S_TEMP3302: Genetic improvement of adaptation and reproduction to enhance sustainability of cow-calf production in the Southern United States

(Multistate Research Project)

Duration: October 2014 to September 30, 2019
Administrative Advisor(s): [Joe W. West]
NIFA Reps:

Statement of Issues and Justification

The Southern region (AL, AR, FL, GA, KY, LA, MS, OK, NC, SC, TN, TX, VA) of the United States accounts has 11.8 million beef cows (40% of the nation's beef cow inventory; USDA, 2014). This region has environmental constraints that require animal adaptation to hot, humid conditions, reduced forage quality, and parasitic loads. Producers have used American Brahman to provide adaptation, as highly productive cattle of European origin lack adaptation to these conditions. However, there are production challenges associated with the use of Brahman, including low production and fertility as purebreds, oscillating (year to year) reproduction rates as young cows, and substandard and variable beef quality. Improved beef cow fertility is desired throughout the Southern Region in most herds. These problems could easily expand to temperate (at the present time) areas contingent upon the extent and severity of changing climatic conditions (Field et al., 2014).

Two broad areas of improvement that would greatly benefit cow-calf producers in this region include: 1) improvement of production and reproduction of Brahman, and 2) improvement of adaptation in cattle of European origin. On a much broader scale, these improvements can be applied to other U.S. and many global regions. These efforts would impact several SAAESD Priority Areas, including Goal 1 (an agricultural system that is highly competitive in the global economy) and several of its priorities including Integrated and sustainable agricultural production systems, Value-added plant and animal genes in conventional breeding and molecular biology, and Health and well-being of food animals, as well as Goal 4 (greater harmony between agriculture and the environment) and its priority of Integrated pest management systems, including biologically-based tactics. This proposed project fits into these priorities particularly well as increased productivity in tropical and subtropical regions of the world is critical to increased global food security. Most of the funded beef cattle work addresses production in temperate areas and is not concerned with adaptation. Most individual university-based research in the South has been curtailed due to the limiting budget environment, including reduction of beef cow research populations. Failure to address this results in inefficient use of a substantial amount of forage resources in the Southern Region that are not suitable for human food crop production, and a large group of producers with little research support for activities important to their productive and economic well-being.

It is appropriate to approach such issues from a multi-state perspective primarily to fully exploit the increasingly limited resources available for research at individual locations; this is especially important from a genetic perspective, as combined sample size facilitates appropriate hypothesis testing. Key areas of beef cattle production system efficiency such as adaptability and reproduction, including their component traits, need to be assessed in the different sub-environments within the region. These traits are the least characterized in beef cattle research, especially among those types and breeds of cattle in the region; results will therefore have potential for impact in similar areas of the world extending into the tropics. This multi-state project will also facilitate the cellular and molecular scientific characterization of these traits, and provide for unique research resources that can be utilized to study numerous scenarios that impact sustainable beef production in the US. It is also likely that these resources will attract potential for additional research partnerships beyond the Southern Region, including international possibilities. Additionally, capitalizing on the multi-state groups extension resources will allow for wide dissemination of impactful research to a broad geographical area, which will increase the impact of this research on profitability and sustainability of beef cattle operations in the southern United States.

The states comprising the Southern region produce approximately 40% of the cattle that enter the U.S. beef chain, with a large proportion possessing some Brahman inheritance. Breeds of cattle have in many cases changed dramatically, especially in relation to other breeds, since original characterization efforts (Cundiff et al., 2004). Therefore, the proposed Brahman objective serves also as an up-to-date evaluation of current bloodlines and type of Brahman cattle used in the United States today, and will be used then to compare to previous scientific characterization of the breed. Particularly, traits relative to Brahman reproduction have been characterized to a very limited extent, and joint work offers an excellent opportunity to assess reproduction on a whole animal basis and serve as a basis for investigation of component traits of reproduction within the breed.

Related, Current and Previous Work

Significant accomplishments from the current project (S-1045) include: 1) estimation of variance components and genetic parameters for infectious bovine keratoconjunctivitis in Angus and Angus cross calves; these parameters are required for the development of selective improvement programs, 2) preliminary confirmation of animal (genetic) differences in response to bovine respiratory disease vaccination and challenge with bovine viral diarrhea virus, 3) characterization of different hair coat types in different breed types of cattle, and their association with various production traits, and establishment of the degree of additive genetic control (heritability) of coat type, 4) preliminary characterization of seasonal coat shedding and accumulation dynamics in cattle and their association with reproductive performance. Those accomplishments will be foundations for objectives in the proposed project and specific activities under those objectives will expand the investigation across breed types and locations. Collaborators have banked sources of DNA for all project animals, and our intent is to use that DNA in the proposed work and leverage these resources to obtain funding for genomics work that will complement these efforts. Previous projects completed within this group characterized 1) alternative adapted breed types and their relative production performance to Brahman, 2) genetic control and breed type

differences of animal temperament and their association with production, and 3) confirmed genotype × environmental interactions of genetic merit for milk production in Angus cows.

