Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science

New Registrations in Swedish Beef Cattle Breeding - with focus on temperament and cow weight

Linn Broström

Examensarbete / Swedish University of Agricultural Sciences
Department of Animal Breeding and Genetics
418
Uppsala 2013

Master Thesis, 30 hp

Agriculture Programme
– Animal Science

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Breeding and Genetics

New Registrations in Swedish Beef Cattle Breeding - with focus on temperament and cow weight

Nya registreringar för avel hos de svenska köttdjursraserna - med fokus på temperament och vuxenvikt

Linn Broström

Supervisor:
Anna Näsholm, SLU, Department of Animal Breeding and Genetics
Helena Nordström Källström, SLU, Department of Urban and Rural Development

Examiner:
Lotta Rydhmer, SLU, Department of Animal Breeding and Genetics

Credits: 30 hp
Course title: Degree project in Animal Science
Course code: EX0558
Programme: Agriculture Programme – Animal Science
Level: Advanced, A2E

Place of publication: Uppsala
Year of publication: 2013
Cover picture: Linn Broström
Name of series: Examensarbete / Swedish University of Agricultural Sciences, Department of Animal Breeding and Genetics, 418
On-line publicering: http://epsilon.slu.se

Nyckelord: köttras, avel, temperament, vuxenvikt
Key words: beef breed, breeding, temperament, docility, mature cow weight

Abstract

In today's genetic evaluation of Swedish beef cattle, mainly traits that are directly related to productivity are measured. However, other traits, such as temperament and mature cow weight affect the economy of the farmer, as well as the welfare of the animals. This thesis evaluates possible ways of measuring new traits, with focus on temperament and mature weight of suckler cows. The goal is to examine the possible benefits of including these traits in the Swedish breeding scheme. To achieve this, studies of literature, analyses of data and qualitative interviews with farmers have been conducted. Analyses of literature and data showed that recordings of temperament and mature weight can be performed during Swedish conditions. Data of Swedish farms showed that temperament scores were affected by breed, year and season, with the highest number of inferior temperament scores recorded around calving. Mature cow weights for Angus, Simmental and crossbreds were 700 to 820 kg, which is higher than figures stated in international literature. Effects of breed could not be observed for cow weight, which is contrary to findings in literature. To achieve a higher interest for breeding values, it is suggested to include new recordings, such as temperament, longevity and fertility, since it would capture the interests of the farmers and their breeding goals better. By including temperament during handling and aggressive behaviour around calving in the genetic evaluation, the safety for workers, animal welfare, productivity and economics at the Swedish farms could be improved. It is however not recommended to include mature cow weight in the genetic evaluation at present, due to lack of interest and thereof given benefits by inclusion of the trait. Although, the knowledge of the cows' weights amongst farmers needs to be improved. In the future, this new information could be used to improve the Swedish beef recording scheme for a more efficient production.

Sammanfattning

I dagens avelvärdering för de svenska köttraserna är det endast egenskaper direkt relaterade till produktiviteten som registreras. Det finns däremot andra egenskaper, såsom temperament och vuxenvikt, som påverkar ekonomin för lantbrukaren så väl som djurvälfärden. Den här studien utvärderar möjliga tillvägagångsätt för att mäta nya egenskaper, med fokus på temperament och vuxenvikt hos dikor. Målet är att undersöka möjligheterna med att inkludera dessa egenskaper i den svenska avelsvärderingen. För att uppnå detta har litteraturstudier, analyser av data och kvalitativa intervjuer med svenska lantbrukare genomförts. Litteraturstudien och dataanalyserna visade att registreringar av temperament och vuxenvikt är möjliga att genomföra under svenska förhållanden. Data från svenska gårdar visade att temperament påverkas av ras, år och säsong, med den högsta andelen ofördelaktigt temperament registrerat kring kalvningar. Vuxenvikter för Angus, Simmental och korsningar låg mellan 700 och 820 kg, vilket är högre än värden angivna i internationell litteratur. Ingen raseffekt kunde ses för kovikt, vilket motsätter uppgifter givna i litteratur. För att skapa ett större intresse för avelsvärden föreslås att nya registreringar såsom temperament, hållbarhet och fertilitet inkluderas, detta eftersom lantbrukarnas intressen och avelsmål då fångas upp bättre. Genom att ta med hanterbarhet och aggressivitet vid kalvning i avelvärderingen så kan riskerna i arbetet minskas, samt djurvälfärden, produktiviteten och ekonomin på de svenska gårdarna förbättras. Det rekommenderas däremot inte att inkludera vuxenvikt i avelsvärderingen i dagsläget, detta på grund av bristande intresse och därav givna fördelar med att införa egenskapen. Kunskapen om kornas vuxenvikter är dock något som bör förbättras hos lantbrukarna. I framtiden skulle den nya informationen kunna användas för att förbättra avelvärderingen för de svenska köttraserna och därigenom ge en mer effektiv produktion.

