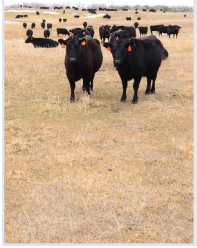

Evaluation of Methods to Measure Temperament in Cattle and Their Impacts on Predictions of Genetic Merit

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The objectives of this study are to: 1) characterize subjective and objective measurements of temperament in cattle, 2) identify evaluator impact on subjective measurements relative to genetic predictions, and 3) determine the feasibility and practicality of objective methods being characterized. The long-term goal is to identify a practical measure of temperament to use in genetic evaluation programs. This report describes the approach and current status of the project.

Introduction

Livestock behavior, particularly the human and animal interactions, is an important consideration because it can influence productivity as well as welfare of the animal (Hemsworth, 2003). Measuring temperament, often defined as the reaction of the animal to human handling (Burrow and Dillon, 1997; Fordyce et al., 1982), in beef cattle has been of industrywide interest because calmer cattle result in less stress and safer work environments for the handler, as well as for that animal and its contemporaries (Grandin, 1989).

The reduction of stress on animals and humans can result in more efficient production of beef, along with reduced costs due to health reasons (for example, King et al., 2006; Cooke et al., 2009a, 2009b, 2011). This is particularly true as wilder, more excitable temperaments alter immune responses in cattle due to increased stress levels (reviewed by Burdick et al., 2011).

Temperament, among other similar traits of production importance, is challenging to measure. Often, using an objective scale or collecting data in an objective manner can be cost prohibitive for a producer. For example, flight speed (Burrow et al., 1988), which is based on the premise that calmer animals leave the chute at a slower rate than their unruly contemporaries, eliminates having evaluators score each animal but requires specific equipment and skills to measure the characteristic.

Researchers have shown that only moderate persistence of flight speed occurs on a given day (Vetters et al., 2012). Additionally, questions have been raised about what aspects of temperament (for example, nervousness, flightiness, gregariousness, aggressiveness) flight speed really accounts for, but besides repeatability, not much research has been conducted to understand that aspect.

Furthermore, purely objective methods often lack the ability to capture the different aspects of temperament. This makes the use of subjective scoring methods appealing because the scales can be adapted to capture multiple descriptors of temperament.

Subjective methods are often more cost-efficient for the producer and can be utilized to capture various attributes of a complex trait. Subjective methods, however, rely on the evaluator's or evaluators' perception of that trait.

In the case of temperament, several subjective methods, including flight distance (Fordyce et al., 1982), crush score (also called temperament score; Hearnshaw and Morris, 1984), movement score (Fordyce et al., 1982, 1988; adapted by Grandin, 1993) and docility score (Beef Improvement Federation, 2010), as well as a different scoring method also called temperament score (Sant'Anna and Paranhos da Costa, 2013), have been identified.

A purely research-based scoring method also has been described for use in identifying biological mechanisms involved in cattle temperament through candidate gene searches and association studies (see Boldt, 2008, and Hulsman Hanna et al., 2014a). In addition, a few breed associations even have incorporated docility scores into their genetic evaluation programs (for example, Hyde, 2010; Northcutt and Bowman, 2010).

Lastly, Wemelsfelder et al. (2000, 2001) utilized free choice profiling techniques to identify behavioral attributes that would signify different aspects of animal welfare in pigs. This technique has been used extensively in food sensory studies to understand what attributes different food products have (for example, chocolate flavor intensity, smoke flavor intensity, fish taste, color), but studies by Wemelsfelder et al. (2000, 2001) were some of the first attempts to transition the technique into use for measuring attributes related to animal behavior.

Sant'Anna and Paranhos da Costa (2013) adapted the work of Wemelsfelder et al. (2000, 2001) and their procedure outlined in Welfare Quality® protocol (Welfare Quality® Consortium, 2009) to fit into the cattle production setting by using a set of behavior attributes in a method called Qualitative Behavior Assessment (QBA). This method sought to capture behavior attributes by using cattle body language in a quantitative fashion. In their study, Sant'Anna and Paranhos da Costa (2013) took those behavior measurements and, through principle component analysis, transformed them into a single score for each animal termed the Temperament Index (TI).

