Breeding Focus 2016 – Improving Welfare

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Preface

The inaugural 'Breeding Focus' workshop was held in 2014 to outline and discuss avenues for genetic improvement of resilience. The Breeding Focus workshop was developed to provide a forum for exchange between industry and research across livestock and aquaculture industries. The objective of Breeding Focus is to cross-foster ideas and to encourage discussion between representatives from different industries because the challenges faced by individual breeding organisations are similar across species. This book accompanies the Breeding Focus 2016 workshop. The topic of this workshop is 'Breeding Focus 2016 - Improving welfare'.

> *"Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment."* (World Organisation for Animal Health 2008).

Animal breeding offers opportunities to improve the state of animals. Existing methodologies and technologies used in animal breeding can be used to improve welfare of animals on farm while maintaining productivity. Welfare and productivity are not necessarily in opposition because several welfare measures are genetically independent from productivity traits. Further, it is often economically beneficial to improve welfare traits. These aspects provide ample opportunities to improve both welfare and productivity through selective breeding.

The chapters of this book describe existing frameworks to define welfare of animals and outline examples of genetic improvement of welfare of farm animals. A reflection on ethical issues of animal breeding and welfare is presented and further avenues for genetic improvement of welfare are discussed.

We thank all authors for their contributions to this book and their presentations at the Breeding Focus 2016 workshop in Armidale. Each manuscript was subject to peer review by two referees. We thank all reviewers who generously gave their time to referee each book chapter. A special thank you goes to Kathy Dobos for looking after all details of organising this workshop and for her meticulous work on putting this book together.

Susanne Hermesch and Sonja Dominik

Armidale, September 2016.

Improving the temperament of Australian cattle and implications for animal welfare

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Abstract

Animals differ in their behavioural response to human interaction. Poor cattle temperament and the behavioural responses of cattle to handling by humans has been associated with losses in enterprise profitability. Breeders are able to improve the temperament and productivity of the herd by selecting on the cattle's behavioural response to human interaction. An increased focus on animal welfare and improved safety of handlers around cattle has brought forth a desire to breed cattle that are less fearful or stressed by human interactions, thus exhibiting a more docile temperament. The Australian beef industry uses docility score and flight time as selection traits to improve the temperament of the national herd. Both traits provide reliable and repeatable measures of temperament. The success of selection for docility in the Limousin breed has allowed seedstock breeders to produce a calmer tempered breed that was previously considered unmarketable due to being considered "stirry and difficult to manage". Genetic correlations for temperament traits with production traits are generally low and indicate that selection to improve temperament can occur without any significant negative impact on other economically important traits including growth, fat, muscle and reproduction. Selection on temperament will further improve the behavioural characteristics of cattle, improving animal welfare, whole farm productivity and handler safety.

Cattle temperament

Beef producers and others involved with handling and processing cattle are well aware that there are differences between animals in their stress and behavioural response to alarming or challenging situations when being handled, moved or milked (Haskell *et al.* 2014). The concentration of cortisol in the blood is widely used in research as an indicator of stress in animals (e.g. Mőstl and Palme 2002) and has been shown to be higher in cattle placed in stressful or novel situations (Mench *et al.* 1990, Stahringer *et al.* 1990, Bristow and Holmes 2007, Cooke *et al.* 2009, Curley *et al.* 2006). However, measuring cortisol levels can be difficult and costly especially in commercial operations. As a result, producers and researchers have explored the use of cattle temperament or behaviour as an indicator of stress in cattle. The measures of temperament are based on an inherent fear of humans and focus on measuring the behavioural response that fear invokes, with the premise that the calmer animals are less fearful, easier to handle and will be more productive (Boissy *et al.* 2005). In studies of American Brahman cross cows (Cooke *et al.* 2009) and yearling American Grey Brahman bulls (Curley *et al.* 2006), high plasma cortisol concentrations (high stress levels) were associated with higher chute exit velocities and more excitable and flighty behaviours when restrained in the chute and pen, indicating that temperament and behavioural characteristics are likely to provide an indication of the level of stress being experienced by the cattle.