Preface

As a little child I grew up watching dairy farms in Sweden close due to a major shift in the agricultural subsidies. Our family, like many others, instead began breeding for beef production. Discussions in my early life, about which animals to keep as breeding stock for the next season, made my interest for breeding and selection grow. Inheritance and animal behaviour has since then always fascinated me, as it became obvious to me watching different maternal and paternal lines growing up, that the importance of a successful breeding programme for a functional production can never be underestimated.

The depth of this work would not have been possible without the farmers that with devoted interest shared their knowledge and life-time experiences during the interviews. Also, Helena Stenberg at Taurus familiarity in practical breeding has helped bringing clarity in the matter. I would like to thank them for their time, recognizing that without their interest the content of this work would not have been as profound.

I would also like to thank my supervisors professor Anna Näsholm and Ph.D. Agronomy Helena Nordström Källström for their dedication and support. Anna Näsholm has with her positive words given me more knowledge in beef breeding and made my progress possible. Helena has through her guidance in the forest of interviewing techniques given me a lifelong interest for the information that can become available through qualitative studies. I would also like to thank my examiner professor Lotta Rydhmer for the good advices.

The farmers sharing data used for the statistical analysis could not be thanked enough, making it possible to complete the work with figures recorded at Swedish conditions, as well as the department of animal breeding and genetics that through their finance made the travels to the farms possible.

In addition, I would like to thank my family and friends, who during the most intensive time of the report have supported me unconditionally.

I hope my work can contribute with new aspects to further enhance the breeding for a sustainable and profitable beef production in Sweden.

Uppsala in June 2013
Linn Broström

Table of content

Introduction

Background

The first beef breed was introduced to Sweden during the 1930s, with a great increase in breeds and numbers during the second half of the 20th century (Lärn-Nilsson, 2006). It has since then reached a total size of 180 000 suckler cows in 2011, where most of them are crossbreds (Jordbruksverket, 2013). The population size for purebred suckler cows was about 12 000 cows in 2011, dispersed over seven common breeds and a few rare breeds (Svensk Mjölk, 2012a). There are about 800 active breeding herds in Sweden (Widebeck, 2012, personal communication), and about 15 000 farms that have beef production (Jordbruksverket, 2012). Since early on, focus in beef production has been on the payment of the slaughter houses; giving payments according to amount of meat, conformation and fat class (Taurus, 2012a). This has led to today's breeding values for Swedish beef cattle to include mainly traits directly related to productivity, such as growth, carcass and calving ability. In the 1970s, a farm had on average ten suckler cows in the Swedish beef recording, KAP (Svensk Mjölk, 2012a). Today a farm has on average 25 suckler cows. As the farms grow bigger, the interest and need for improving additional traits connected to production have increased.

