operation in 2011 must deal with fluctuating feed prices, widely variable output prices, pasture shortages due to drought, decreased domestic consumption, steep competition from exporters in other countries, a shrinking national beef herd (Informa Economics, 2011), as well as the uncertain size and impact of the biofuels industry. This particular combination of influences on the cattle industry is unique in recent years.

Individual cattle operators have always been challenged by weather, soil fertility, insects, and other biological factors to produce forage for their cattle. They have had production challenges such as genetic selection, disease, and nutrition. The variability caused by these challenges presents production risks for the individual operator. Variability in production, combined with wide fluctuations in current cattle prices, can lead to relatively little profit or even large losses for an operator. Historically, except for seasonal fluctuations in the cattle price cycle, the price for cattle has had a generally low variability. For cow-calf operators this is particularly important because they are in the market only once or twice per year. However, the widely erratic nature of the cattle price in recent markets magnifies the importance of efficiently managing production risks.

Objectives

1) Define the characteristics of beef cattle operations in the southeastern United States.
2) Determine the factors that impact production for southeastern beef cattle operations.
3) Examine the causes of variability in production factors within beef herds of the Southeast.

Previous Literature

Popp and Parsch (1998) surveyed Arkansas cattle producers in 1996. They found that the average first calving age was approximately 26.4 months, the average culling age was 8.3 years, and the breeding age range was 14 to 21 months. Compared to data from McBride and Mathews (2011) and the 2007 Census of Agriculture (USDA, NASS, 2007), the results from Popp and Parsch (1998) show similarities across several operational characteristics. Popp and Parsch concluded that smaller operations, primarily cow-calf only, calve year-round or use little structured control over the calving season. In contrast to smaller operations, McBride and Mathews (2011) found that larger operations exert more control over their calving seasons.

Further, Popp and Parsch (1998) found that almost 60% of all beef cattle farms in Arkansas maintained less than 50 head, although the average size in the survey, due to some larger operations, was 94 cows and 19 heifers. The 2007 Agricultural Census reveals that Arkansas had changed since the data collected by Popp and Parsch in 1996; the percent of farms with less than 50 head of beef cattle had increased to slightly over 68% (USDA, NASS, 2007).

Little, Forrest, and Lacy (2000) found, via a 1999 survey of Mississippi cattle producers, that the average Mississippi herd size was 33 head. At that time 93.3% of all producers were over 41 years of age or older. Over 44% of these producers were employed full-time off of the farm and approximately 42% of the producers' spouses had full-time off-farm employment.

The 2007 Census of Agriculture and statistics from USDA's National Agricultural Statistics Service (NASS) highlights the decline in the number of beef cattle operations. From 1993 to 2007 the total number of beef cattle farms in the southeastern United States decreased by 24.2%. The national decline in beef cattle operations was 10.5% (USDA, NASS, 2007; 2011). This has been accompanied by a 1.6% decrease in total head of beef cows.

Another survey of the Arkansas beef industry was conducted in 2007, by Troxel, et al. The survey analyzed the strengths, weaknesses, opportunities and threats to the Arkansas cattle industry. The authors split the cattle operations into five segments: (1) herds of less than or equal to 50 head, (2) more than 50 head, (3)stocker only herds, (4) purebred only herds, and (5) industries that provide support those operations. They report from the 2002 Census of Agriculture that over 80% of operators surveyed in the beef cattle industry in Arkansas were commercial cow-calf operations that produced less than 50 cows per year (Troxel, et al. 2007). Their findings agreed with the National Animal Health Monitoring System (NAHMS) study of 1997 (USDA, APHIS, 1997) as well as previous work by Popp and Parsch (1998) and Little, Forest and Lacy (2000). The self-assessment by Arkansas beef cattle producers showed a higher percentage of small-herd cow-calf operators than are in the 2007 Census. The 2007 Census shows only 68.6% of cattle operations are smaller than 50 head (USDA, NASS, 2007). That may indicate a growing presence of stocker/feeder operations in the state. The NAHMS study of 2008 shows a national figure of 67.3% of cow-calf operations being smaller than 50 head (USDA, APHIS, 2008).

Management practice's impacts on productivity have been extensively researched via animal production trials. Sellers, Willham, and deBaca (1970) divided the birth months into seasons: December through February is defined as winter; March through May, spring; June through August, summer; and September through November is defined as fall. They found that calves born in the winter and spring seasons weaned heavier than those born in summer by 7.7 kg and in the fall season by 4.5 kilograms. Management practices, as defined in Sellers, Willham, and deBaca (1970), had a significant effect on each sex. A calf—heifer, bull, or steer—that was creep-fed showed 13.0 kg, 19.1 kg, and 10.2 kg increases in weaning weight. Doren, Long, and Cartwright (1986) found that the weaning weight of the previous calf increases calving interval and does significantly account for a portion of the variation in calving interval when adjusted for breed type, parity, age, and other factors.

Decreasing the replacement rate, shortening the breeding season, a smaller herd size, and lowering the bull yearling percentage all had significant (99% confidence level) association with a higher calving rate (Wittum, et al., 1990). The mortality rate increased with early calving seasons—brought on by breeding seasons that began in April or earlier—and smaller herd size. The higher mortality rates associated with those early calving seasons was attributed to extreme cold or wet weather. They offer that neonatal calf mortality in larger herds may be less likely to be reported since it may not be observed; this may explain a lower calving rate—the neonatal birth and subsequent death is never recorded as a live birth—and a lower mortality rate both being associated with larger herds.

Gaertner, et al. (1992) used the records of 1909 Simmental-sired calves born to Brahman-Hereford F_1 dams from 1975 to 1990 to determine the effects of year, season of birth, age of dam, age at weaning, and sex of calf on birth weight and weaning weight. Weaning weight was significantly affected by sex and season of birth as well as season of birth and stocking rate interaction variables. As in Cundiff, Willham, and Pratt (1966), steers weighed more at weaning than heifers across season of birth. Fall-born (September through December) calves exhibited a 61.6 kg weaning weight difference between low and high pasture stocking rates than did winter-born (January through March) calves; which had a mean weaning weight of 215.9 kg in high stocking rate pastures and 264.6 kg in pastures with a low stocking rate. The greater difference is attributed to better quality forage—cool season, annual forage versus predominantly Bermudagrass—and the ability of calves to better utilize that high-quality forage (Gaertner, et al., 1992).

In a study of the factors that affect beef herd costs, Ramsey, et al. (2005) used Standardized Performance Analysis (SPA) to combine financial and production records into one analysis. Their data came from producers in New Mexico, Oklahoma, and Texas. There were 394 herd-year observations gathered over the period from 1991 to 2001. Of note are their results that indicate a declining cost per unit, at a decreasing rate, as herd size increased, leading to the conclusion of increasing economies of size at a decreasing rate. Also, weaning weight was positively affected by investment in livestock and a higher calving percentage; and negatively affected by death losses and longer breeding seasons. Further, Ramsey, et al. (2005) calving percentage was the only variable to show significance in all three—cost, production, and profit—of their models.

Dhuyvetter and Langemeier (2010) examined the differences between high-, medium-, and low-profit cow-calf operations. They found that profit was positively related to selling weight, *ceteris paribus*. Also, profits increased at a decreasing rate for increased herd size, up to 345 head, also indicating economies of size. There existed more variability in returns at a point in time across producers than there did across years implying that producers can possibly improve management in order to improve operational outcomes although they may have little to no control over the year-to-year variability effects of the cattle cycle. The authors placed particular importance on managing non-feed costs through economies of size since larger operations experienced lower per cow costs for labor, machinery, and depreciation. As the percent of total costs dedicated to feed increased, so did the profit of an operation; conversely, the costs in dollars per cow decreased.