Genetics of Cattle Health.

U.S. government researchers have assessed genetic control of respiratory disease in Bos taurus cattle (Muggli-Cockett et al., 1992; Snowder et al., 2005, 2006; Casas and Snowder, 2008) and have data that would permit extensive evaluation of reproductive performance of Bos taurus cows under temperate conditions (G. E. Bennett, personal communication).

As few as 200 horn flies on an animal cause economic losses, reducing the productivity of animals by creating increased irritation and stress, which in turn increases body temperature and water intake (Byford et al., 1992). These effects are more complex than just loss of blood, affecting and reducing milk production, altering behavior patterns, and resulting in lighter weaning weights of calves (Byford et al., 1992). It is estimated that horn flies are responsible for $800 million in annual losses in the US alone (Loftin and Corder, 2013). Several studies have indicated that a possibility exists to select animals for resistance to horn flies and other parasites in the absence of pesticide application. Steelman et al. (1993) found that there was ample variation between animals in resistance to horn flies, and that this resistance was maintained over the animals lifetime. Brown et al. (1992), using 215 beef cows from seven different breeds, found the heritability of horn fly resistance to be 0.78.

Ticks parasitize cattle and can be important vectors for infectious diseases such as anaplasmosis and Texas cattle fever. Prayaga (2003) estimated tick counts on 31 different genetic types including tropically adapted British (Belmont Adaptaur), Sanga-derived, Zebu cross, Zebu, and Continental breeds in Queensland Australia and observed Belmont Adaptaur, Sanga-derived breeds, and crossbred populations with greater quantities of Continental, Sanga, and British breeding expressed higher tick counts. Cardoso et al. (2006) reported a heritability of 0.2 for tick counts in Braford cattle, but the heritability increased to 0.25 when cattle with very few ticks (low tick load) were eliminated. Bovine ocular squamous cell carcinoma is a skin cancer occurring on the eyelids and/or eyeball (also nictitating membrane and caruncle) of cattle, most common in Herefords, frequently known as cancer eye (Anderson et al., 1957). Production losses in Hereford cattle due to bovine ocular squamous cell carcinoma (commonly called cancer eye) are a major concern in the beef industry. Anderson et al. (1957) and Anderson (1960, 1963, 1991) reported the lower incidence of bovine ocular squamous cell carcinoma in white faced cattle with increased pigmentation around the eyes, and the heritability of pigmented eyelids is high (> 0.40). Updated characterization of eye pigmentation in Hereford straightbreds and crossbreds would facilitate identification of possible genomic regions controlling eye pigmentation.

Newborn calves need to nurse unassisted, particularly in range conditions where assisting those calves may not be feasible. Dam udder type is one factor that affects the calfs ability to nurse. Calves had difficulty nursing when the dams have poor udder attachment or teat sizes of either extreme (Wythe, 1970; Edwards, 1982; Ventorp and Michanek, 1992). Poor udder quality resulted in delayed consumption of colostrum, which was important for immunity. Therefore, calf mortality rates were higher when dams had large teats and pendulous udder suspension

(Frisch, 1982). Thus, improving udder quality can be beneficial to producers through reducing the amount of labor associated with assisting calves to nurse and increasing the number of calves weaned per cow, an important measure of efficiency

Udder quality is one of many factors considered by producers when culling cows from the herd. Poor udder quality, defined by large teats, pendulous udder suspension, or mastitis, ranked as one of the top reasons for culling aged cows (Greer et al., 1980; Frisch, 1982). No significant difference in culling for udder problems was found across breeds in Canadian data (Arthur et al, 1992). Udder quality continuously declined with age; therefore, more aged cows were culled for this reason. By improving udder quality, cows remained in the herd longer resulting in the need for fewer replacement heifers. Replacement heifer development is a significant cost to producers; so, increasing cow longevity should result in more efficient and economical beef production.

Further research regarding all three of these areas (external parasitism, eyelid pigmentation in whiteface crosses, and udder conformation) is warranted in modern cattle and for production systems where less artificial inputs are desired, due to economic and environmental sustainability considerations. Improved characterization of these adaptation type traits and their economic impacts are needed for producers in the Southern region to make more informed decisions regarding production and profitability. These types of traits are the focus priority for Objective 1.

Meta-Genetic Evaluation of Economically Relevant Traits.