Temperament and weight of suckler cows affect the economy of the farmer as well as the welfare of the animals (Golden et al., 2000; Grandin, 1989). Temperament is a heritable trait, seen to have impact on production traits such as growth ability, feed conversion and meat quality (Café et al., 2011). A cow with bad temperament further proposes a safety risk for the farmer and increases the work load (Grandin, 1989). Mature cow weight, on the other hand, is a factor that many farmers overlook today (Evans et al., 2002), but it has great impact on feed costs (Golden et al., 2000) and required measurements of stable (SJVFS 2010:15 Saknr L100). Cows with a heavier live weight do not necessarily lead to a better economy for the farmer, however the trait is positively correlated to growth traits that are included in the selection index today (Marshall et al., 1984; Stenberg, 2008). This proposes risks that mature cow weight of the Swedish suckler cows have increased, and without knowing how much the increase is, above the most economical weight. Temperament and mature cow weight are already included in beef recording schemes of various countries (Hyde, 2010; Evans et al., 2009). In Sweden, many breed associations have temperament and cow size in their breeding goals (Alarik & Hansson, 2009), however these goals are often unspecified and not accounted for by the breeding values.

Consequently, an interest for evaluating the possibility to include new traits, such as temperament and mature cow weight, in the breeding scheme of Swedish beef cattle has been developed. Including these traits on a national level could lead to faster progress within the area. However, it is important to investigate the possibilities and limitations already given in literature and in available data from Swedish herds, due to the extra time and expenses to record additional traits. Additionally, Swedish farmers' interest for introducing additional traits needs to be explored, in order to know which changes that are applicable for Swedish conditions.

Objectives of study

The aim of this thesis is to look into and evaluate possible ways of recording new traits in the Swedish beef cattle breeding, with focus on the future prospects to add temperament and cow weight. This will be achieved by; studying literature and homepages of breeding organisations to see how these traits are measured and recorded in various beef breeds today, evaluating these methods and suggesting improvements related to the Swedish market. Additionally data from Swedish herds will be analysed and farmers involved in breeding work will be interviewed to broaden the viewpoints of limitations and possibilities due to Swedish conditions. The goal is to examine the possible benefits of including additional traits in the breeding scheme of Swedish beef cattle.

Literature review

Breeding goals

The breeding goals are set by the breeding organisations for each breed (Alarik & Hansson, 2009). In general the goals consists of calving ability, calf viability, milk production, growth, carcass traits, longevity, fertility, temperament and cow live weight. Cow live weight had, during a survey performed by Fjelkner in 2003, a low priority amongst the breeders for all breeds whilst temperament had a high priority especially for Charolais and Limousin breeders.

Registrations in Swedish beef cattle breeding

Sweden has a tradition of monitoring and reporting data from beef cattle into a national database (Taurus, 2012a). Until recently all breeding data was handled by Taurus, an organisation that works to strengthen the role of beef production in Sweden, using their PC-program PC-KAP. However, in May 2012 the ownership of the database was shifted to be included in the Swedish Dairy Association database KKPC, which now incorporates both the beef and dairy cattle. Växa Sverige is today the responsible organisation for the beef breeding evaluation in Sweden (Carlén, 2013, personal communication). In 2011 there was about 20 000 cows registered in PC-KAP, of which 12 000 were purebred (Svensk Mjölk, 2012a).

The breeding values of beef breeds in Sweden are estimated with multiple trait BLUP animal models (Taurus, 2012a). Traditionally, focus in beef breeding has been on traits that directly affects the results of the production such as growth, carcass and calving abilities. Growth and birth weight were the first breeding values to be introduced in the year of 2000. During 2005 the values came to include calving ability and carcass traits. Today, there are eleven breeding values estimated. Breeding values for maternal and direct birth weight, maternal and direct calving ease, maternal and direct weight gain until 200 days in which the maternal part reflects the cow's milk production, gain between 200 and 356 days weight and total live weight gain are based on traits recorded on the farm. Additionally, breeding values are calculated for carcass growth, conformation class and fat group, which are recorded at the slaughter houses. In 2009 a total merit index was formed (AIX), with three sub-indexes; maternal index (MIX), production index (PIX) and birth index (FIX) (Näsholm, 2009). MIX includes maternal calving ease and growth until 200 days. PIX includes carcass growth, conformation class and fat group. FIX includes direct calving ease. Information of the traits not included in the indexes but for which breeding values are estimated, is considered to be included in the indexes through the use of multiple trait animal models and the correlations between traits.