Data and Methods

This study uses data gathered from responses to an online survey of cow-calf and stocker producers in the cattle industry. Survey respondents were drawn primarily from contacts compiled by the Agricultural Economics and Animal Science Departments at Mississippi State

University, the Mississippi Cattle Industry Board (MCIB), and the Mississippi Cattlemen's Association (MCA). The survey was also made available to academic, Extension, or industry personnel in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia for further distribution to targeted respondents. The regions specified in this survey are defined in figure 1.

The survey was targeted to those operators that have cow-calf only enterprises, stocker only operations, and those operators that have a combination of cow-calf and stocker enterprises. The survey was made available for eight weeks with a reminder sent after three weeks of the initial contact.

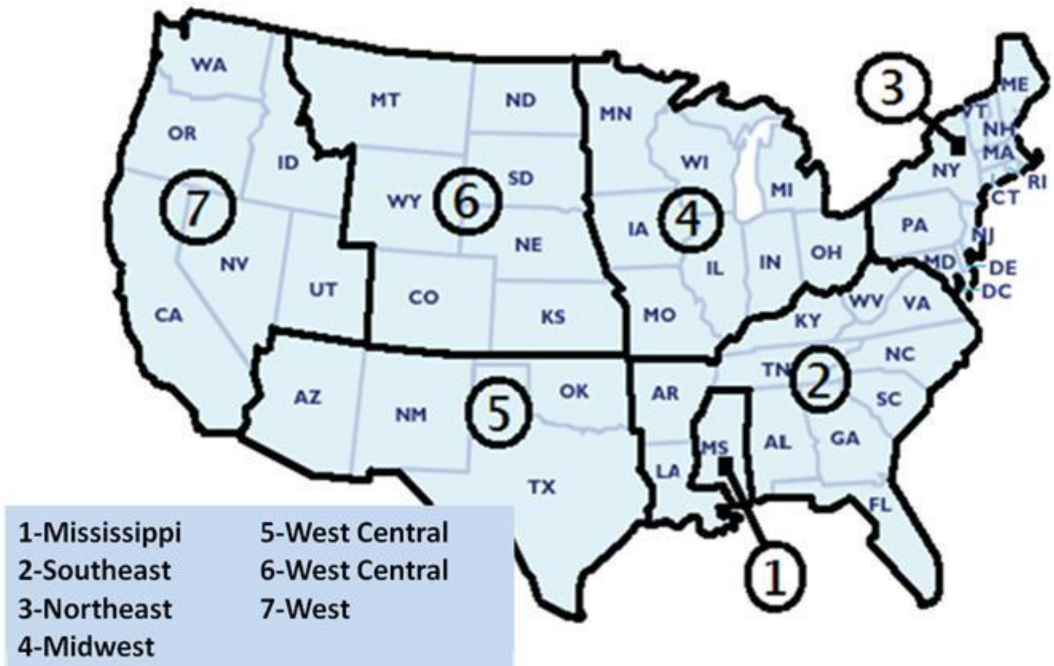

Figure 1. Definition of the Regions Used in this Research

Models

Five econometric models are specified to determine which factors of production have a significant effect on production components of cow-calf operations. These models describe the factors that affect average weaning weight, the standard deviation of within-herd weaning weight, the birth-to-weaning rate (defined as the number of calves that are weaned per cows conceived), average pregnancy rate, and the standard deviation of the weaning rate. The dependent and independent variables collected in the survey, and used in the empirical models, are listed in table 1.

Table 1. Dependent and Independent Variables Used in Empirical Analysis of Southeastern Cattle Production

Variable	Definition
Dependent Variables	
WWAVG	Average calf weight at weaning (in pounds)
WWσ_i	Standard deviation of low, high, and average responses to weaning weight survey questions
B2W	Birth to weaning rate as a ration of weaning rate to pregnancy rate.
PRAVG	Pregnancy rate—calves conceived per breeding females exposed
WRσ_i	Standard deviation of low, high, and average responses to calf weaning rate (calves weaned per breeding females exposed)
Independent Categorical Variables	
EXP14, EXP29, and EXP30	Operators with up to14, 15-29, and >30 years of experience owning or managing a cattle operation (EXP14 is the base category)
BEEFINC20, BEEFINC21	20% or less, or 21% or more, of the operators household income is from the cattle operation
CC0, CC49, CC199, and CC20	0, 1-49, 50-199, and >200 head of commercial cattle (CC0 is the base category)
SS0, SS49, SS199, and SS200	0, 1-49, 50-199, and >200 head of seedstock cattle (SS0 is the base category)
WIN, SPR, SUM, FALL	Seasons of year in which at least one calf was born on the operation
CALFMON3, CALFMON4	All calves born on operation were born within a single 3-month period, or in 4 or more months within a year
CALFSEA2, CALFSEA0	The operation was managed with two distinct calving seasons, or no distinct calving season was detectable
FIN20, FIN21	20% or less, or 21% or more, of cattle and feed are being financed by outside source
RYE, OTHER	Annual ryegrass is used as a cool-season forage or another type of forage was used
SUPPCALF, SUPPCALF0	Creep-fed calves were fed 3 or more pounds of supplement daily, or less than 3 pounds were fed
Independent Continuous Variable	
WEANAGE	A continuous variable that describes the age (in months) at which the calf is weaned

Cattle operations are assumed to be profit-maximizing firms. The average weaning weight of a calf is the first model because of its importance as the primary product of the operation. Due to the natural impact that pregnancy rate and birth-to-weaning rate has on the number of calves that actually make it to sale, these two models were estimated. The remaining models, variability in weaning weight and variability in weaning rate are examined for two reasons. First, previous literature contains no known direct examination of the variability of these two factors of production; and second, minimizing variability in the product of the operation decreases the potential for profit risk at market time.

The beef cattle data in this research is analyzed using ordinary least squares (OLS) regression. The average weaning weight provided by each respondent was quantified using the following equation:

$$\begin{aligned} WWAVG_i = {} & \alpha_0 + \alpha_1 \mathrm{EXP29}_i + \alpha_2 EXP30_i + \alpha_3 BEEFINC21_i + \alpha_4 CC49_i + \alpha_5 CC199_i \\ & + \alpha_6 CC200_i + \alpha_7 SS49_i + \alpha_8 SS199_i + \alpha_9 SS200_i + \alpha_{10} FIN21_i + \alpha_{11} RYE_i \\ & + \alpha_{12} WIN_i + \alpha_{13} SPR_i + \alpha_{14} SUM_i + \alpha_{15} FALL_i + \alpha_{16} CALFMON3_i \\ & + \alpha_{17} CALFSEA2_i + \alpha_{18} SUPPCALF_i + \alpha_{19} WEANAGE_i + u_i , \end{aligned} \qquad [1]$$

where EXP14, BEEFINC20, CC0, SS0, FIN20, CALFMON4, CALFSEA0 are default dummy variables, and *i* corresponds to each individual observation.

Following Ramsey, et al. (2005), weaning weight is used as a key indicator of profitability in cow-calf operations because of its direct effect on revenue and total costs of production. Dhuyvetter and Langemeier (2010) found that pounds of beef weaned per exposed female had significant positive effect on profit for cow-calf producers; however, they also found that the factors that drive costs are more important to distinguishing between low-profit and high-profit producers. Buskirk, Faulkner, and Ireland (1995) also determined in a 1994 study of 452 calves purchased in the southeastern United States (observed in Illinois), that increased weaning weight yields several long-term production benefits.