Temperament has been described as the cattle's behavioural response to human interaction and incorporates behavioural demonstrations ranging from docile to fear or nervousness, non-responsiveness ("freezing"), escape or withdrawal or aggressive behaviour (Burrow 1997). Researchers and the industry have focussed on recording temperament and behavioural response of cattle when handled by humans with the aim to improve both the welfare of the cattle and those that interact with them. Consequently, the majority of scientific studies have focussed on the behavioural response of cattle when confined in the crush (Ewbank 1961, Tulloh 1961, Hearnshaw *et al.* 1979, Fordyce *et al.* 1982, Grandin 1993), when approached by humans either in yards or paddock (Murphey *et al.* 1980, Fordyce *et al.* 1982, Boivin *et al.* 1992b, Le Neindre *et al.* 1995) and during the milking procedure (O'Bleness *et al.* 1960, Arave and Kilgour 1982). Researchers have also studied behavioural traits including dominance within the herd (Brown 1974, Blackshaw *et al.* 1987) and the maternal behaviour of the cow with calf at foot (Brown 1974). Many of these temperament measures provide a reliable and repeatable measure of the stress response in cattle (Halloway and Johnston 2003) allowing for the estimation of the genetic variation and the potential for genetic selection (Haskell *et al.* 2014).

Value of docile cattle

The economic cost of poor-tempered cattle to the Australian cattle industry is poorly reported. However, anecdotal evidence suggests that commercial producers will avoid stud bulls that appear "wild" and show a strong preference for docile yard-weaned cattle when sourcing feedlot cattle. Poor temperament in cattle has been associated with higher production and labour costs, and reduced productivity (Burrow 1997). In a study of 13,000 beef calves fed across 8 North American feedlots, the poor-tempered calves were associated with lower carcase quality and yield grades, poorer growth rates, lower survival rates, increased health costs and on average returned $62.19 US per head less than the more docile calves (Busby *et al.* 2006). The cattle's temperament and response to the stress of transportation and pre-slaughter management is well reported in the Australian beef industry (Ferguson *et al.* 2001, Kadel *et al.* 2006). Cattle who respond poorly to the stresses associated with the slaughter process can deplete glycogen stores within the muscle resulting in the phenomenon of dark cutting meat and a decline in the quality and tenderness of the meat (Ferguson *et al.* 2001). During the 2012/13 financial, year 4.8% of the 2.4 million beef carcases graded by Meat Standards Australia (MSA) were deemed to be dark cutting (McGilchrist *et al.* 2014) with the penalty of dark cutting equating to a cost of about $7 per animal graded under MSA in 2009 to the producer alone (McGilchrist *et al.* 2012).

Improving cattle temperament has also been linked to favourable improvements in reproductive performance, cattle and handler safety and handling times. In a comparison of calm vs. excitable temperaments in beef cattle (based on chute exit speeds), the calmer cows had significantly better pregnancy rates (fertility), calving rates and weaning rates than their more excitable contemporaries (Cooke 2014). Temperament traits currently being used within the industry are perceived to improve both the welfare of the cattle, by reducing stress and risk of injuries, and by improving the welfare of the handler, by creating a safer workplace and reducing the time and stress associated when handling cattle (Grandin 1993).

Improving temperament through learnt behavioural change

It has been well reported in literature that cattle will habituate to handling experiences (Alam and Dobson, 1986; Stookey *et al.* 1996). Repeated and positive training or handling have been shown to improve the temperament of cattle (Hassal 1974, Fordyce *et al.* 1985). Kadel *et al.* (2006) reported a favourable change in both the flight time (increase) and docility of Australian tropical adapted cattle when handled at the start of finishing (564 days old) after previously experiencing the management procedure at post weaning (246 days old). It was hypothesised that the improved temperament was due to the cattle becoming conditioned to management and human interaction (Kadel *et al.* 2006).

Cattle become conditioned to the production environment over time resulting in behavioural change within the herd (Phillips 2008). It has been shown that dairy cattle are able to distinguish between handlers based on the treatment received (Munksgaard *et al.* 1997), suggesting a learnt behavioural response, with cattle avoiding handlers where the previous experience was poor. This can become an issue in some systems if certain handlers or stimuli (eg. same car) become associated with aversive tasks such as catching, restraining, dehorning, branding or administration of medicine (Rushen *et al.*1999). There is also some evidence, although poorly reported in literature, of social learning in cattle with cattle whom observe contemporaries being poorly treated often showing similar levels of apprehension as the affected cattle when reintroduced to the handler (Munksgaard *et al.* 2001). Consequently, with regular negative interactions the cattle and the herd will tend towards a natural fear of humans and are likely to become harder to handle (Rushen *et al.*1999).