The importance of regular reproduction in beef cows is routinely and historically cited as necessary for economic sustainability of cow-calf operations. Large numbers of animals are needed to accurately characterize binomial traits such as reproduction and calf survival. Most research facilities do not have enough cows to publish their own results from analyses of cow reproductive traits. Combining data from multiple locations will provide adequate numbers of records for analyses of such traits. The priority of Objective 2 will be to compile data from participating locations for analyses of traits that are poorly characterized such as calving rate, weaning rate, calves displaying inadequate vigor or poor nursing instinct immediately after birth, and calving difficulty in addition to traditional calf weight measures. The primary effect of interest will have as levels broad categories of breed type-production system combinations. Production systems that differ with respect to seasonality, forage types, and age of heifers at first breeding exposure will be assessed. Breed and production system combinations regarding overall production and economic assessment need to be evaluated and conveyed to producers.

Adaptive Traits.

Heat stress from elevated temperature and humidity has a significant impact on performance in beef cattle herds. Cattle performance declines due to heat stress when ambient temperature index values exceed 23.3° C (LCI, 1970). In the Southeastern United States, a large percentage of the year exceeds these temperatures resulting in substantial economic losses. Brown-Brandl et al. (2003) observed that increasing ambient temperature resulted in increased respiration rate, rectal temperature, and decreased feed consumption in feeder steers. Feedlot heifers exposed to thermal stress without shade or misting had lower average daily gains and lighter carcass weights than heifers provided shade or mist (Mitlöhner et al, 2001). Methods to alleviate heat stress can

drastically impact production efficiency. Selecting environmentally adapted cattle is one method to negate these performance losses and subsequently increase productivity. This can be accomplished through selection of adapted breeds or selection within a breed. Genetic selection for increased environmental adaptability to elevated temperatures and humidity within the temperate Bos taurus breeds is one possible method to increase performance traits while maintaining carcass and growth traits of these breeds. One trait which warrants attention is hair coat.

Significant variability has been shown to exist in traits of the hair coat with associations with performance measures. Yeates (1955) noted that animals with a wooly coat showed distress and failed to stabilize heat regulation while smooth coated animals stabilized body temperature after two hours. Gray et al (2011) observed that there is a moderate genetic correlation between weaning weight and hair coat shedding with dams that shed their winter hair coat earlier in the season weaning heavier calves than dams which shed later in the season in Angus females. These findings suggest that selection for hair shedding can impact environmental adaptability. Determining which genetic components that lead to heat tolerance in cattle are essential for selection program recommendations. Emphasis on heat tolerance and associations with cow reproduction including heifer development are priorities for Objective 3.

Genetics of Reproduction of Cattle Adapted to Southern Conditions.

Vargas et al. (1998) reported genetic parameters for a limited set of traits using a small Brahman data set from a single location. Previous Australian work evaluated genetic control of reproductive traits in Brahman cattle (Johnston et al., 2009; Prayaga et al., 2009) that project was terminated and the cattle resource sold. Field data of Nellore cattle in Brazil (Van Melis et al., 2010) and Bos taurus cattle in the United States (Doyle et al., 2000) have been analyzed and some estimates of genetic parameters for cow fertility traits have been reported. No one anywhere has attempted to characterize reproductive performance across parity-age combinations through the variable young years in a cows life; this information would be especially valuable for Brahman straight and crossbreeding programs that are typical of Southern United States beef production. An even greater need is for the existence of a multi-state group of Brahman that can serve as a validation of other genomic work, and a population for which the aggregated phenotypes can be used as a basis for proposal for joint genomic work and funding. No comparable resource exists today in our phenotype-deficient cattle research environment. Emphasis on age-parity combinations among Brahman and Brahman-cross females on lifetime production is a priority of Objective 4.

Economic evaluations.

Several economic evaluations at the herd level (McGrann, 2003; (Dhuyvetter and Langemeier, 2010; FINBIN, 2012) have indicated large potential for profitability among cow-calf producers in various regions of the USA. Many breeding and production decisions are made without formal economic analyses. Preconditioning of calves for feedlot conditions is widely recommended to many producers, and, calves that are documented to be preconditioned (weaned, received recommended vaccinations, trained to eat from feed bunk, etc.) typically receive $3 to $8 per 100 lb ($0.07 to $0.17 per kg) price premium. However, several studies (Pate and Crockett, 1978;

Peterson et al., 1989; Pritchard and Mendez, 1990) have indicated that preconditioning may not be justified when feeding costs are high. Evaluations regarding economic indicator traits such as net present value have been utilized for breeding cows (e.g., Meek et al., 1999; Mathews and Short, 2001), but these economic evaluations have not included genetic information nor have they been targeted toward situations or cow types typical in the Southern USA. Cow-calf producers need and desire economic and well as genetic evaluations for more efficient and sustainable breeding and production systems. Emphasis on economic-based evaluations on multiple production traits will be included in all project objectives.

