Docility EPD: A Tool for Temperament

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Introduction

Poor temperament in beef cattle has been associated with reduced performance, carcass quality, and health in beef cattle. Cattle with calm temperaments had higher average daily gains (**ADG**) (Burrow et al., 1997; Voisinet et al., 1997b) and decreased incidence of dark cutting beef (Voisinet et al., 1997a; Scanga et al., 1998) when compared to cattle with anxious temperaments. Feedlot cattle with excitable temperaments had lower immune function (Fell, et al., 1999) and tougher meat (Voisinet et al., 1997a; King et al., 2006; Vann, 2006) than calm cattle. Busby et al. (2005) examined the effect of disposition on feedlot performance and carcass quality grade and reported docile calves returned $62.19 per head more than aggressive calves. Additionally, aggressive cattle jeopardize stockperson safety and are more likely to become injured during handling (Grandin, 1989). The combination of these factors make docility an economically relevant trait (Golden et al., 2000), and should be strongly considered by beef producers when breeding or purchasing cattle.

Review of Literature

Measuring Temperament

Temperament has been described as reaction of beef cattle to handling by humans (Burrow, 1997). Various methods used to measure temperament in the literature include flight speed test (Burrow et al., 1988), docility test (Le Neidre et al., 1995; Grignard et al., 2001), and crush test (Tulloh, 1961; Grignard et al., 2001).

Flight speed (**FS**) test objectively measures the time taken (in hundredths of a second) for an animal to pass through two light beams separated by a distance of 1.7m, after leaving a weight crush or chute (Burrow et al., 1988). Flight speed may be reflective of intrinsic fearfulness (Petherick et al., 2002), and has been used to measure temperament in cattle, where faster FS reflects aggressive temperaments and slower FS indicates calmer temperaments (Burrow, 1997). Direct heritability of 0.40 was estimated for FS in a tropical breed of beef cattle (Burrow 2001), however, both data and pedigree files were relatively small and included animals of two different, but very similar composite breeds.

An association between FS and ADG in feedlot cattle has been shown in the literature (Burrow and Dillon, 1997; Petherick et al., 2002; Müller and von Keyserlingk, 2006). Burrow and Dillon (1997) found a negative correlation between FS and ADG in one group of *Bos indicus* cattle but not the second group, Petherick et al. (2002) reported significant but low correlations between FS and ADG in *Bos indicus* cross steers (-0.24 average from seven correlations), and Müller and von Keyserlingk (2006) observed a quadratic rather than linear relationship between FS and ADG in Angus cross heifers (i.e. animals with the highest FS had the lowest ADG, but many animals with low FS also had low ADG). Müller and von Keyserlingk (2006) also examined the correlation between ADG and personality traits measured in a social separation test (e.g. cattle were isolated from pen mates and video recorded to quantify locomotion, mobility, etc.) and concluded that fast animals were not the most fearful, as previously thought, but animals with lower ADG were the most fearful. Even though FS has proven to be an objective measure of flight speed, the relationship between FS and ADG is not clear (Müller and von Keyserlingk, 2006). Additionally, if temperament is reflective of an animals' reaction toward handling by humans, allocating temperament (good vs. poor) based solely on FS may not be appropriate (Müller and von Keyserlingk, 2006).

Docility test, similar to social separation test (Müller and von Keyserlingk, 2006) and handling test (Boivin et al., 1992), measures animals' total time in locomotion and changes in mobility, along with aggressiveness towards humans. Using the handling test, Boivin et al. (1994) found that sire differences significantly influenced aggressiveness towards humans in Limousin heifers ($P < 0.05$). Le Neindre et al. (1995) estimated heritability of docility in Limousin cattle to be 0.22 using procedures similar to Boivin et al. (1992).

Crush test (Tulloh, 1961) allows for assessment of animals confined in a chute. Following Tulloh (1961), Hearnshaw and Morris (1984) reported heritability estimates for temperament of 0.03 ± 0.28 for *Bos taurus* sired calves and 0.46 ± 0.37 for *Bos indicus* sired calves. Grignard et al. (2001) evaluated temperament in Limousin heifers using both docility test (similar to Le Neindre et al., 1995) and crush, and found sire effect was significant for both tests ($P < 0.05$), and heifer responses to docility test were significantly correlated with their responses to crush test ($P < 0.001$). Overall, results indicated a general reaction of beef cattle to handling by humans, which was influenced by sire (Grignard et al., 2001).

Beef Improvement Federation (**BIF**) guidelines describe a temperament scoring system (BIF, 2002) adapted by breed associations for genetic evaluation of docility in cattle. Although subjective, BIF guidelines (BIF, 2002) used to allocate docility score encompass many aspects illustrated in other tests. Several of these factors include general behavior when restrained in a chute (i.e., crush test, Tulloh, 1961), rate at which a calf exits the chute (e.g., slow vs. fast), vocalization (Watts et al., 2001), and aggressiveness towards humans (i.e., docility test; social separation test, Müller and von Keyserlingk, 2006; handling test, Boivin et al., 1992).