Increasing the level of positive interaction between humans and young cattle has been shown to reduce the fearfulness of the cattle (Boivin *et al.* 1992a, b, Hemsworth *et al.* 1996). Positive human to cattle interactions include feeding, talking quietly, avoiding sudden movement, touching animal at first approach, and using natural flight zones to move stock (Grandin 1989, Rushen *et al.*1999). However, low-stress stock handling techniques are not always adhered to and cattle are almost certain to encounter novel and antagonistic stressors, especially at slaughter. There is strong evidence that noises (humans shouting and metal clanging), especially novel noises, will evoke a fear response in cattle, resulting in increased heart rate and movement (Waynert *et al.* 1999). It could be hypothesised that if cattle, or their contemporaries, have not experienced these stressors before, then the natural response will be increased stress and behavioural responses including nervousness, non-responsiveness ("freezing"), escape and aggression.

Therefore, whilst producers should aim to follow the practices of low-stress stock handling (Grandin 1989), they should also endeavour to allow cattle to experience stressors that are known to occur during transportation and slaughter. In conjunction with adjusting management practices, breeders can improve the innate temperament of the herd by selecting on the cattle's response to human interaction as part of a focussed breeding program (Fordyce *et al.* 1988, Burrow 1997, Haskell *et al.* 2014).

Breeding to improve the temperament of Australian Cattle

Measuring temperament in Australian Cattle

Docility Score

Docility score is a subjective measure of the wildness of the cattle based on the animals response to human interaction (approach) when unrestrained (Murphey *et al.* 1980, Fordyce *et al.* 1982, Boivin *et al.* 1992b, Le Neindre *et al.* 1995) or when held in a crush, chute or yard (Ewbank 1961, Tulloh 1961, Hearnshaw *et al.* 1979, Fordyce *et al.* 1982, Grandin 1993). Docility is scored in categories from 1 to 5 where 1 represents the quiet and 5 the extremely nervous, anxious or aggressive animals (Tulloh 1961, Hearnshaw *et al.* 1979). The current scoring of docility, which is part of the national beef cattle genetic evaluation in Australia by BREEDPLAN (Johnston *et al.* 1999), is based on the original 1 to 5 scoring system published by Tulloh (1961). This scoring system has since been adjusted to suit mass distribution within seedstock breeders with producers scoring cattle to the nearest half score based on the behaviour of the cattle when held unrestrained in a crush (Table 1). Producers are recommended to score docility at weaning or shortly afterwards so as to measure the inherited docility and avoid the influence of handling experience.

Just over 200k docility score records have been submitted by Australian seedstock producers to BREEDPLAN for genetic evaluation, from 11 breeds (Table 2). Limousin seedstock producers have provided 80k docility scores to BREEDPLAN for genetic evaluation (Table 2) with the docility estimated breeding value (EBVs) made available to seedstock producers in 2000. Aside from the Australian Limousin Breeder Society, the Australian Angus Society and their seedstock producers have been the major contributor of docility score records with just under 90k records provided since 2000, enabling genetic evaluation and in turn the publishing of trial estimated breeding values (EBVs) in 2013.

Table 1: Criteria for scoring docility (wildness) of cattle when restrained in a crush.

Score	Description	Behaviour
1	Docile	Settled, somewhat dull, exits crush calmly.
2	Restless	Quieter than average but slightly restless, stubborn during handling, may try to back out of crush, some flicking of tail, exits crush promptly.
3	Nervous	Nervous and impatient, a moderate amount of struggling, movement and tail flicking, repeated pushing and pulling on headgate, exits crush 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 handling.
5	Aggressive	May be similar to Score 4 but with added aggressive behaviour, fearful, extreme agitation, continuous movement which may include jumping and bellowing while in crush, exits crush frantically and may try to attack through the crush.

Table 2: Summary of docility score and flight time records provided to BREEDPLAN by seedstock producers as of December 2015 for Northern and Southern cattle breeds.