Age of calf at weaning (WEANAGE) and calving season (winter (WIN), spring (SPR), summer (SUM), or fall (FALL)) are used to estimate weaning weight following Pell and Thayne (1978) and Gaertner, et al. (1992). This research also analyzes additional production factors for southeastern cow-calf operations similar to those found in the research of Sellers, Willham, and deBaca (1970) and Buskirk, Faulkner, and Ireland (1995). Those variables included are: availability of quality winter ryegrass forage (RYE); amount of creep-fed calf supplements (SUPPCALF); the existence of distinct calving seasons (CALFSEA2); and number of months calved (CALFMON3) (Sellers, Willham, and DeBaca, 1966). Management intensity is proxied using CALFSEA2, CALFMON3, FIN21, BEEFINC21, EXP29, and EXP30.

Gaertner et al. (1992) found significance in the effects of forage type, such as cool season annual (RYE), warm season perennial, and other types on calf weaning weight. The availability of quality forage, RYE, to winter-born calves and creep-fed supplements, SUPPCALF, to all calves is expected to have a positive effect on the weaning weight of a calf. The age of calf at weaning is expected to have a positive effect on weaning weight. Wittum, et al., (1990) found that calf mortality negatively affects overall weaning rate and that calf mortality increased with earlier calving seasons, as they observed in Colorado beef herds. The implication of this facet of their research was that the extreme weather of earlier calving seasons could lead to higher calf mortality. The calving season timing is therefore used in the empirical model, equation [1], to capture any significant effects of calving season on weaning weight.

The winter variable (WIN) captures calves born in December, January, or February; the summer (SUM) variable captures those calves born in June, July, and August. Those two variables are expected to have a positive effect on the weaning weight of calves due to the subsequent mild weather after birth. Cundiff, Willham, and Pratt (1966) found that calves born in months that were typically followed by extreme weather had a decrease in weaning weight. The Oklahoma herds that they studied had the greatest increase when the calves were born in February, March, or April. The warmer climate of the Southeast would tend to push the optimal calving months to December through February, corresponding to the winter variable in this research (WIN).

The request for operator demographics is a common survey tool (Little, Forrest, and Lacy, 2000; Troxel, et al., 2007) and determining the use of supplements is common when surveying for purposes of observing weight gain in cattle. The experience level of operators (EXP14, EXP29, EXP30), the percent of income from cattle (BEEFINC20, BEEFINC21), the level of financing of land and feed (FIN20, FIN21) and the size of the commercial herd (CC0, CC49, CC199, CC200) and/or seedstock herd (SS0, SS49, SS199, SS200) are included to determine if there exists any significant effect on factors of production from these explanatory variables. EXP14, BEEFINC20, CC0, SS0, FIN20, CALFMON4, and CALFSEA0 are the default dummy variables.

The standard deviation of the weaning weight, , is determined using the responses of low, high, and average for those categories from each respondent. The properties of the triangular distribution[2] are then used to find the variance and the standard deviation. The model is expressed as:

$$\begin{aligned} WW\sigma_i = {} & \beta_0 + \beta_1 \mathrm{EXP}29_i + \beta_2 EXP30_i + \beta_3 BEEFINC21_i + \beta_4 CC49_i \\ & + \beta_5 CC199_i + \beta_6 CC200_i + \beta_7 SS49_i + \beta_8 SS199_i + \beta_9 SS200_i \\ & + \beta_{10} FIN21_i + \beta_{11} RYE_i + \beta_{12} WIN_i + \beta_{13} SPR_i + \beta_{14} SUM_i \\ & + \beta_{15} FALL_i + \beta_{16} CALFMON3_i + \beta_{17} CALFSEA2_i \\ & + \beta_{18} SUPPCALF_i + \beta_{19} WEANAGE_i + u_i \end{aligned} \qquad [2]$$

where the same default categorical variables are used as in equation [1].

[2] The three values—high, low, and mean—are used to find the mode for each individual respondent. The triangular distribution properties are:
$\mu=(a+b+c)/3$, thus $c=(3\mu)-a-b$ and
$\sigma^2=(a^2+b^2+c^2-ab-bc-ca)/18$
where a = the low response value, b = the high response value, c = mode, μ = mean, σ^2 = variance.

The birth-to-weaning rate (B2W) points to mortality rate (the number of calves born less the number of calves that die—or are lost due to other causes—equals the number of live calves that make it to weaning), and thus affects the total pounds weaned. The model for birth-to-weaning rate is expressed as:

$$\begin{aligned} B2W_i = {} & \gamma_0 + \gamma_1 \text{EXP29}_i + \gamma_2 EXP30_i + \gamma_3 BEEFINC21_i + \gamma_4 CC49_i \\ & + \gamma_5 CC199_i + \gamma_6 CC200_i + \gamma_7 SS49_i + \gamma_8 SS199_i + \gamma_9 SS200_i \\ & + \gamma_{10} FIN21_i + \gamma_{11} WIN_i + \gamma_{12} SPR_i + \gamma_{13} SUM_i + \beta_{14} FALL_i \\ & + \beta_{15} CALFMON3_i + \gamma_{16} CALFSEA2_i + u_i, \end{aligned} \quad [3]$$

where the same default categorical variables are used as in equation [1].

The percentage of calves that are born and then make it to the weaning stage is not a prevalent statistic in the literature. Normally, it is the calving rate (number of calves born per cows exposed) that is reported, as in *Beef 2007-08* from the National Animal Health Monitoring System (USDA, APHIS 2008). Additionally, weaning rates (number of calves weaned per cows exposed for breeding), mortality rates, and other loss rates are typically the measures that are reported.

Instead of examining the factors that affect calf loss within 24 hours of birth, pre-weaning mortality, loss to predators, or other losses, the B2W variable allows the researcher to capture all losses at once. This measures the success of the operator in managing the herd for maximum number of calves weaned per calves born. The survey instrument used in this research asked the respondents directly to give the weaning rate for their operation. The birth-to-weaning rate (B2W) is then determined as a ratio of weaning rate to pregnancy rate, using the average per operation responses for each variable. It is assumed to be impossible to achieve a within-herd weaning rate greater than the pregnancy rate at any given point since they are both based on the same number of cows exposed. Therefore, in any case in which operators reported a weaning rate that was greater than the pregnancy rate, the B2W rate was recorded as the upper bound of weaning rate or pregnancy rate, 1.0. The B2W variable is then used as the dependent variable in equation [3] to determine the factors that influence the weaning success of a representative Southeastern cow-calf operation.

Reproductive efficiency is a well-known determinant of production success (Buskirk, Faulkner, and Ireland, 1995; Wittum, et al., 1990), so the average pregnancy rate (PRAVG) supplied by the survey respondents is used. Pregnancy rate is analyzed using the following model:

$$\begin{aligned} PRAVG_i = {} & \delta_0 + \delta_1 \text{EXP29}_i + \delta_2 EXP30_i + \delta_3 BEEFINC21_i + \delta_4 CC49_i + \delta_5 CC199_i \\ & + \delta_6 CC200_i + \delta_7 SS49_i + \delta_8 SS199_i + \delta_9 SS200_i + \delta_{10} FIN21_i + \delta_{11} WIN_i \\ & + \delta_{12} SPR_i + \delta_{13} SUM_i + \delta_{14} FALL_i + \delta_{15} CALFMON3_i + \delta_{16} CALFSEA2_i \\ & + u_i, \end{aligned} \quad [4]$$

where the same default categorical variables are used as in equation [1].

Pregnancy rate is defined as the number of cows that conceive per number of cows exposed for breeding. The regression is based on the stated observations of average pregnancy rate (PRAVG). In their analysis of calving management, Dargatz, Dewell, and Mortimer (2004) rightly point out that "there is no production without reproduction" (p. 998). The pregnancy rate is analyzed because of its biological significance to the operation; only cows that conceive can eventually give birth to calves that are later weaned. Any factors of production, particularly management, that may be negatively affecting the pregnancy rate within a herd lead to direct biological effects on the ability to produce pounds of weaned beef. The variables RYE, SUPPCALF, WEANAGE are dropped in the model for conception success (PRAVG), equation [4], because they are used specifically in the weaning weight of the calf and not in the pregnancy rate of the dam.