Objectives

1. Estimate genetic variation associated with animal health using classical animal breeding and genomic techniques to facilitate sustainable beef cattle production systems.
2. Meta-analyses of economically important traits of cow productivity and fertility to assess breed and production system combinations.
3. 3. Documentation of genetic components pertaining to heat tolerance adaptive traits in sustainable beef cattle production systems.
4. Investigation of early cow-life performance (first four parities) affecting lifetime production in Brahman and Brahman × Angus cows.

Methods

Activity 1. All objectives--DNA Collection

DNA samples will be collected from pedigreed populations of cattle (purebred and crossbred) from various units throughout the Southeastern United States. Whole blood will be harvested in purple top tubes, and transferred to DNA cards for storage at room temperature or to cryotubes and stored in a 80pC freezer at each location until testing is determined. Data on each animal will include individual, sire, and dam identification, breed or breed type, and location. A catalogue of information including phenotypic data and DNA samples from the different locations will be assembled and updated annually.

Activity 2. All Objectives--Economic analyses

Economic analyses will be conducted to evaluate the value of traits measured from the cows and resulting calves. The economic value of selected traits will be analyzed using net present value methods. Simulation methods will be used to incorporate risk and uncertainty into the analyses. These methods will allow quantification of economic impacts for numerous production considerations at the cow-calf level and assist in development of decision tools to aid in economic-based decision making; many breeding and genetic recommendations have not been formally evaluated economically.

Net present value (NPV) is defined as the present value of the revenue minus costs over the investment period. NPV is commonly utilized to analyze the profitability of an investment. In this case, the investment is the cow. Revenues are generated from the calves sold and the salvage value of the cow.

$$NPV = \sum_{i=1}^{t} \frac{REV - COST}{(1+i)^t}$$

Where:

$NPV =$ net present value

$REV =$ cash inflows

$COST =$ cash outflows

$i =$ discount rate

t = (cow age in years – 2)

The NPV for each year will be estimated for individual cows. The effect of increased longevity will be evaluated in terms of the difference in NPV. Stochastic simulation techniques, using Simetar (Richardson et al., 2008) will be used to account for variability in steer and heifer weaning weight and the weaning rate based on the variability observed in the cow data. Simulation provides the opportunity to make probabilistic estimates of alternative strategies based on the estimated distributions of economic returns.

The basic cow-calf model will account for revenue and the cost associated with each cow in the herd. Revenue will be determined as products of the probability a cow would wean a steer with the stochastic weight of a steer and the stochastic price of a steer for that particular year. This value will then be added to the dollar amount generated by multiplying the probability of the cow having a heifer calf by the heifer price and stochastic heifer weight. A cost for maintenance (e.g., $600, but revised in accordance with current conditions) will be deducted every year that a cow is in the herd. The profit (loss) dollar amount will then be discounted to present value. This basic model will be altered relative to the different types of traits in the different objectives of the proposed project.

Changes in dollar value across the project duration will be modeled, as well as the differences in reproductive rate and performance traits (e.g., weaning weight) for the different breeds utilized. Price data will be stochastically simulated.

Objective 1. Estimation of genetic variation associated with animal health using classical animal breeding and genomic techniques to facilitate sustainable beef cattle production systems.

Activities by sub-objective:

Objective 1.1 External Parasites

Fly count data collection will begin in May or June, and will continue until the end of summer when a decline in fly numbers is observable. High-resolution photos of the animals head, neck, body and legs will be taken once per week early in the morning (between 0600 and 1000 h) during the coolest time of the day. This photographic record will document the peak number of flies on the animal while they remain on the visible areas of the body. Using a grid, photographs will be used to record the number of horn flies on each individual animal. Genotypes evaluated will vary across locations; however, breed type and phenotypic data will be obtained for analysis. Data will include, but not be limited to, age, color, breed, past insecticide application, cow size, body condition score, and calf weaning weight. Data will be analyzed using a mixed model approach in ASREML, where we will estimate variance components (heritability) and obtain breeding value estimates. Because the visual appraisal of tick burden is a discrete variable (1 = clean, 2 = light tick burden, 3 = moderate tick burden, 4 = heavy tick burden) it will be analyzed as such; an appropriate link function will be applied to these categorical data, but results will be presented on the original scale.

Hair or blood samples will also be obtained for future genomic analyses of these traits.