Although measuring the behavior attributes for the QBA requires subjective assessment, the use of principal component analysis converts these measurements, which may have correlation, to a set of values that are linearly uncorrelated (the principal components). The TI is the first principal component, meaning that it accounts for the largest amount of variation in the data, and each following component is uncorrelated to the TI.

This is particularly interesting because it may negate or reduce the impact the evaluator has on the behavior measurements. If this is true, then allowing producers to conduct a QBA for their animals and reporting those to breed associations for analysis may provide a cost- and time-efficient method to improve selection criteria that can replace current methods being used.

The primary challenge to Sant'Anna and Paranhos da Costa (2013) is that they employed a single evaluator to conduct the QBA method and it was utilized only on Nellore cattle, which are typically very expressive in their behavior.

In any case, these methods rely on the evaluator's perception of the animal's reaction to human handling. Due to this, the potential exists for evaluator bias among evaluators or across days of evaluation (see Vetters et al., 2012).

Very little is known of the actual impact of evaluators on these subjective scoring methods. Rather, a limited number of studies have reported repeatability of scores on animals (for example, Vetters et al., 2012; Jones, 2013), which provides an indication of usefulness in the production setting but not necessarily an indication of what variation could be expected among evaluators for any given method. Even fewer studies compare these repeatability measures across methods.

Because temperament is a complex trait and often highly influenced by environmental cues, assessing current and new methods for their effectiveness in capturing this trait of interest is important, especially if these methods are used for selection purposes. Findings related to temperament scoring methods have farther-reaching implications because they also could be translated to other difficult-to-collect traits such as fertility and reproductive performance.

Therefore, a **long-term objective** of this project is to identify a practical measure of temperament to use in genetic evaluation programs. Current **short-term project objectives** of this study are to: 1) characterize subjective and objective measurements of temperament, 2) identify evaluator impact on subjective measurements relative to genetic predictions, and 3) determine the feasibility and practicality of objective methods being characterized. This report describes the approach and current status of the project.

Materials and Methods

Animals

Calves at weaning age from the Central Grasslands Research Extension Center (CGREC) were evaluated for temperament using subjective and objective scoring systems. Weaning age is recommended to reduce influences on temperament evaluation due to past experiences (BIF, 2010).

The cow herd producing these calves consisted of approximately 450 females (mature cows and heifers) with primarily Angus and/or Hereford influence that were bred to Angus or Hereford bulls. Each calf had blood drawn via jugular venipuncture for white blood cell extraction.

White blood cell pellets are being stored long term in an ultralow freezer until funding becomes available for DNA extraction and genotyping. Data were collected on weaning-age calves from 2014 to 2017, resulting in approximately 1,542 calves with records available.

Data Collection and Traits

During weaning time, temperament was evaluated by randomly assigning evaluators (n = 6) to two of three subjective scoring methods (n = four evaluators per method). This was constructed to determine the level of differences between evaluator perceptions of temperament (evaluator bias) without introducing bias due to stress of scoring three scales.

Efforts were taken to keep evaluators consistent across years. Many evaluators were involved during all four years and kept the same two scoring systems during those years; however, a subset was involved only in specific years. Replacements typically had similar backgrounds or experiences, and differences are being investigated as part of the long-term objective. Furthermore, novel objective methods of measuring temperament also were investigated.

Subjective evaluation methods include:

1) Qualitative Behavior Assessment (QBA; Sant'Anna and Paranhos da Costa, 2013) - The QBA method uses 12 behavioral attributes: active, relaxed, fearful, agitated, calm, attentive, positively occupied, curious, irritated, apathetic, happy and distressed. Evaluation occurs as the animal leaves the chute and enters a working pen. Evaluators interpret the body language of the animal and score each attribute independently on a 136-millimeter (mm) line, where the far left of the line is no expression and the far right of the line is full expression. The score is the distance (in mm) of the mark from the left side.

2) Temperament score (Sant'Anna and Paranhos da Costa, 2013) - Like QBA, temperament score is used to evaluate the animal as it leaves the chute and enters a working pen. It is a 1 to 5 scale with whole numbers, where a score of 1 is a calm animal and a score of 5 is a wild animal. The middle value (3) is not included to avoid having evaluators chose an intermediate score.