A final model to be estimated for cow-calf operators is the variability (expressed by the standard deviation) of the weaning rate of calves in the herd. The standard deviation of the weaning rate was regressed on the same variables as in the previous two equations and is expressed as:

$$\begin{aligned} WR\sigma_i = {} & \omega_0 + \omega_1 \mathrm{EXP}29_i + \omega_2 EXP30_i + \omega_3 BEEFINC21_i + \omega_4 CC49_i + \omega_5 CC199_i \\ & + \omega_6 CC200_i + \omega_7 SS49_i + \omega_8 SS199_i + \omega_9 SS200_i + \omega_{10} FIN21_i + \omega_{11} WIN_i \\ & + \omega_{12} SPR_i + \omega_{13} SUM_i + \omega_{14} FALL_i + \omega_{15} CALFMON3_i + \omega_{16} CALFSEA2_i \\ & + u_i, \end{aligned} \qquad [5]$$

where the same default categorical variables are used as in equation [1].

The variability in a herd's weaning rate is equally important due to its biological link to pounds of beef weaned; fewer calves weaned leads to fewer pounds weaned, *ceteris paribus*. Survey respondents were asked to provide their weaning rate as a percentage of calves weaned of cows exposed for breeding. For example, if 100 cows were exposed for breeding and 85 calves were weaned, the weaning rate percentage was reported as 85. As in the other questions for weights and rates, the weaning rate responses also allowed for low, average, and high weaning rates over the last three years of operation of the herd. The standard deviation, , for the triangular distribution of each herd's weaning rate was then obtained.

In each of the econometric models for the standard deviation, and if the respondent did not provide an answer for each of the low, high, and average possibilities, the standard deviation could not be calculated and was, therefore, treated as a non-response. This explains the somewhat fewer responses for

The expected effects that each of the explanatory variables will have on the dependent variable, equations [1] through [5], are discussed following each of the equations. The expected signs of each of those variables are in table 2.

Management of the cattle operation is reflected in the amount of experience the operator has, the percent of income derived from the operation and the amount invested in it, the season of birth, the length of calving season, and the number of calving seasons. As those practices improve or increase, they are expected to positively affect the weaning weight, pregnancy rate, and birth-to-weaning rate; and decrease the standard deviation in the weaning weight and weaning rate. The availability of quality forage, represented by RYE, and feeding of supplements is expected to increase average weaning weight and decrease its variability. An increase in weaning age should positively affect weaning weight and weaning weight variability. Seedstock herds are expected to weigh more than commercial cow-calf herds due to breed; the variability of weaning weight and weaning rate should decrease in seedstock herds compared to commercial cow-calf herds; and pregnancy rate and birth-to-weaning rate should also be greater in the seedstock herd.

Table 2. *A Priori* Assumptions for the Independent Variable Effects of Equations 1 through 5.

Variable	WWAVG	WWσ	B2W	PRAVG	WRσ
EXP29	+	-	+	+	-
EXP30	+	-	+	+	-
BEEFINC21	+	-	+	+	+
CC49	+	-	+	+	-
CC199	-	+	-	-	+
CC200	-	+	-	-	+
SS49	+	-	+	+	-
SS199	+	-	+	+	-
SS200	+	-	+	+	-
FIN21	+	-	+	+	-
RYE	+	-	N/A	N/A	N/A
WIN	+	-	+	+	-
SPR	-	+	-	-	+
SUM	+	-	+	+	-
FALL	-	+	-	-	+
CALFMON3	+	-	+	+	-
CALFSEA2	+	-	+	+	-
SUPPCALF	+	-	N/A	N/A	N/A
WEANAGE	+	+	N/A	N/A	N/A

The "+" or "-" sign indicates the sign of the expected effect that the independent variables in the left-hand column will have on the dependent variables in the top row.

Weaning weight is perhaps one of the most common production factors examined in the literature. The genetic variables that affect weaning weight are not necessarily directly examined in the present research. Genetics may affect the ability of a calf to more efficiently use feed and certainly to grow at different rates than other calves. However, this research is generally more concerned with those variables over which the producer has an amount of control (Ramsey, et al., 2005; Dhuyvetter and Langemeier, 2010). Once the operator has made the decision concerning the genetics of cattle to use in his operation, the next decisions are related to managing the calving seasons, the herd size, feeding routines, and other production-related practices.

The specification of equations [1] through [5] lend themselves to both heteroskedasticty and multicollinearity problems. All models were tested for these issues and, if found, corrected for using the appropriate methods.

Results

Summary Statistics of the Cow-Calf Industry in the Southeast

There were 194 respondents from the southeastern region that completed all of the questions through the demographics section of the survey. The summary results of these questions are found in table 3. Almost 90% of the responses came from operators in the three states of Mississippi (40.5%), Alabama (39%), and Florida (9.7%). Cow-calf only operators comprise 158 of the 194 (81%) responses. Of the 194 respondents 90% were male and 30.3% identified themselves as college graduates. McBride and Mathews (2011) report 20% of cattle operators in the Southeast have completed college but they only examine cattle operations with 20 or more head of cattle in the herd; suggesting the possibility that smaller operations of 1 to 19 head may be owned by college-educated producers. The use of an online survey instrument for data collection, as opposed to personal interview or mailed surveys, might explain the difference between the proportion of college graduates in the present research and those of McBride and Mathews (2011) which were based on the data collected in the USDA's Agricultural Resource Management Survey of 2008.

The number of years of experience category was centered around 19 to 20 years. The experience category in the survey divides the responses into six separate, 5-year categories and one additional block of "More than 30 years". The four lower blocks ranging from "Less than 5 years" to "15 to 19 years" comprise 50.3% of all respondents; and 49.7% had more than 20 years experience owning or managing a cattle operation. Little, Forest and Lacy (2000) found the average number of years of experience for Mississippi cow-calf operators to be almost 30 years. Little, Forrest, and Lacy used trained enumerators at the Mississippi Agricultural Statistics Service (MASS), USDA, to administer the survey for their research. The difference between the experience results in the present research, gathered through an online survey, and those of Little, Forrest, and Lacy might be explained by the difference in survey delivery.

Table 3. Producer Demographics for Southeastern Beef Cattle Operations

Parameter	Frequency	Percent
How many years have you owned or managed a cattle operation		
Less than 5 years	22	11.34
5 to 9 years	34	17.53
10 to 14 years	22	11.34
15 to 19 years	19	9.79
20 to 24 years	27	13.92
25 to 29 years	22	11.34
More than 30 years	48	24.74
In which state is your primary operation located		
AL	76	39.18
AR	1	0.52
FL	19	9.79
GA	11	5.67
LA	3	1.55
MS	79	40.72
NC	1	0.52
SC	2	1.03
TN	2	1.03
What is the primary operator's highest level of education		
Some high school	1	0.52
High school graduate	19	9.79
Some college	33	17.01
Technical Degree	10	5.15
College graduate	59	30.41
Some post-graduate work	12	6.19
Graduate or professional degree	60	30.93

Nationally, McBride and Mathews (2011) report that 36% of operators worked off-farm in 2008, with 39% of their income coming from their cattle operation. Approximately 53% of the operators in Mississippi in 1999 had some off-farm employment, and 84% of those that worked off-farm were employed full-time (Little, Forrest, and Lacy, 2000). The results in table 4 reveal that almost 81% of operators responding are employed off-farm in 2011 (excluding the "Prefer to Not Answer" responses). Of those operators working off-farm, 15.9% are part-time and 84.1% are full-time; similar to the findings of Little, Forrest, and Lacy (2000). Table 4 also presents the results for spouse off-farm work. Little, Forrest, and Lacy (2000) found that 47.6% of spouses worked off the farm and 89% of those worked full-time. According to this survey, almost 79%, 78.7% of spouses work off-farm with 84% of those working full-time. In this research, of those who indicated income from cattle, 70.3% of the respondents receive 1 to 20 percent of their total household income from their cattle operation and 14.1% receive 21 to 40 percent from the beef cattle operation.