Tick counts will be obtained from bull and heifer calves at weaning and at yearling age. Heifers will also be evaluated at first breeding. Cattle will be evaluated prior to any treatment (dip or spray) to remove external parasites. Tick counts will be conducted as a visual, subjective observation. The areas of concern for evaluating tick burden are under the tail and between the hind legs as this is the most common area to see ticks. The overall surface of the animal, the inner surface of the ears and around the head will also be evaluated as well to detect the presence of ticks. Tick burden will be scored using 1 = clean, 2 = light, 3 = moderate and 4 = heavy. Cattle will be restrained in a chute and photographs of lateral, dorsal and ventral body surfaces of each animal will be recorded using a hand held digital camera. Special care will be taken to photograph the area from just under the tail down to between the rear legs as this is the area where most of the ticks are commonly found on the cattle. Images will be reviewed on a monitor and total tick counts will be determined for each animal. Genetic types evaluated will vary across locations and will consist of purebred and crossbred Bos taurus and Bos indicus cattle. Data will be analyzed using genetic type, sex, time of year and location in the model to evaluate differences in tick counts. The use of any tick control methods will also be incorporated into the analysis.

Objective 1.2 Eye and facial pigmentation associated with animal health

We will use photographs and digital quantification software to determine proportion of eyelid with pigmentation. Each animal will have one photo to identify the animal (primarily have used tag or brand), one of full face straight on to clarify markings, one of eye straight across on left side, one of eye aiming up (to characterize the eyelid under the upper eyelashes) on the left side, one of eye straight across on right side, and one of eye aiming up on the right side.

Preliminary quantifications will include image modification with Adobe Photoshop Elements 2.0 (Adobe Systems Incorporated, San Jose, CA), including cropping and conversion to 8-bit grayscale images. Image J software (Java, Bethesda, MD) will be used to accommodate a 255-pixel background and quantify images in terms of x- and y-axis coordinates in pixels. Microsoft Excel (Microscoft Corporation, Redmond, WA) will be used, at least in preliminary stages, for identification of pigmentation pixel peaks and area delineation. There may be consolidation of these steps into an analysis pipeline using code developed in the course of the project. Alternative quantification software will actively be sought and evaluated if identified.

Participation from multiple sites will provide a larger number of records needed to analyze this trait. Breed types to be evaluated include 1) straightbred Hereford, 2) Hereford-*Bos taurus* crosses (to date those have been Angus), 3) Hereford-*Bos indicus* crosses (including Braford in this category even though it is recognized as a distinct breed). Target numbers of animals in each breed type category are 667 (one third of the 2000 animals), but it may be beneficial to increase numbers in one or more categories. Although initially the intent of this objective is to evaluate animals with Hereford ancestry, it may be possible to expand to animals of Simmental ancestry and such decisions will be considered during the course of this project.

Dependent variables will be analyzed using 1) mixed models in ASReml (Gilmour et al., 2009). Investigated fixed effects will include parameterizations of animal age, location, breed type, sex, and interactions of these. Random effects will include year. Some locations will be breeding cows with the same sire; however, limited potential for modeling of pedigree exists at this point. Dependent variables are expected to be distributed normally; if they are not, appropriate link functions (log, logit, probit, etc.) will be applied to data for analyses and means comparisons.

Objective 1.3 Udder conformation

Teats and udder will be evaluated according to Beef Improvement Federation udder scoring guidelines (BIF, 2010). Teat length will be evaluated as the distance from the base of the udder to the distal end of the teat, and teat diameter will be measured at the midpoint of that distance. Teat shape will be scored on a 1 to 9 scale such that low scores from one to three will indicate a conical or funnel shape in that the diameter of the teat being greater near the base of the udder than at the distal end of the teat. High scores from 7 to 9 indicated the opposite: bulbous or balloon shaped teats in which the teat is narrower at the base of the udder that at the middle or distal end. Teat shape scores from 4 to 6 will indicate a teat that was cylindrical (diameter near the base of the udder was about the same as that at the distal end of the teat).

Teat placement on the udder will be evaluated as the relative positioning of pairs of teats with 4 subjective scores. Side placement scores are assigned for the 2 left and 2 right quarters; lateral placement scores are assigned for the 2 front quarters and the 2 back quarters. Low placement scores of 1 to 3 indicate pairs of quarters in which the teats are close together; for example, a score of 1 could indicate teats that seemed to be fused together. High scores of 7 to 9 indicated pairs of quarters in which teats are far and/or pointed away from each other. Placement scores of 4 to 6 indicate intermediate positioning of the two teats relative to each other.

Udder balance scores will be assigned to describe the relative size of the fore quarters as compared to the rear quarters. Low scores of 1 to 3 will indicate fore quarters that are small relative to the rear quarters. Scores from 7 to 9 indicate fore quarters that are larger than the rear quarters. Scores from 4 to 6 indicate udders with fore and rear quarters of about the same size.