Cow live weight is not included in the breeding values and is not systematically measured in Swedish beef cattle today (Widebeck, 2012, personal communication). However, the possibility to record weights of individual animals at any time exists, but it is not common to record weights of cows in Sweden. When a weight is registered it is possible to state if the weighing took place at pasture release, weaning, winter housing, service, calving, at sale or for finishing weight (Stormwall, 2012, personal communication). Weight could be measured both by using a live weight scale as well as by chest measurement. It is not possible to add, and thereby adjust, information about the cows body condition score to the recorded weight. There is a possibility to register hip height of bulls to be able to calculate frame score, however it is not a common practice in Sweden (Widebeck, 2012, personal communication).

The possibility to register cow temperament as additional information to each cow existed in the old program PC-KAP (Widebeck, 2012, personal communication). However, this function was not widely used and was removed in the new program. Today, there is no possibility to register temperament into the national database for beef cattle, except as a note if an animal were slaughtered because of faulty temperament (Carlén, 2013, personal communication), and no breeding values are present for the trait (Widebeck, 2012, personal communication).

Possible benefits with including the beef breeds into the dairy cow database system are that traits that are already recorded for dairy cattle also easily could be transferred into registrations for beef cattle, such as exterior conformation judgement and hoof health (Widebeck, 2012, personal communication). Temperament scoring is performed in relation to the linear conformation scoring for dairy cattle and a breeding value is calculated for the trait (Svensk Mjölk, 2013). The trait is assessed on a linear scale from one to nine, indicating very nervous to very calm. It is also possible to include the animal's height and size in the linear conformation scoring. A model for linear conformation scoring of beef cattle has been developed for Nordic countries during the autumn of 2012, with the goal to have this service available across the whole country (Widebeck, 2013a). In the future there is hope to include traits from the scoring into the breeding goals. The conformation scoring for beef cattle does, however, not include temperament. At the moment there is work in progress at the Swedish Dairy Association to develop a fertility measure consisting of age at first calving and calving interval (Carlén, 2013, personal communication). A longevity-index, based on productive life length of cows, is developed for beef breeds in Sweden, but has yet not been introduced (Widebeck, 2013b).

The Swedish Performance Testing of Beef Breeds

At the Swedish Performance Testing of Beef Breeds, selected young bulls from the most common breeds in Sweden are tested for a number of quality traits at a station (Svensk köttrasprövning, 2013a). The numbers of bulls per breed are selected in proportion to how common the breeds are in Sweden. The bulls stay at the station from the age of about six months to about one year, after which the approved bulls are sold at auction. Most of the bulls at the auction are sold to breeders, though a few bulls are sold to Viking Genetics to be used for artificial insemination (AI). Data recorded on the bulls are health, growth, hooves, male fertility, linear conformation score including judgement of the animals size, and docility recorded as either acceptable or not. The station is also actively participating in development of new breeding methodology through cooperation with breeding organisation and universities. At the moment the station is evaluating genomic selection as a breeding tool for Swedish beef breeds and is also active in the evaluation of including marbling as a tool for increased meat quality.

Temperament

Cattle displaying good temperament are highly attractive on the market and cows with good temperament are often sought for among breeders (Widebeck, 2013c). This is because large animals with an agitated or aggressive behaviour present a safety risk for the handler, as well as a risk for the safety and welfare of the animal itself (Grandin, 1989). Animals with poor temperament also take longer time handling, increasing the time spent on labour and thereby the production costs. Studies show that cattle with excitable temperament have a lower productivity and poorer meat quality (Voisinet et al., 1997; Café et al., 2011), making temperament an important trait from the aspects of safety, welfare and economics (Grandin, 1989; Golden et al., 2000).

Temperament can generally be defined as “biologically rooted individual differences in behavior tendencies that are present early in life and are relatively stable across various kinds of situations and over the course of time” (Bates, 1989). In cattle genetics, the term is often redefined to “an animal’s behavioural response to handling by humans” (Burrow, 1997), since it is the most common method to measure temperament. The term “docility” is often similarly used as a term for temperament, for example in Ireland (Evans et al., 2009) and North America (Hyde, 2010), and it implies how easily an animal can be managed (Le Neindre et al., 1995).