Table 4. Household Income Structure for Southeastern Beef Cattle Operations

Parameter	Frequency	Percent
Which of the following best describes your 2010 total household net income?		
Less than $30,0000	8	4.12
$30,000 to $59,999	38	19.59
$60,000 to $89,999	46	23.71
$90,000 to $119,999	44	22.68
More than $120,000	38	19.59
Prefer to not answer	20	10.31
Approximately what percentage of your 2010 household net income came from your beef cattle operation?		
0 percent	18	9.28
1 to 20 percent	129	66.49
21 to 40 percent	26	13.41
41 to 60 percent	6	3.09
61 to 80 percent	3	1.55
81 to 99 percent	1	0.52
100 percent	1	0.52
Prefer to not answer	10	5.15
What is the extent of off-farm work for the primary operator?		
No off-farm work	37	19.07
Part-time off-farm work	25	12.89
Full-time off-farm work	132	68.04
What is the extent of off-farm work for the spouse of the primary operator (if applicable)?		
No off-farm work	31	15.98
Part-time off-farm work	19	9.79
Full-time off-farm work	99	51.03
Not Applicable	45	23.20

Table 5 details the summary statistics for weaning weight and rate weaning age, and breeding success. The results of this study found the mean weaning weight of male calves for the herds of 122 respondents to be almost 553 pounds. The NAHMS (USDA, APHIS, 2008) study reports an average weaning weight for male calves in the East region (the region most identical to the one used in this survey) as 531 pounds. The NAHMS national average weaning weight for male calves across all beef cattle operations was reported as 559 pounds; by operation size, herds of 1 to 49 head produced male calves of 532 pounds at weaning and herds with 100-199 head produced male calves of 572 pounds at weaning. The mean weaning age for calves in the NAHMS study was approximately 200 days, or 6.67 months, for the East region and 207 days across all regions in the USDA survey (USDA, APHIS, 2008). For 131 herds in the present study the mean weaning age was 6.77 months, or 203 days based on a 30-day month.

This study calculated the birth-to-weaning rate as a ratio of the weaning rate (weaned calves compared to exposed breeding females) to pregnancy rate (cows that conceived per exposed breeding females). To clarify: the birth-to-weaning rate is defined as the number of calves that survived from birth to weaning based on the number of cows that conceived. For example, if an operator has 100 cows that are exposed for breeding and 95 of them become pregnant, the pregnancy rate is 95%. If, of those 95 cows, 90 give birth to a live calf, the calving rate (calves born per cows exposed) is 90%; and if 88 of those 90 survive to weaning, the weaning rate (calves weaned per cows exposed) is 88%. The birth-to-weaning rate captures, instead, the number of calves that are weaned based on the number of cows that actually become pregnant. This allows the researcher to account only for management of the pregnant cow and subsequent live-born calf and does not capture management of exposed females that do not conceive. This research is generally concerned with the optimal management of the calf after conception (but not to the exclusion of reproductive performance) to achieve the product of the operation: pounds of beef weaned. Considering the same 95 pregnant cows and 88 weaned calves from the example above, the birth-to-weaning rate would be 88 divided by 95, or 92.6%.

Table 5. Summary Statistics for Cow-Calf Weights and Rates and Weaning Age

Parameter	Mean	Standard Deviation	Minimum	Maximum	N
Cow herd pregnancy rate (percent)[1]					
Average	89.0	6.3	65.0	100.0	110
Calf death loss at birth (percent)[2]					
Average	2.8	9.5	0.0	99.0	109
Cow herd weaning rate (percent)[3]					
Average	89.7	7.7	60.0	100.0	101
Birth-to-weaning rate (percent)[4]					
	98.3	3.4	84.0	100.0	101
Calf weaning age (months)					
	6.8	1.0	4.0	9.0	131
Weaning weight for male calves (in pounds)					
Average	552.7	87.4	350.0	800.0	122
Brood cow weight (in pounds)					
Average	817.7	316.0	325.0	1800.0	123

[1]Total breeding cows pregnant as a percentage of exposed cows.
[2]Number of calves that die within 24 hours of birth as a percentage of total calves born.
[3]Number of calves weaned as a percentage of exposed breeding cows.
[4]Number of calves weaned as a percentage of calves conceived (average weaning rate/average pregnancy rate).

The mean birth-to-weaning rate in this study is 98.3%. The birth-to-weaning ratio used in this survey is a unique value and therefore, makes comparison of this result to any regional or national average responses pointless. It implies that for every 100 cows that conceive, approximately 98 of them will give birth to calves that make it to weaning. There is a conflict in this research with the average death loss figure of 2.8%, suggesting that the birth-to-weaning ratio may be a bit inflated due to survey response error.

The average death loss from the present research is 2.8%. The national average was 3.6% and the Southeast region (the region in this NAHMS study that is most identical to the Southeast region in the present research) death loss was reported at 3.1% (USDA, APHIS, 2010a). Part five of the NAHMS (2010b) study reports the national average death loss for the first half of 2008 as 3.2% and the Southeast regional average as 2.5%. The 2.8% in the present research is within .03% of the two southeast regional averages reported in parts four and five of the NAHMS study (USDA, APHIS, 2010a; 2010b).

Part three of the NAHMS (USDA, APHIS, 2009) reports a national average calving percentage of 92.4%, 92.6%, and 91.5% for 1992-1993, 1997, and 2007-2008, respectively. The calving percentage contained in the NAHMS study does not include pregnant heifers and cows that were sold or moved off of the operation, causing it to possibly be slightly higher than a true pregnancy rate. In 2007, 3.1% of pregnant beef cows left the average operation (USDA, APHIS, 2009a). This suggests an approximate average pregnancy rate in 2007 of 88.4% nationally (91.5% calving rate less 3.1% pregnant cows moved off the operation). However, the survey results in table 5 show an 89% pregnancy rate, suggesting similar results to the 2007 national averages.

Figure 2 illustrates the percent of cattle operations in each region, as mapped in figure 1, by the number of head per farm (USDA, NASS, 2007).