Udder support scores will be assigned to assess the strength of udder attachment. Low scores from 1 to 3 indicate udders that were pendulous and(or) broken down. High scores, from 7 to 9, indicate udders with strong attachment held to varying degrees close to the body cavity.

Dr. Jeremy Powell will be coordinator for objective 1, and Dr. David Anderson will coordinate and lead economic-based evaluations. Drs. Robert Godfrey and Megan Rolf will be responsible for leading data assimilation, statistical analysis of the combined data set, and publication of results for Objective 1.1. Dr. David Riley will be similarly responsible for leadership on Objectives 1.2 and 1.3.

Objective 2. Meta-analyses of economically important traits of cow productivity and fertility to assess breed and production system combinations.

Activities:

The following data will be collected for heifers and cows: (1) Breed of cow, (2) Sire ID/sire breed and dam ID/dam breed of cow, (3) cow birth date, (4) Mating information (natural or artificial insemination; single or multiple sires; number of cows per bull; season or insemination date(s), (5) Predominant forage in pastures (fescue 0 = no; 1 = yes), (6) Sire/sire breed of calf, (7) Cow:bull ratio, (8) Body condition score (date and stage of production), (9) Palpation status (0 = non-pregnant; 1= pregnant), (10) Calving status (0 = no; 1 = yes), (11) Weaning status (0= no; 1 = yes), (12) Calving date (calving season, spring or fall), (13) Calving difficulty (1 = normal; 2 = easy pull; 3 = hard pull; 4 = caesarian section; 5 = abnormal presentation, note the abnormal presentation of calf), (14) Calf vigor issues (1 = normal; 2 = weak but nursed without assistance; 3 = weak and assisted to nurse; add any notes), (15) Calf birth weight, (16) Calf weaning date, (17) Calf weaning weight, (18) Cow temperament at calving, (19) Date of death and reason/notes for cow or her calf, and (20) Date of culling and reason/notes for cow and/or her calf leaving herd.

Objective 2 is designed ~~by definition~~ so that all committee members and locations may be able to participate (Table 1) and so that future participants may also be recruited.

Analyses will be conducted using mixed models and ASReml 3.0 (Gilmour et al., 2009) or other comparable programs. Effects investigated will include year and location in addition to the effects that would be investigated in data from a single location. Breed effects will not be separable from location effects in some cases—it may be necessary to analyze subsets of data to avoid such confounding. Assessment of categories of reasons for culling cows or for their exit from projects will be initially evaluated with standard χ^2 tests for proportion differences from expected values, but linear models will be investigated for these as well. Opportunities to use subsets of data to evaluate potential sources of genotype-environment interactions (e.g., similar breed types on different forage) may exist as well. Opportunities to investigate cow longevity

for locations with similar cow removal criteria will likely exist; the impact of censured data will be considered in the modeling of cow age at removal or survival to particular ages. Some locations may have stronger pedigree connectivity of their cattle to those in other herds, which would provide the opportunity for modeling relatedness (animal model) on some subsets of data. In all cases, the appropriate link functions will be applied to non-normal data.

~~Dr. Gary Hansen will be objective coordinator and be assisted by~~ Drs. ~~Hayden Brown and~~ Andy Herring and David Riley will direct ~~for~~ data organization. Meta-analyses geared toward genetic assessment of production traits will be led by Dr. Elzo; economic analyses will be coordinated by Dr. Anderson.

Objective 3. Documentation of genetic components pertaining to heat tolerance adaptive traits in sustainable beef cattle production systems.

Activities: 1. Cows, calves, and yearlings will be evaluated each spring starting in March and assessed every 28 days until July for hair coat characteristics. At each evaluation animals will be visually inspected for amount of winter hair shed and shedding pattern.

2. Hair shedding will be evaluated using a numerical scoring system. A score of 1 = completely shed or slick (100% shed); 2 = 75% shed; 3 = 50% shed; 4 = 25% shed; and 5 = 0% shed or full winter coat. For shedding pattern a score of 1 = slick, shedding complete; 2 = animal has shed off to below the middle of the rib cage; 3 = slick strip covers the full topline and the back of the hindquarters; 4 = a completely slick strip down the topline of the animal; and 5 = no evidence of shedding, even down the topline.

3. A subset of animals showing the extreme phenotypes will be evaluated for differences in body temperatures through rectal and thermal images if possible. Respiration rates will also be recorded prior to animals entering the chute and in the shade.