	Docility Score		Flight Time	
Breed	Records	EBVs	Records	EBVs
Northern tropical cattle				
Brahman	2,091	-	7,602	Yes
Belmont Red	4,190	-	17,111	Yes
Santa Gertrudis	2,505	-	18,466	Yes
Southern temperate cattle				
Charolais	416	-	1,013	-
Simmental	17,217	-	-	-
Limousin	79,640	Yes	400	-
Murray Grey	121	-	68	-
Hereford	11,499	-	211	-
Angus	87,939	Yes	486	-
Shorthorn	5,873	-	-	-

Flight time

Along with docility score, flight time or flight speed is a behavioural trait currently being used for genetic evaluation of Australian cattle by BREEDPLAN. Flight time was originally used in northern Australian cattle by Burrow *et al.* (1988) and has since been a popular trait in northern Australia and elsewhere (Haskell *et al.* 2014). Flight time provides an objective measure of cattle behaviour and refers to the time taken for the cattle to exit down a runway after being released from a chute (Figure 1, Burrow *et al.* 1988). The flight time of the animal is then presented as the time taken to travel an approximate distance of 2 meters as per BREEDPLAN guidelines (http://breedplan.une.edu.au/). Calves should be scored at weaning or shortly afterwards, avoiding the influence of handling experience.

Flight time is the preferred behaviour trait in Northern Australia and is preferred of docility score due to the extensive nature of the production systems resulting in the cattle having a "wilder" temperament. The flight time measure have been preferred by many due to the objective nature of the trait, which requires very little training and avoids issues with consistency of scoring between recorders. Sufficient numbers of flight time records have allowed the publishing of flight time EBVs for Brahman, Belmont Red and Santa Gertrudis since the early 2010s.

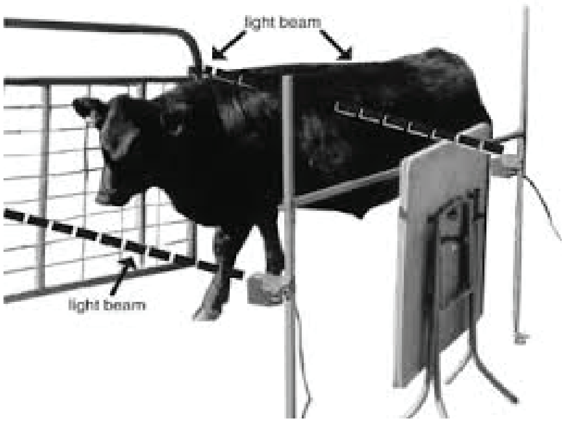

Figure 1: Flight time is the electrically recorded time taken for an animal to cover a distance between of 2.0m after leaving the weighing crush (image source: Beef CRC)

Genetic variation in temperament

Heritability estimates for docility score across cattle breeds and studies have ranged from 0.03 to 0.46 (Hearnshaw and Morris 1984, Le Neindre *et al.* 1995, Burrow and Corbet 1999, Tier *et al.* 2001, Halloway and Johnston 2003, Phocas *et al.* 2006, Kadel *et al.* 2006, Beckman *et al.* 2007, Hoppe *et al.* 2010). Studies by Tier *et al.* (2001) and Walkom *et al.* (2016) which reported the genetic evaluation for BREEDPLAN, have favoured the use of threshold models (Gianola and Foulley 1983) and observed slightly higher heritability estimates than previous literature estimates using linear models. The threshold models were preferred for genetic evaluation of docility score due the categorical nature of the trait where the phenotypes are not continuously distributed but scored within ordered categories. The heritability of docility score from Australian seedstock Angus has been estimated at 0.21 with an estimate of 0.39 for Australian seedstock Limousin cattle (Walkom *et al.* 2016). The heritability estimates for flight time ranged from 0.09 to 0.13 in Angus (Halloway and Johnston 2003) and from 0.28 to 0.40 in tropical and tropically adapted beef breeds (Burrow *et al.* 2001, Johnston *et al.* 2003, Kadel *et al.* 2006, Corbet *et al.* 2013).

Behavioural characteristics in livestock are either innate or a learned behaviour either from the dam, siblings or herd mates (Burrow 1997). Fordyce and Goddard (1984) suggested that cows have a non-genetic influence on the behaviour of their offspring that persists until offspring are mature. In a study of Australian Angus and Limousin cattle by Walkom *et al.* (2016) they were unable to estimate either a maternal genetic or maternal permanent environment effect for docility score, citing a lack of information on the docility of the dam or the dam's influence on the maternal environment faced by the calf within the industry data. Very few studies have been able to estimate maternal heritability for temperament with Beckman *et al.* (2007) and Prayaga and Henshall (2005) reporting small maternal effects for docility score (0.01 to 0.05) and flight time (0.00 to 0.03), respectively. As recording of temperament traits and information on the dam and maternal environment increases within the industry, it is likely that the influence of the maternal genetic and non-genetic effects should become clearer and estimatable.