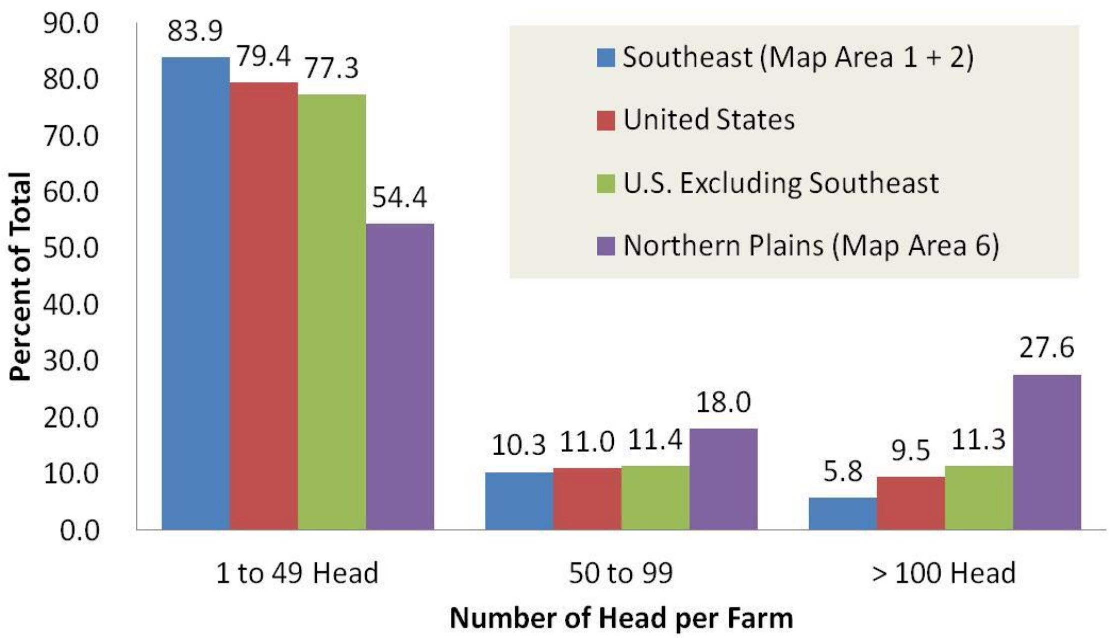

Figure 2. Percent of Cattle Operations by Herd Size, 2007

The results of the survey questions that asked for herd size and makeup are presented in table 6. The primary results for discussion are the size categories of the commercial cow herds. The Agricultural Census of 2007 (USDA, NASS, 2007), reports that the number of operations in the

Southeast with 1 to 49 head comprised 83.9% of all beef cattle operations in the region. Those operations in all of the U.S. with 1 to 49 head comprised 79.4% of all beef cattle operations. The Northern Plains (map area 6 in figure 1) had the lowest percentage of total beef cattle farms with only 54.4%. Only 5.8% of operations in the Southeast had more than 100 head. The results in Table 5.4 show that about 52.7% of all cattle operations in the Southeast had 1 to 49 head and 24.8% of all respondents with commercial cow herds had 50 to 99 head (excludes "No response" and "0" responses). Operations with more than 100 head in the herd comprise 22.4% of the operations responding to the survey in this research. The difference between the results of this survey and the results reported in the 2007 Agricultural Census (USDA, NASS, 2007) could be due to the time of year in which responses were collected or the type of survey delivery used.

Survey respondents also reported on the number of head, if applicable, in a seedstock herd, the number of stocker cattle owned, the number of head in a feedlot for finishing or being custom backgrounded, and the number of head that were dedicated for freezer beef or sold direct-to-customer. Seedstock operations of 1 to 49 head made up 72.9%, 50 to 99 head was 16.1%, and more than 100 head was 11% of all operators with a seedstock herd.

Only 36.6% of respondents reported owning stocker cattle. Of those, nearly 61% had 1 to 49 head of stocker cattle and the other 39% had more than 100 head. No operators responded positively to owning a stocker herd of 50 to 99 head. Approximately 77% of respondents that owned or managed custom backgrounded herds reported having 1 to 49 head and the remaining 23% had herds from 50 to 1,999 head. Twenty-seven respondents reported ownership of feedlot cattle; 70% owned 1 to 49 head and 30% reported 50 to 499 head. Fifty-eight operators reported freezer beef or direct-to-customer sales; fifty-one, nearly 88%, utilized 1 to 9 head for these purposes.

Table 6. Summary Statistics of Cow-Calf Operations—Herd Type and Size

Parameter	Frequency	Percent
Total number of commercial cows (breeding age females only) N=194		
No response	6	3.09
0	23	11.86
1 to 9	14	7.22
10 to 29	34	17.53
30 to 49	39	20.10
50 to 74	34	17.53
75 to 99	7	3.61
100 to 149	18	9.28
150 to 199	6	3.09
200 to 299	5	2.58
300 to 499	4	2.06
500 to 999	3	1.55
1000 or more	1	0.52

Table 6. (Continued)

Parameter	Frequency	Percent
Total number of seedstock cows (breeding age females only) N=194		
No response	6	3.09
0	70	36.08
1 to 9	31	15.98
10 to 29	31	15.98
30 to 49	24	12.37
50 to 74	9	4.64
75 to 99	10	5.15
100 to 149	5	2.58
150 to 199	2	1.03
200 to 299	1	0.52
300 to 499	4	2.06
500 to 999	0	0.00
1000 or more	1	0.52
Total number of stocker cattle owned N=194		
No response	6	3.09
0	117	60.31
1 to 49	43	22.16
50 to 99	0	6.19
100 to 199	6	3.09
200 to 499	6	3.09
500 to 999	3	1.55
1,000 to 4,999	0	0.00
5,000 to 9,999	1	0.52
10,000 or more	0	0.00
Total number of custom backgrounded head managed N=194		
No response	6	3.09
0	135	69.59
1 to 9	15	7.73
10 to 29	19	9.79
30 to 49	7	3.61
50 to 74	2	1.03
75 to 99	1	0.52
100 to 149	3	1.55
150 to 199	2	1.03
200 to 299	2	1.03
500 to 999	1	0.52
1,000 or1,999	1	0.52
2,000 or more	0	0.00

Table 6. (Continued)

Parameter	Frequency	Percent
Total number of head placed in a feedlot for finishing N=194		
No response	6	3.09
0	161	82.99
1 to 49	19	9.79
50 to 99	6	3.09
100 to 199	1	0.52
200 to 499	1	0.52
500 to 999	0	0.00
1,000 to 1,9999	0	0.00
2,000 to 4,9999	0	0.00
5,000 to 9,999	0	0.00
10,000 to 19,999	0	0.00
20,000 or more	0	0.00
Total number of head for freezer beef or direct-to-consumer sales N=194		
No response	6	3.09
0	130	67.01
1 to 9	51	26.29
10 to 29	5	2.58
30 to 49	2	1.03
50 to 74	0	0.00
75 to 99	0	0.00
100 to 149	0	0.00
150 to 199	0	0.00
200 to 299	0	0.00
300 to 499	0	0.00
500 or more	0	0.00

Results of Regression Models

Table 7 gives the results of the regression performed using equation [1]. The overall *F*-statistic for the model is 2.54 ($Pr>F$ 0.0015) and the R^2 value is 0.321. The results from this regression demonstrate the importance of weaning age on the weight of a weaned calf. Weaning age has a positive effect on the weaning weight of a calf, following the *a priori* assumptions based on Pell and Thayne (1978). Weaning age is significant at = 0.01. The significance of WEANAGE also points to increased weight gain as the calf is weaned at a later age. This increase in the growth relationship between weaning age and weaning weight was found to be significant in the research of Pell and Thayne (1978). It is best described by a curved line with a non-constant increase up to 300 days of age.

Table 7. Weaning Weight Results from Equation 1

Variable	Significance Level	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept		403.150	74.154	5.440	<.0001
EXP29		14.441	17.680	0.820	0.416
EXP30		0.203	20.591	0.010	0.992
BEEFINC21		29.561	20.154	1.470	0.146
CC49	**	-77.670	30.263	-2.570	0.012
CC199	**	-77.831	31.483	-2.470	0.015
CC200	***	-75.054	39.643	-1.890	0.061
SS49	**	42.686	17.611	2.420	0.017
SS199	**	61.627	28.881	2.130	0.035
SS200	***	90.197	45.980	1.960	0.053
FIN21		19.996	21.776	0.920	0.361
RYE		-17.436	17.222	-1.010	0.314
WIN		9.243	21.208	0.440	0.664
SPR		-12.595	23.753	-0.530	0.597
SUM		-16.593	21.980	-0.750	0.452
FALL		-3.966	20.703	-0.190	0.849
CALFMON3		2.474	20.532	0.120	0.904
CALFSEA2		-31.209	30.467	-1.020	0.308
SUPPCALF		16.911	15.474	1.090	0.277
WEANAGE	*	28.161	7.810	3.610	0.001