4. Cow data will be collected for assessment of the influence of shedding type on production characters. These will include breed, breed type, and pedigree information on each animal for genetic analysis. Cow performance data will include cow weights, body condition scores, reproductive records and performance of their calves from birth to weaning. In order to appropriately build models, other information will be collected including forage type, calving season, internal parasite control, and type of mineral supplement.

Analyses will be conducted using SAS (SAS Inst. Inc., Cary, NC) and ASReml (Gilmour et al., 2009). Because they are categorical rather than normally-distributed, hair scores will be analyzed using logistic regression procedures after application of appropriate link functions, such as a logit or probit function. Results will be presented after application of inverse of the link function used.

Dr. Trent Smith will be objective coordinator and be assisted by Drs. Jim Sanders and Bob Godfrey for data organization and analysis.

Objective 4. Investigation of early cow-life performance (first four parities) affecting lifetime production in Brahman and Brahman × Angus cows.

Objective 4.1. Comparison of cow reproductive ability as success/failure after the first insemination and at calving.

Activities:

1. Calving and weaning dates will be recorded and those cows that calve and wean will be assigned values of 0 and 1 indicative of failure and success, respectively. Calving dates and/or palpation records will be used to assign success and failure values for conception relative to first AI service in cows that are artificially bred. These reproductive rates will be analyzed as binomially-distributed variables using appropriate methodology and software.

2. Analyses will also be conducted to assess effects on reproductive rate associated with cow age-parity combinations for the initial 4 parities of a cows reproductive life. If cows conceived at every opportunity, Table 2 illustrates the distribution of those parity values across cow age. Locations that manage both spring and fall calving seasons will evaluate cow ages 2.5, 3.5, and 4.5

3. Females will be first exposed to bulls at 12, 18, or 24 mo age.

4. All or some females at locations may be bred using artificial insemination combined with exposure to clean-up bulls. To confirm parentage, either 1) clean-up bulls will be of a different breed, or 2) parentage will be confirmed by DNA testing.

Objective 4.2. Comparison of preweaning calf nursing ability and its effect on survival and weaning weights.

Activities:

1. Calf vigor will be recorded for calves born alive using a subjective score assigned by the attending herdsman: 1 = normal vigor, 2 = less than normal vigor, but calf nursed on its own, 3 = score of 2 but calf required special assistance to nurse.

2. Calf nursing ability will also be assigned when calves are weighed and processed at birth: 1 = calf nurses normally, 2 = calf has poor nursing instinct (dummy calves that cannot find udder, and nurse the brisket).

3. Dystocia will be assessed with a subjective score: 1 = normal birth; 2 = difficult birth but was not assisted; 3 = difficult birth that required minor assistance; 4 = difficult birth requiring major assistance or caesarean section.

4. Udder scores, including 1 to 9 subjective evaluation of udder suspension and teat size (Beef Improvement Federation Guidelines, 2009) will be recorded for each cow at parturition in conjunction with Objective 1.

5. Herdsmen notes about the birth or unusual conditions at birth will be considered in the construction of dependent variables for analysis.

6. Some of these traits may be condensed into binomially-distributed 0/1 traits (indicative of occurrence or nonoccurrence) for analyses.

7. The interaction of vigor and nursing ability scores with dystocia, udder scores, and herdsman notes will be of importance and will also be investigated.

8. The same data will be collected on crossbred calves and will serve as useful breed type comparison, although it is expected that calf vigor at birth and nursing ability will be primarily problems observed in purebred calves.

Objective 4.3. Comparison of cow-calf productivity in terms of calf preweaning gains and calf postweaning ultrasound measurements.

Activities:

1. Birth and weaning weight will be recorded for all calves, and ADG will be constructed from those weights and age at weaning.

2. Ultrasound measurement of fat thickness over the 12th rib, loin muscle area, and loin muscle % intramuscular fat will be recorded between 365 to 467 days of age.

3. In addition to genetic analysis and comparison of breed types, it will be a priority to document with appropriate statistical methodology the phenotypic and genetic association of these traits with the reproductive and birth traits in Objectives 4.1 and 4.2.

Objective 4.4. Comparison of carcass traits and meat quality.

Activities:

1. Spring-born steers from some locations will be commercially fed.

2. Steers will be slaughtered commercially at a commercial slaughter facility in South Texas.

3. Carcass data will be recorded and will include (a) slaughter weight, (b) hot carcass weight, (c) adjusted 12th rib fat thickness, (d) loin muscle area, (e) kidney, pelvic, and heart fat, (f) USDA marbling score (g) USDA quality grade, and (h) USDA yield grade.

Across the 5-yr proposed project this will result in approximately 2,000 straightbred Brahman calves and 1,000 crossbred Brahman-Angus calves with records (650 calves weaned per year); sex-specific traits will be approximately half that number (Table 3). Repeated records will add support to analyses of cow traits.