Genetic correlations between temperament measurements at 246 days and 564 days of age in Australian tropical cattle were high for both docility (0.96) and flight time (0.98) (Kadel *et al.* 2006), indicating that temperament is moderate to highly repeatable across time. Repeatability estimates in cattle have ranged from moderate to high (Petherick *et al.* 2002, Johnston *et al.* 2003, Kadel *et al.* 2006). In summary, both flight time and docility score have been shown to be moderately heritable and repeatable indication that there is genetic variation in the behaviour of cattle and that selection provides the potential for improvement.

Genetic relationships between temperament and production

The phenotypic and genetic relationships between temperament and growth vary in both magnitude and direction across breeds, production systems and the trait used to measure temperament (docility score vs. flight time) (Burrow 2001, Phocas *et al.* 2006, Haskell *et al.* 2014). The genetic correlation between growth (200 and 400 day weight) and docility has been reported to be low and favourable (more docile = increased growth) in Australian Angus and Limousin cattle, ranging from -0.15 to -0.27 (Walkom *et al.* 2016). Weak favourable correlations between docility score and growth have been estimated in French Limousin (Phocas *et al.* 2006) and German cattle (Hoppe *et al.* 2010) but were associated with high standard errors due to the small number of animals in the trials. The genetic relationship between flight time and growth has been reported to be weak but favourable. Johnston *et al.* (2003) reported a low genetic correlation between weaning weight and flight time of -0.10 in feedlot finished tropically adapted beef cattle. However, Burrow (2001), and Prayaga and Henshall (2005) found the genetic correlations between weight and flight time in northern Australian cattle to not be significantly different from zero.

Fordyce *et al.* (1988) and Walkom *et al.* (2016) reported no phenotypic relationship between fat depth and temperament in Australian Brahman cross, Angus and Limousin cattle. Genetic correlations between docility score, and scan fat and muscle depth are poorly reported within literature. Walkom *et al.* (2016) presented low to moderate negative correlations indicating a lower docility score was associated with increased rump fat (-0.14 to -0.02), rib fat (-0.07 to 0.04) and eye muscle area (-0.22 to -0.02). A study of Canadian *Bos taurus* bulls found moderate to strong positive genetic correlations for flight speed with ultrasound back fat (0.36) and eye muscle area (0.81) (Nkrumah *et al.* 2007). Flight time has also been reported to be positively (favourable) correlated with rump fat in Brahman bulls (0.25) but negatively correlated in tropical composite bulls (-0.21) (Corbet *et al.* 2013). Barwick *et al.* (2009) reported weak genetic correlations in Australian tropical adapted steers for flight time with scan rib fat depth (0.10), scan rump fat depth (0.10), scan eye muscle area (-0.05) and scan intramuscular fat (0.15).

In Australian tropically adapted cattle, flight time has been genetically associated with tenderness, with animals identified as having a desirable temperament tending to produce progeny with more tender meat (Wolcott *et al.* 2009). Genetic correlations between flight time and shear force of the loin in tropical beef cattle range from -0.15 (Wolcott *et al.* 2009) to -0.42 (Kadel *et al.* 2006). Kadel *et al.* (2006) reported a moderate positive correlations between docility score and shear force of 0.39, indicating that the more docile animals were associated with greater tenderness.

The genetic relationship between temperament and reproduction has been reported in literature to be low (Burrow 2001, Phocas *et al.* 2006, Corbet *et al.* 2013, Walkom *et al.* 2016). The genetic correlation between docility score and gestation length was reported as very weak to negligible in Australian Angus and Limousin (Walkom *et al.* 2016). Days to calving (trait of cow, days from bull entry date to calving date) has been reported to be lowly unfavourably correlated (0.15) with flight time in composite tropical beef cattle (Burrow 2001). In the study of French Limousin heifers, Phocas *et al.* (2006) reported low to moderate favourable genetic correlations for docility score with age of puberty and fertility. A low negative genetic correlation between docility score and scrotal circumference was observed for Australian Angus and Limousin cattle with increased scrotal size associated with more docile cattle (Walkom *et al.* 2016). Corbet *et al.* (2013) reported that the genetic correlation between scrotal circumference at different ages and flight time in Brahman and tropical composite bulls ranged from 0.07 to 0.39 in tropical composite bulls.