The on-going change in husbandry system, where the number of farms are decreasing whilst the size of the herds are increasing is leading to less time handling each animal (Lukkarinen & Lannhard Öberg, 2012). This gives less opportunity for animals to learn how to interact with humans which could minimize stress in the systems (Grandin, 1989). This increases the need for animals that biologically have a reduced fear towards humans, since they are more prone to instinctively adapt to handling with less training (Boissy et al., 2005). This is especially important in extensive systems where cattle are handled less frequently.

Genetic background

It is well recognized today that temperament in cattle has a genetic background (Boissy et al., 2005; Glenske et al 2010; Schmutz et al., 2001). Heritability estimates are moderate, but differ greatly depending on the methodology applied and temperament trait studied. During a separation- and restraint test performed by Le Neindre et al. (1995) a heritability estimate for docility score of 0.22 was observed for Limousin heifers. In a similar test performed by Gauly et al. (2001) heritability estimates for different measures of temperament varied between 0.0 and 0.61 for German Angus and 0.0 to 0.59 for Simmental cattle. When the maternal influence was restricted through use of embryo transfer calves, a heritability of 0.36 was found for their temperament score by measurements of movements on a scale (Schmutz et al., 2001). By using repeated weighing every second week, heritability for habituation at 0.46 was calculated. Burrow (2001) found heritability for flight speed scores, as a measure for temperament, to be 0.4 in a tropical composite breed. Similarly, Fordyce et al. (1996) found heritability for shorthorn cross beef cattle in Australia to be between 0.32 and 0.70 for flight distance, however they found a lower heritability of 0.08 to 0.14 for subjective temperament scores during a restraint test.

Differences in temperament have also been observed between breeds. Café et al. (2011) found that Brahman cattle generally are less docile then Angus and display greater individual differences within the breed. This study is supported by Voisinet et al. (1997) who similarly found that Brahman crossbreds were more excitable with inferior temperamental score then cattle without crossbreeding to Brahman. Evans et al. (2009) found that purebred animals tend to be more docile then crossbreds. When comparing German Angus and Simmental it was found that Angus cattle were easier to handle (Gauly et al., 2001). Tulloh (1961) found that Hereford and Angus cattle were more docile then Shorthorn. A few studies support that heifers are more difficult to handle (Voisinet et al., 1997; Gauly et al., 2001); it is however discussed that this could change with maturity (Bouissou & Gaudioso, 1982).

The heritability estimates for temperament are affected by age, where older animals are more docile and perceive lower heritability for the trait (Café et al., 2011; Evans et al 2009). In a study performed by Burrow et al. (1988) the heritability for flight speed was estimated to 0.54 when the cattle were six months old whereas at the age of 18 months the heritability for the same trait was lowered to 0.26. In a review, Boissy et al. (2005) draw the conclusion that

additional experience of the older animal from early environment and later experience will interact with the individuals' genetic makeup and modify its perception of what is fearful. Café et al. (2011) found that even though response to handling declined as time progressed, the temperament score of individuals is kept persistent in relation to each other over time. Schmutz et al. (2001) who looked at habituation found that some cattle had a higher agitation during the initial test whereas some had higher during the second test. When calculating a habituation value, by taking the difference between the initial test and a later test when the animals had been accustomed to the test situation, the author could observe that there was a big difference between animals. Some animals seemed to have learnt the process whilst others still were much agitated. The habituation score gave a higher heritability then the initial temperament score. Furthermore, cattle tend to be more docile with increased days on meal feeding (Evans et al., 2009) and when reared indoors (Le Neindre et al., 1995).