Classical polygenic or genomic-polygenic analyses will include both estimations of means per breed group and of variance-covariance components and genetic and genomic parameters. Tissue samples will be collected from all calves born at all locations that will serve as a source of DNA. Samples have been stored for all animals at all locations. Genomic analyses will be conducted subsequent to the completion of the above objectives and will be contingent upon successful funding.

Many of these traits (e.g., reproductive rates) will be analyzed as binomially-distributed variables using animal models with a logit link function of data to an underlying normal distribution ASReml 3.0 (Gilmour et al., 2009) and separately using the threshold models in the software package THRGIBBS1F90 (http://nce.ads.uga.edu/wiki/doku.php?id=application_programs) to model linear or categorical (including 2 or more thresholds). The GLIMMIX procedures of SAS may also be appropriate for some analyses with a less sophisticated random structure required.

Statistical analyses will be led and coordinated by Dr. Elzo. Economic analyses will be conducted by Dr. Anderson.

Measurement of Progress and Results

Outputs:

- Outputs will include unique datasets that provide for assessment of genetic influences on multiple health, reproduction and adaptation traits in multiple production environments within the Southern region. These large datasets that include detailed phenotypes, pedigree information and banked DNA will provide important resources for both genomic and economic-based evaluations. Several individual and joint-analysis publications will be provided in the scientific literature as well as to producer groups.
- It is likely that new measures of genetic assessment and economic values for breeding beef cows may be developed through meta-analyses.
- New standardized measures for tick count, eye pigmentation or udder assessment for producers.
- New considerations or weighting on production traits in cow-calf herds due to breed and production system combinations.
- New measurements of adaptability for heat tolerance.
- Output 6 Specific recommendations for Brahman breeders regarding heifer development and young cow management for improved production. Output 7 Decision-support methods or tools that incorporate economic analyses.

Outcomes or projected Impacts:

- Production of improved animal health in cow herds
- Improved characterization of and improvement in cow herd fertility
- Use of hair scoring as a selection tool to assess adaptation
- Increased production and profitability in Brahman and Brahman crossbred females

- Outcome/Impact 6 Increased beef cow longevity, which would lead to increased economic efficiency Outcome/Impact 7 Improvements in health and adaptation traits would not only allow for increased fertility in cows herds but also allow for less reliance on artificial inputs (insecticide, pharmaceuticals, purchased feeds, etc.) for improved environmental and economic sustainability. Outcome/Impact 8 more precise information regarding beef cattle breeding systems in the Southern Region will allow producers to tailor breeding and management decisions for improved production efficiency and therefore improved sustainability. It is likely that producers will become more familiar with consideration and incorporation of economic considerations based on corresponding breeding and management strategies, with increased emphasis on assessment and utilization of adaptation concepts.

Milestones:

(2015): There are no specific milestones required for one objective to be completed before another one begins or is completed. However, successful completion of each objective relies on annual communication among participants and annual data collection and reporting.

(2016): Annual communication among participants and annual data collection and reporting.

(2017): Annual communication among participants and annual data collection and reporting. Analyses of preliminary pooled datasets will be emphasized (such as after first 2 or 3 years of project) to aid in publication development and the timeline for final joint analyses (as opposed to only conducting joint analyses after all yearsdata are collected).

(2018): Annual communication among participants and annual data collection and reporting.

(2019): Annual communication among participants and annual data collection and reporting. Final joint analyses.

Projected Participation

Include a completed Appendix E

Outreach Plan

Traditional publication outlets will continue to be utilized and include scientific abstracts, peer-reviewed journal articles and proceedings papers. Presentations will be made to scientists and graduate students at scientific meetings such as the American Society of Animal Science sectional and national meetings. Information will be made to producers through state and university field days and short courses. Many participants will also be able to reach large numbers of producers on national levels through committee assignments and invited presentations associated with National Cattlemens Beef Association, the Beef Improvement Federation as well as state-level cattle industry groups. Publications and presentations will be audience-appropriate.

Organization/Governance

The standard form of governance as described in Guidelines for Multistate Research Activities will be employed. Objective coordinators will be: 1) Dr. Jeremy G. Powell, University of Arkansas, 2) Dr. Gary R. Hansen, North Carolina State University, 3) Dr. Trent Smith, Mississippi State University, and 4) Dr. David G. Riley, Texas A&M University. Participants of each location provide guidance for joint analyses and associated publications.

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Attachments

[Tables.pdf]

Land Grant Participating States/Institutions

AR, FL, MS, OK, South Carolina Cooperative Extension, Texas AgriLife Extension Service, TX, VI

Non Land Grant Participating States/Institutions