In summary, weak but favourable genetic correlations between temperament traits with growth, fat, muscle and reproduction traits indicates that cattle temperament is largely independent of these traits and that selection to improve temperament can occur without any impact on other economically important traits including growth, fat, muscle and reproduction.

Breeding for a calmer temperament in Limousin cattle – case study

Docility score was first recorded in Limousin cattle in 1995 in response to anecdotal evidence from commercial breeders using Limousin bulls, cartage contractors and livestock agents that Limousin progeny were often “stirry and difficult to manage” which in turn was affecting the marketability of the breed (pers. comms. Alex McDonald; Agricultural Business Research Institute). The docility EBV is now considered by many Limousin buyers as the most important piece of information they can get on young bulls. Docility score is scored on a scale from 1 (quiet or docile) to 5 (nervous, anxious or aggressive). Therefore, docility score is effectively measuring the prevalence of 'wild' behavioural characteristics expressed by the animal when approached. However, in BREEDPLAN the docility EBV is presented as the animal's docility, and is expressed as the differences in the percentage of progeny that will be scored with acceptable temperament (docility score 1) compared to the breed average. This means that as producers select for a higher docility EBV (more docile animals) they should observe a gradual decline in the prevalence of 'wild' behaviours within the herd, resulting in a decline in docility scores greater than 1 within the herd.

The breed-wide recording and selection on docility scores has resulted in improved docility of the national Limousin herd, from 2003 to 2013, achieving an average annual improvement of +1.89 in the docility EBV (Walkom *et al.* 2016). The genetic improvement in the Limousin breed is supported by the mean docility score of Limousin docility records, submitted to BREEDPLAN, declining by 0.5 scores over the same period (Figure 2) along with a the proportion of docility scores of 2+ being submitted declining from 59% to 34 % (Walkom *et al.* 2016). The success of the genetic selection for docility in Limousin cattle has been driven by the Limousin seedstock breeder's readiness to record phenotypes and select against poor temperament.

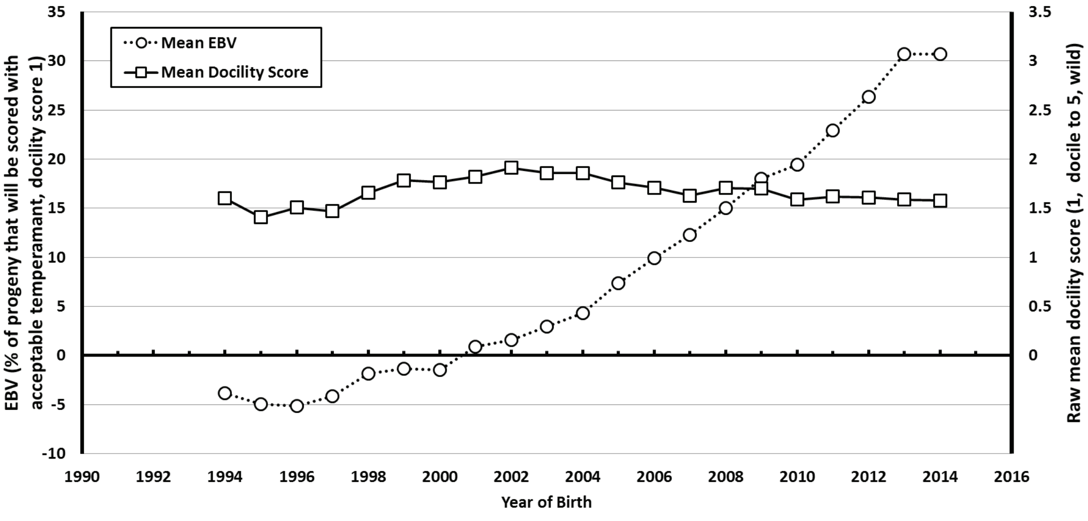

Figure 2: Genetic trend in average estimated breeding value (EBV) of docility (percentage of progeny that will be scored with acceptable docility, circles with dashed line) and the mean docility score (1, docile to 5, wild) record (squares with solid line) by year of birth for Limousin cattle (Walkom et al. 2016).