* Significant at = 0.01. $F_{stat} = 2.54$
** Significant at = 0.05. $R^2 = 0.321$
***Significant at = 0.10. N = 122

The variables for commercial herd size and seedstock herd size are each significant at = 0.05 for CC49, CC199, SS49, and SS199. The variables, CC200 and SS200 are significant at = 0.10. The parameter estimates for these variables should be interpreted as a comparison of commercial cow herd influence versus seedstock herd influence. For example, the parameter estimate for SS200 implies 90.1968 additional pounds to be gained on the weaning intercept compared to the similar commercial cow category. Generally, dummy variables are interpreted on a base dummy category; in this case, CC49, CC199, and CC200 are compared to a seedstock only operation of the same size. Also, SS49, SS199, and SS200 are compared to a commercial only operation. This comparison shows the weaning weight premium that may result from seedstock cattle being heavier, purebred breeds. Commercial cow producers with 1 to 49, 50 to 199, and more than 200 head will produce a calf that weans 77.7, 77.8, and 75.1 pounds, respectively, lighter than seedstock herds of the same size. Seedstock herds of 1 to 49, 50 to 199, and more than 200 head will have an average weaning weight of about 43, 62 and 90 pounds, respectively, greater than like-sized commercial cow herds.

An *F*-test was performed on the commercial cow and seedstock categories. The null hypothesis for the first test was: $H_0 : CC49 = CC199 = CC200$. The resulting *F*-statistic for the test was

0.00 (*Pr>F* 0.996), so the null hypothesis was rejected. For the seedstock variables, the null hypothesis was: $H_0: SS49 = SS199 = SS200$ and the *F*-statistic was 0.63 (*Pr>F* 0.536); the null hypothesis was rejected. White's test for heteroscedasticity in the regression of equation [1] yielded a χ^2_{stat} result of 1.60 (*Pr>ChiSq* 0.45); heteroscedasticity was not detected in the results.

Table 8. Weaning Weight Variability Results from Equation 4.2

Variable	Significance Level	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept		-12.169	29.407	-0.410	0.680
EXP29	**	16.585	6.751	2.460	0.016
EXP30		3.804	7.639	0.500	0.620
BEEFINC21		7.249	7.889	0.920	0.361
CC49		1.032	11.593	0.090	0.929
CC199		-8.911	11.941	-0.750	0.458
CC200		-1.871	15.851	-0.120	0.906
SS49		4.146	6.761	0.610	0.541
SS199		12.064	11.368	1.060	0.292
SS200		11.891	16.647	0.710	0.477
FIN21		5.440	8.412	0.650	0.520
RYE		-0.924	6.771	-0.140	0.892
WIN		-1.876	8.201	-0.230	0.820
SPR		13.502	9.025	1.500	0.138
SUM		11.094	8.368	1.330	0.188
FALL		13.328	8.145	1.640	0.105
CALFMON3		0.024	7.670	0.000	0.998
CALFSEA2		-17.626	11.392	-1.550	0.125
SUPPCALF		-3.365	5.880	-0.570	0.569
WEANAGE	***	5.349	3.045	1.760	0.082

* Significant at = 0.01. $F_{stat} = 1.22$
** Significant at = 0.05. $R^2 = 0.207$
***Significant at = 0.10. N = 109

The variance inflation factors (VIF) were calculated and none exceeded 5.0 for any of the variables, so no high degree of multicollinearity was detected. Operator experience, calving season timing and length, number of calving seasons, supplemental feeding of creep-fed calves, the use of cool annual rye, income and financing level show no significant on weaning weight as regressed in this equation.

Table 8 contains the results of the regression of the standard deviation of the weaning weight, equation [2]. The properties of the triangular distribution were used to determine the variance of weaning weight in an individual herd, then the standard deviation of the low, high, average group of weaning weight responses. This regression is important in that it examines the factors that directly affect the variability of the key product, pounds of beef weaned, in a cow-calf enterprise. The overall *F*-statistic for the model is 1.22 (*Pr>F* 0.258) and the R^2 value is 0.207. The *F*-

statistic alone indicates that this model, as constructed, may not adequately explain the factors that affect weaning weight variability.

The two variables of significance were the ones representing 15 to 29 years of experience (EXP29) and WEANAGE. EXP29 has a significant positive effect, at = 0.05, on the variability of weaning weight. This level of experience increases the variability in weaning weight by 16.6 pounds compared to those operators with 1 to 14 years of experience. The cause for such an increase compared to those lesser-experienced operators is difficult to explain and seems to contradict the conventional wisdom that more experienced operators manage their herds closer.

The weaning age (WEANAGE) also has a significant, at = 0.10, effect, increasing variability by 5.35 pounds for every additional month that weaning is postponed. As a calf ages, the weight of any given group of calves becomes more spread out. For example, humans may be born weighing 6 to 11 pounds but by 30 years of age, the weight may be spread from 75 pounds to more than 500 pounds; significant variability. The birth weight of a calf will fall into a relatively tight range of weights, but by six to seven months of age many factors have been able to influence its growth and cause the range of weaning weights to spread. No other variables in this equation have significant effect on the variability of weaning weight within an individual herd. The χ^2_{stat} of 0.48 in White's test indicated no notable presence of heteroscedasticity. The VIF for each of the variables did not exceed 5.0 so indicating that no high degree of multicollinearity exists in the results of equation [2].

Table 9 reveals the significance of 49 or fewer head of commercial or seedstock cattle in relation to the birth-to-weaning rate (B2W) of the herd. The categorical interpretation here is similar to that of table 7. The variables CC49 and SS49 both show significance at the = 0.10 level. No other variables in these results show significance at = 0.10 or smaller. Commercial cow-calf producers with 1 to 49 head have a 22% lower birth-to-weaning rate than those producers who own solely seedstock cattle. Conversely, seedstock producers with 1 to 49 head can expect to have a birth-to-weaning rate increase of 13.5% over those operators with only commercial cow-calf herds. Small commercial cow producers have a lower birth-to-weaning rate than seedstock producers and seedstock producers have a higher B2W than commercial cow producers. The relative success of small seedstock producers may be due to the genetic makeup of their herd; often purebred cattle.

The F-statistic for the model is 1.24 ($Pr>F$ 0.255) and the R^2 value is 0.182. These two values together indicate that the explanatory variables, as specified, may not significantly explain the variation in the birth-to-weaning rate.

Pregnancy rate is defined as the number of cows that conceive per number of exposed breeding females in the herd. Ramsey, et al. (2005) show that positive changes in calving percentage (resulting from positive changes in pregnancy rates) increase the profitability of an operation. The regression results in table 10 have a model F-statistic of 1.08 ($Pr>F$ 0.384) and an R^2 value of 0.157. These results indicate that the regression equation used to obtain the results may not be correctly specified.

Table 9. Birth-to-Weaning Rate Results from Equation 4.3

Variable	Significance Level	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept		1.073	0.218	4.910	<.0001
EXP29		0.055	0.082	0.670	0.504
EXP30		-0.003	0.088	-0.030	0.973
BEEFINC21		-0.071	0.086	-0.830	0.407
CC49	***	-0.220	0.122	-1.800	0.075
CC199		-0.034	0.126	-0.270	0.790
CC200		-0.113	0.161	-0.700	0.483
SS49	***	0.135	0.077	1.760	0.082
SS199		-0.002	0.129	-0.010	0.989
SS200		0.135	0.190	0.710	0.479
FIN21		-0.031	0.097	-0.320	0.751
WIN		-0.117	0.092	-1.280	0.205
SPR		0.071	0.111	0.640	0.525
SUM		0.061	0.105	0.580	0.561
FALL		0.029	0.103	0.280	0.781
CALFMON3		0.055	0.091	0.600	0.547
CALFSEA2		-0.103	0.133	-0.780	0.439

* Significant at = 0.01. $F_{stat} = 1.24$
** Significant at = 0.05. $R^2 = 0.182$
***Significant at = 0.10. N = 106

The plot of residuals versus predicted values for this model indicated potential heteroscedasticity in the error terms in the pregnancy rate model. Based on the graphical observation of the residuals, White's test was used to detect heteroscedasticity in the results. The of 86.69 and *Pr>F* = 0.6368 indicates that there is no heteroscedasticity. White's general test for heteroscedasticity was used in each of the sets of results. The variance inflation factors (VIF) were calculated and the presence of a high degree of multicollinearity between any of the variables in the equation was not detected.