Docility EPD

Docility expected progeny differences (**EPD**) reflects the probability that the offspring will inherit genes for acceptable behavior, with a greater docility EPD associated with progeny exhibiting calmer behavior.

Limousin cattle have long been known for their ability to efficiently convert feed to lean muscle. On the flip side, they are also known as a breed with a less than desirable disposition. In the early 90's the North American Limousin Foundation (**NALF**) identified improving disposition as their number one breed priority (Hyde, 2004). A temperament scoring system (BIF, 2002) was adapted by producers and in 1998 the NALF became the industry's first breed to implement docility (**DOC**) EPD in their national genetic evaluation (Hyde, 2004). In the spring of 2008 the American Angus Association (**AAA**) released a docility EPD sire listing with their National Cattle Evaluation (Northcutt, 2007).

Basic assessment of the level of aggressiveness is determined while calves are in a chute at weaning or yearling (NALF or AAA, respectively). Individuals with scores of 1 or 2 are considered docile or mildly restless, and were handled with little trouble. A score of 3, defined as the typical (average) temperament, is assigned if the animal is nervous, impatient or exhibits a moderate amount of struggle. Animals scored 4, 5 or 6 (flighty to very aggressive) are jumpy, out of control, and may exhibit attack behavior when handled individually. The three latter scores comprise animals which possess unacceptable behavior. A detailed description of the scores used by breeders to categorize temperament are in Table 1.

Expected progeny differences for threshold traits such as docility, calving ease, and heifer pregnancy are reported as probabilities, unlike continuous traits such as weaning weight EPD which is reported in pounds of calf. Interpreting differences between animals for temperament using their docility EPDs can be very challenging. An explanation for differences in sires' docility EPDs is illustrated in Table 2.

Odie is shown to have a docility EPD of +20% and Rowdy an EPD of -15% with a difference of 35%. On average, assuming bulls are mated to comparable females, we would expect 35% more of Odie's calves to posses genes for docile temperament compared with calves sired by Rowdy.

Current Methodology of Genetic Evaluation

Docility is analyzed as a threshold trait due to its categorical nature. A threshold analysis assumes that the trait of interest (observed categorial trait) is influenced by an underlying variable (not observed) that follows a normal distribution such that when the unobservable normal variable crosses a threshold it causes a change in the observable character (Gianola and Foulley, 1983). An example would be the relationship between marbling score and quality grade. Although marbling score is observable in this example, when it reaches a certain threshold level, quality grade (the categorical trait) changes. A maximum *a posteriori* probit threshold model is used to generate genetic predictions of docility on the underlying scale which are transformed to an observable scale, expressed as deviations from a 50% probability (Kuehn et al., 1998).

The genetic evaluation of docility in Limousin cattle currently utilizes a single trait, single component threshold model with random direct genetic and residual effects, along with fixed effects of weaning contemporary group and sex. The direct genetic component accounts for the effect an individuals genes have on its own performance (observed docility). Prior to analysis, observed scores are truncated into 3 groups; 1; 2; and scores of 3, 4, 5, and 6 are truncated to form group 3. Evaluation of docility in Angus cattle also employs a single trait threshold model with random direct genetic and residual effects, and fixed effects of yearling contemporary group, age of dam, and a linear covariate of calf age (Northcutt, 2007). Instead of 3 categories, AAA uses four categories for scores 1; 2; 3; and a fourth category comprising scores 4, 5, and 6 (Northcutt, 2007). Heritability of docility used by NALF and AAA for genetic evaluation are 0.40 and 0.37, respectively.

These heritabilities of direct genetic effects of docility are similar to the estimate of 0.34 ± 0.01 reported by Beckman et al. (2007) and an un-weighted average (0.36) of various measurements of temperament reported by Burrow (1997), and higher than the estimate of 0.22 in Limousin cattle reported by Le Neindre et al. (1995).

Maternal or Sire by Herd Interaction Effects on Docility in Limousin Cattle

Maternal genetic effects account for genes in the dam that influence the phenotype of her offspring through the environment she provides her calf. Recent work examining maternal effects on docility in Limousin cattle (Beckman et al., 2007) showed a model containing maternal effects fit significantly better than a reduced model with direct genetic and residual random effects. A negative direct-maternal correlation estimate of -0.55 ± 0.09 suggested sires' with genes that result in docile daughters will tend to produce grand progeny with unfavorable temperaments.