Impact of selecting on temperament for cattle welfare

The consumer's concerns about livestock welfare primarily focus around three broad questions 1) is the animal functioning well, 2) is the animal feeling well, and 3) is the animal able to live a reasonably natural life (Fraser *et al.* 1997, Von Keyserlingk *et al.* 2009). The World Organization for Animal Health defines the animals as exhibiting good animal welfare if they are "healthy, comfortable, well nourished, safe, able to express innate behaviour, and not suffering from unpleasant states such as pain, fear and distress (World Organization for Animal Health, 2008). Measuring welfare in livestock species involves measuring the animal's harmony with the environment, the animal's ability to perform genetically pre-disposed behaviours and the animal's feelings (Phillips 2008). When the welfare of the animal is considered poor due to the impairment of biological fitness, animal welfare can be measured by focussing on changes in productivity, health status, and reduced reproductive success and longevity (Broom 1991).

However, many consumers focus on the affective (emotional) state of the animal, in particular suffering from unpleasant feelings, such as pain, fear or hunger, or positive feelings such as those associated with play (Von Keyserlingk *et al.* 2009). Animals have been described as sentient creatures and yet there is no exact knowledge of what animal emotional experiences are about (Boissy *et al.* 2007) making it difficult to quantify the affective state or feelings of the animal. Boissy *et al.* (2007) suggests that measuring feelings, whilst difficult, is primarily associated with the presence of positive emotions in particular play behaviours, self-grooming, vocalisation, information gathering and affiliative behaviours. However, temperament traits can be used as an indication of the animal's coping style or fearfulness (Boissy *et al.* 2007), providing a quantifiable measure of behaviour (Burrow 1997) that has been associated with the cattle's physiological responses to stress (Cooke *et al.* 2009, Curley *et al.* 2014). Thus, the temperament of the animal provides a descriptor of the animal's welfare.

Through the domestication process humans have selected for cattle to be productive in a production environment very different from the environment in which they originally flourished (Phillips 2008). As part of this process the temperament of the cattle has been adjusted by removing the innate fearfulness of the cattle to human (Boissy *et al.*2005), making the cattle easier to handle and reducing the risk of injury to the cattle and handler. It should be noted that quiet animals may not always be coping with the environment, as cattle are often reluctant to attract attention through excessive vocalisation (Phillips 2008). Consequently, just because a herd of cattle is 'quiet' or 'calm' the welfare of the cattle may not be morally justified, especially if their biological fitness is hindered resulting in poor productivity or reproductive longevity. Selection for calm tempered cattle has a perceived value in improving productivity, especially in regards to the welfare of the handler by improving safety and reducing the time associated with moving and managing cattle (Grandin 1989, Grandin 1993). However, is it ethical for cattle to be bred to suit an environment that the consumer would consider to be far from their natural environment even if the animals seem content?

This also brings forth the question is it ethical to adjust the behavioural characteristics of the animal to meet production demands even if this leads to changes to the innate behavioural characteristics of the bull, the protective nature of cows with calf at foot, the herding nature of cattle in response to predators or the maternal bonding between cow and calf? For example, selection for docility in cows will also reduce fearfulness in the cows and could soften their innate desire to protect their calves from predators (including humans). The impact of reducing the innate fearfulness of the cattle on other behavioural characteristics is poorly reported in literature and research is required to expand upon current anecdotal evidence.

Summary

The welfare and temperament of cattle can be improved through positive interactions with handlers and exposure to potential stressors. An increased focus on animal welfare and improving the safety of handlers around cattle has brought forth a desire to breed for cattle that are less fearful or stressed by human interactions and thus exhibit a more docile temperament. Docility score and flight time provide reliable, repeatable and heritable measures of temperament. The success of the docility EBV in the Limousin breed has brought forth an increased level of recording within both the Limousin breed and other breeds. The increase in records will assist in partitioning the learned, maternal and innate variation in the animals' behavioural characteristics and will result in improvements in the current genetic evaluation. This may also bring forth the use of multi-trait selection to improve temperament. However, the weak but favourable genetic correlations between temperament traits with growth, fat, muscle and reproduction traits indicate that cattle temperament is largely independent of these traits and the gains from multi-trait selection are likely to be minimal unless temperament is part of the breeding objective and is recorded on farms. Breeding for more docile animals will result in inherent behavioural change in the cattle herd and improved animal welfare and handler safety.

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