3) Docility score (BIF, 2010) - Docility score is evaluated when the animal is in the squeeze chute with its head restrained, but body movement is not restricted. Each calf is scored on a 1 to 6 scale, where 1 indicates a docile, easily handled animal, and 6 indicates a very aggressive, wild animal.

Objective evaluation methods include:

1) Video image analysis (VIA) - Video was captured on each calf from the top as it entered the silencer chute in 2016 and 2017. Prior to entering the chute, the calf had a red tape marker placed on its tail head. A second red tape marker was present at a designated location within the chute. The video clip was reduced to a 10-second window for each calf in the same time frame of being in the chute for consistency. Deviations of the calf's red tape marker from the permanent red marker will be used to determine movement and possible measure of temperament for that calf.

2) Pupil dilation and thermal imaging - After the head of the calf was caught in the silencer chute but before blood draw, an infrared picture of the calf's left eye was taken for pupil dilation and a thermal image reading of the calf's face was recorded as two additional measures of temperament. These records also were recorded only in 2016 and 2017.

3) Four-platform standing scale (Pacific Industrial Scale, British Columbia, Canada) - Immediately after being evaluated in the squeeze cute for docility score, the animal was placed on a custom four-platform standing scale for a minimum of 45 seconds to record weight borne on each quadrant through time (records multiple times per second).

Qualitative Behavior Assessment (QBA) Attributes

Sant'Anna and Paranhos da Costa (2013) investigated these traits using principle component analysis. Our preliminary analysis of records from 2014 and 2015 also investigated using this statistical approach to create the temperament index (TI).

The results of this investigation indicate that very different outcomes can occur across populations (*Bos indicus* vs. *Bos taurus* breeds) and evaluators. Due to this, additional methods to characterize the QBA attributes are warranted. We are pursuing a factor analytic model using multivariate approaches (Henderson and Quaas, 1976).

Statistical Analysis

Phenotypes (scores and attributes) are being evaluated using a mixed-model procedure in SAS (SAS Institute Inc., Cary, N.C.). Fixed effects of evaluation day, birth year, evaluator and other environmental effects (for example, sequence of evaluation) are being evaluated for significance. The average score for each method will be used for an aggregate value to compare against evaluators and across methods, particularly for project objective 3.

Genetic Predictions

The current focus of this project is genetic predictions using a traditional animal model in ASReml software (Gilmour et al., 2015). Analysis will be conducted as single traits and in pairs to meet project objectives.

Both approaches predict genetic merit and estimate heritability for that trait. Analyzing two traits together allows for genetic correlations between traits to be estimated, while having nearly 2,000 animal records typically is necessary for reasonable estimates. Predictions will be generated and used for comparison of method efficacy and evaluator impacts on animal rankings.

Results

Data from 2014 and 2015 have been analyzed collectively, which resulted in a sample size of 802 calves. Preliminary analyses of data from 2014 and 2015 calves have found that temperament scores are influenced by date of evaluation and calf sex, and that temperament scores differ by evaluators ($P < 0.05$).

These models prove that evaluator differences are present, and preliminary analysis of genetic predictions indicate this causes re-ranking of animals. As these are based on pedigree relationships, however, the sample size needs to be larger for formal conclusions to be made and for project objectives to be met.

Discussion

Four years of data have been collected. As several of the methods to measure temperament are novel, many procedures on how to process the large amount of data and turn them into formal scores or measures to use have been challenging. The research team is working to finalize data processing and entry for all four years and begin formal analysis to meet project objectives.

Acknowledgments

The authors express their gratitude for the many personnel (former or current) involved in this project, including CGREC personnel; graduate students Friederike Baumgaertner, Dani Black, Nayan Bhowmik, Elfren Celestino Jr., Mellissa Crosswhite, Felipe Da Silva, Jordan Hieber, Blaine Novak, Nicolas Negrin Pereira and Haipeng Yu; NDSU personnel Kelsey Amborn, Justin Crosswhite, Billy Ogdahl and Sarah Underdahl; and the many undergraduate students who have assisted through the years.

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