The results reveal that the response variable for operators that derive 21% or more of their income from their cattle operation (BEEFINC21) is significantly different from zero at = 0.05. If an operator derives 21% or more of total income from the cattle operation, pregnancy rate increases 3.3% over the mean of 88.9%. The significance and sign of the BEEFINC variable seems to indicate that the higher investment in the farm, the greater attention the operator gives to the success of the herd. Only 37 operations, of the 166 respondents reporting cattle income, derive 21% or more of their income from the cattle operation.

Table 10. Pregnancy Rate Results from Equation 4.4

Variable	Significance Level	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept		0.889	0.042	21.240	<.0001
EXP29		0.009	0.015	0.590	0.560
EXP30		0.004	0.017	0.230	0.817
BEEFINC21	**	0.033	0.017	1.870	0.064
CC49		-0.016	0.023	-0.680	0.500
CC199		-0.011	0.024	-0.450	0.652
CC200		-0.012	0.031	-0.390	0.696
SS49		0.008	0.014	0.580	0.560
SS199		-0.006	0.025	-0.250	0.802
SS200		0.030	0.037	0.810	0.420
FIN21		-0.024	0.019	-1.260	0.213
WIN		-0.014	0.018	-0.810	0.421
SPR		-0.010	0.019	-0.560	0.577
SUM		0.024	0.019	1.250	0.215
FALL		0.008	0.018	0.440	0.664
CALFMON3		0.026	0.018	1.480	0.142
CALFSEA2		-0.008	0.021	-0.370	0.712

* Significant at = 0.01. $F_{stat} = 1.08$
** Significant at = 0.05. $R^2 = 0.157$
***Significant at = 0.10. N = 110

The model for weaning rate variability, equation [5], also shows few significant variables. These are reported in table 11. This model has an *F*-statistic of 0.75 (*Pr>F* 0.736) and an R^2 of 0.146. These two values, considered together, indicate that the explanatory variables, as specified, may not significantly explain the variation in the weaning rate variability.

The one variable of significance in the regression results of equation 5 is FIN21; which represents those operators that finance 21% or more of their cattle and feed. FIN21 is signed negative and is significant at = 0.10. It is a dummy variable, and should be interpreted as compared to the base category of zero to 20% financed. In these results, if 21% or more of the cattle and feed are financed by outside sources, the mean variability of weaning rate is decreased by 1.5% compared to an operator that is financing less than 21% of their feed and cattle costs. The significance and sign of FIN21 seems to indicate that an operator that is invested in their operation with more than 21% outside financing is more attentive to the outcome of the production process than those that finance less than 20% of their cattle and feed.

White's general test was used to detect the presence of heteroscedasticity and the variance inflation factors were generated to detect a high degree of multicollinearity; neither of these issues existed in the results.

Table 11. Weaning Rate Variability Results from Equation 4.5

Variable	Significance Level	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept		3.449	1.798	1.920	0.059
EXP29		-0.160	0.649	-0.250	0.806
EXP30		-0.007	0.697	-0.010	0.992
BEEFINC21		0.380	0.738	0.510	0.609
CC49		-0.881	1.049	-0.840	0.404
CC199		-0.862	1.091	-0.790	0.432
CC200		-1.302	1.299	-1.000	0.320
SS49		-0.143	0.605	-0.240	0.814
SS199		-0.489	1.188	-0.410	0.682
SS200		-1.105	1.441	-0.770	0.446
FIN21	***	1.507	0.760	1.980	0.051
WIN		0.775	0.758	1.020	0.311
SPR		0.174	0.893	0.200	0.846
SUM		-1.279	0.891	-1.440	0.156
FALL		-1.039	0.886	-1.170	0.245
CALFMON3		0.401	0.721	0.560	0.580
CALFSEA2		0.978	1.057	0.920	0.358

* Significant at = 0.01. F_{stat} =0.75
** Significant at = 0.05. R^2 = 0.146
***Significant at = 0.10. N = 87

<u>Conclusions and Implications</u>

The first objective of this study was to characterize current cow-calf operations in the southeastern United States. This was compared with results of past research related to beef cattle operations in this region. This was also compared with the results of current national statistics. Frequency counts and percentages as well as the common summary statistics of mean and standard deviation provided the details of the results for these two objectives. The characteristics of southeastern beef cattle operations are different in the results of this research in average size and demographic when compared to results from past research. A larger percentage of operators and their spouses are now working off of the farm for income. The national average of 36% from McBride and Mathews (2011)—taken from 2008 data—differs from the results of this research in which average off-farm employment was near 81%. The prevalence of small farms with less than 49 head of beef cattle remains similar to prior years. Part three of the NAHMS (USDA, APHIS, 2009) study reported 81% of operations had 49 or fewer head in 1992 and 79.1% in 2007. The results of this research reveal that over 53% of commercial operators have fewer than 49 head and 72.9% of seedstock operators have fewer than 49 head.

The second objective for this research was to examine factors affecting production on beef calf operations in the Southeast. The third objective was to examine the within-herd production risks associated with variability in weaning weight—the product of the operation—and weaning rate.

Those models were constructed using dependent and explanatory variables found in previous research literature. The weaning age of calves has significant positive effect on the weaning weight of calves and on the variability of pounds of beef weaned. An additional month in weaning age leads to a gain of 28 pounds in the weight of the calf but can also increase the standard deviation of weaning weight by 5.3 pounds. The signs of the explanatory variables in each of the models follow prior research and the *a priori* assumptions with few exceptions.

The results of the research merit further examination to define the differences in variability between seedstock operators and commercial cow-calf operators, cow-calf only versus cow-calf/stocker operations, and perhaps a comparison of operations by state. Additionally, soliciting answers to derive the triangular distribution for pregnancy rates, weaning weights and rates, and death loss rates within individual herds, would provide a foundation for examination of the causes of variability in those factors. This would allow individual operators to perhaps improve management practices, herd makeup, or other production factors to gain more pounds of beef weaned and thus, a greater profit.

The results of this research provide a beef cattle operator in the Southeast an analysis of factors that affect production through pregnancy rate, weaning weight, and the birth-to-weaning rate. The lack of significance in some of the models provides the opportunity for extended data collection to perhaps improve results of the models. This research has also provided a foundational body of work on which to build future cattle industry research for the Southeast. The factors that affect cattle production have been extensively explored in this work and can be built on as further research is completed. The producer demographics and operation data collected provides extension personnel have current data to describe the southeastern beef cattle operation.

Past research has included operator age and experience. Inclusion of a variable to capture age of the operator could add to the demographic information but could also possibly aid in partially explaining some of the production practices and issues. Age is a common question that was not used in this research. Questions for direct calving rate, pregnant heifers and cows taken off of the operation, and artificial insemination success rates could help to explain reproductive and weaning efficiency. Those questions were not used in this research.

Empirical model development demands the use of foundational economic research; that past research reveals a large number of factors that influence the production criteria that were examined in this research. It is difficult, particularly through an online survey instrument, to capture all of the primary variables that affect weaning rate, for example, without encountering models that require a large number of explanatory variables. The controlled discipline of animal science research is well-equipped to capture the biological and physiological data that is needed.

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