Negative estimates of direct-maternal correlations observed in weaning weight in beef cattle have been attributed to sire by herd (**SH**) (Notter et al., 1992) or sire by year (**SY**) (Robinson, 1996; Lee and Pollak, 1997) interactions. Variation in the relative performance of sires across herds contributes to SH interaction. Using simulated weaning weight data, Robinson (1996) found SY effects explained 6% of phenotypic variation, and produced negative direct-maternal correlation estimates of approximately -0.5 when ignored. Lee and Pollak (1997) reported SY interaction represented only 3% of phenotypic variance but explained 62% of the covariance between direct and maternal genetic effects in weaning weight of Simmental cattle.

Similar to Notter et al. (1992), additional analysis of docility was conducted (Beckman and Garrick, 2007) to assess the strong negative relationship between direct and maternal genetic effects reported by Beckman et al. (2007). Models incorporating SH interaction as a random effect revealed the interaction was a significant source of variation. These models assumed homogeneous variance of residuals, which may be inappropriate considering a skewed distribution of scores within the data (Beckman et al., 2007).

Significance of maternal and SH interaction effects inferred by previous research were determined to be an artifact of the data (Beckman and Garrick, 2007). Most of the heterogeneous variance observed in docility was due to herd effects, resulting from the subjective method used to allocate scores. Breeders are not obligated to report all performance information on each individual within the herd. Consequently, animals' allocated scores for unacceptable temperament are typically not registered.

Although a moderate direct heritability estimate (0.34 ± 0.01) reported by Beckman et al. (2007) indicated selection of cattle with favorable docility scores would be effective in producing cattle with desirable temperaments, not accounting for heterogeneous variance associated with herd effects may greatly reduce selection efficiency.

To determine whether the heterogeneous variance of docility scores is Limousin cattle resulting from herd effects stems from the subjective method used to allocate scores, animals were assigned to a low or high variance cluster according to phenotypic variation estimated within-herd (Beckman and Garrick, 2008). Results indicated variance of docility scores between herds is not homogenous, and is due to the subjective nature of scoring. Although the source of heterogenous variance has been isolated, reporting a low DOC and high DOC EPD is not practical. Further research is necessary to determine appropriate methodology for reporting a single DOC EPD that accounts for heterogeneous variance due to herd effects.

Conclusions and Implications to genetic improvement of beef cattle

The dramatic increase in cost of feed and fuel in recent years has forced cattle producers to tighten their belts once again, while igniting the quest of identifying the most efficient beef animal. Efficiency, defined as achieving maximum productivity with minimum wasted effort or expense, describes an animal that requires little input (i.e., cost) while generating maximum returns (i.e., profit). A clear economic advantage of docile cattle compared to aggressive cattle has been demonstrated in the literature. Docile beef cattle gain more efficiently, harvest more desirable carcasses, and are easier to handle than aggressive cattle.

The scoring system defined by BIF guidelines reflects typical, everyday handling practices of cattle producers, while also being simple and inexpensive to implement. Considering labor and equipment necessary for other methods discussed, the BIF system would likely be more effective for influencing temperament. Additionally, literature estimates of direct heritability of docility in which these scoring systems have been implemented suggests that selecting cattle with more favorable docility scores would be effective in producing cattle with more acceptable temperaments.

Given the benefits associated with docile cattle, and with access to affordable tools such as temperament scoring and docility EPD, why tolerate wild cattle? Perhaps the gap between researchers (scholastic and breed association alike) and cattle producers is larger than most would like to admit. The majority of producers have finally become comfortable with birth weight, weaning weight, and yearling weight EPDs, but traits reported on a percentage basis such as docility, heifer pregnancy, and stayability prove to be far more challenging to understand, let alone use as tools in their breeding programs.

Certainly the application of these tools will require producer education efforts by both extension personnel and breed associations, but it is an endeavor that is worth while from a breed improvement and an economic standpoint.

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Table 1. Temperament scoring system

Docility Score	Description
1. Docile	mild disposition, gentle and easily handled, stands and moves slowly during processing, undisturbed, settled, somewhat dull, does not pull on head-gate when in chute, exits chute calmly
2. Restless	quieter than average but slightly restless, may be stubborn during processing, may try to back out of chute, pulls back on head-gate, some flicking of tail, exits chute promptly
3. Nervous	typical temperament, manageable but nervous and impatient, a moderate amount of struggling, movement and tail flicking, repeated pushing and pulling on head-gate, exits chute briskly
4. Flighty (wild)	jumpy and out of control, quivers and struggles violently, may bellow and froth at mouth, continuous tail flicking, defecates and urinates during processing, frantically runs fence-line and may jump when penned individually, exits chute wildly
5. Aggressive	similar to score 4 but with added aggressive behavior, fearful, extreme agitation, continuous movement which may include jumping and bellowing while in chute, exits chute frantically, may exhibit attack behavior when handled alone
6. Very Aggressive	extremely aggressive temperament, “killers”, pronounced attack behavior

Table 2. Docility EPD Sire Comparison Example

Sire	*Docility EPD*
Odie	+ 20
Rowdy	-15
Difference	= 35

Docility EPD reported on a percent basis