Cattle with poor temperament have reduced average daily gain (Voisinet et al., 1997; Gauly et al., 2001; Café et al., 2011) and lower feed intake causing smaller carcasses with less fat cover (Café et al., 2011). The meat quality was also lower, with darker meat colour, increased muscle pH, greater shear force, compression and increased cooking loss. The lower daily gain and dry matter intake depending on poor temperament is discussed by Café et al. (2011) to be an effect of behaviour rather than metabolic function. Phocas et al. (2006) found that aggressiveness in cattle is genetically correlated to more escaping trials, causing higher risks for safety and increase in work load. Selecting for more docile animals could lead to less active animals, since they are running less. The authors concluded that more studies are needed to understand if this proposes a risk for animal fitness traits.

Maternal behaviour and defensive aggressiveness

Maternal behaviour in cattle, studied by noting active behaviour of the dam to get the calf to start suckling particularly by licking it, is heritable (0.32 and 0.36) and genetically positively correlated to calmer temperament in heifers (0.34 and 0.17) (Le Neindre et al., 2002; Phocas et al., 2006). Phocas et al. (2006) additionally found that good temperament was favourably associated to high reproduction performance and suggest that cows with better temperament will be more suited for producing calves. This is mainly due to correlations to higher fertility and calving performance but also due to the slightly positive correlation to better maternal behaviour and milk yield. Burrow (2001), who also studied production traits, could however not find any correlation between temperament and fertility.

The majority of the calves registered in KAP are born under the first months of the year, from January until April (Svensk Mjölk, 2010), and there is a trend towards earlier calving each year (Svensk Mjölk, 2012b). During this time of the year, cows are generally kept in barns with food and water given inside the barn or outside in an enclosed area (Röken et al., 2006). According to Swedish legislation, farmers should have access to calving pens for their cows (SJVFS 2010:15 Saknr L 100), but the calving often takes place within the herd (Röken et al., 2006). There is a risk when selecting for animals that show less fear that, when untrained, they will be more aggressive upon defending their newborn calves against humans (Le Neindre et al., 1998). Due to European Union regulations (European Council regulation 1760/2000) where young calves needs to be ear tagged, the handling of cows with newborn calves are often becoming unavoidable. This occurs at the same time as the more extensive systems are used and the routine contact at other situations has decreased (Turner & Lawrence, 2007). This has led to that handling of cows postpartum have become one of the major threats in handling safety of suckler cows and, as reviewed by Turner and Lawrence (2007), aggression due to maternal defensiveness is a heritable trait. The authors conclude

that better maternal care and reduced flightiness are associated to more maternal defence in other species. The genetic correlation between temperament score in cattle and aggressive defence of the calf need to be investigated to understand the consequences of a breeding programme for less fearfulness, and the possible effects such a selection program could have when not accounting for aggressiveness around calving. The authors suggest that selection against defensive aggressiveness can be directly measured by farmers during ear tagging.

Selection and measurements

Heritability for temperament score in beef cattle is sufficiently high to be able to efficiently improve the trait by selection (Le Neindre et al., 1995). Café et al. (2011) found that relationships with temperament generally are linear in their nature, meaning that a much greater effect of selection can be seen if the trait is selected for instead of just culling the worst animals. Temperament measurements can be performed in multiple ways, some examples are through separation- and restraint test, flight speed test, weighing test and subjective scoring.

In the **separation- and restraint test**, also called "docility test", the animal's behaviour is studied during isolation from its herd mates; firstly the animals reactions towards a motionless observer is studied, secondly the reactions to handling is noted (Le Neindre et al., 1995; Gauly et al., 2001). During the last phase the observer tries to maintain the animal in a corner and if it succeeds the handler additionally tries to pet it. The animals are tested a few weeks after weaning, approximately at eight to ten months of age. During all stages the animal's reactions, such as aggressiveness, trials to escape, response to petting and time to reach the given areas, running and time in the corner are recorded. If the animal shows any sign of aggression that part of the test is stopped. In Gauly et al. (2001) the animals are given a docility score, ranging from one to five, where one indicates a calm temperament and five indicates a very excited and nervous temperament. In Le Neindre et al. (1995) the score is either given as a continuous number or grouped into four groups from aggressive to able to pet. The authors concluded that it was easier to observe cattle temperament during the test compared to observations in the daily routines, and that the test measures the animal's reaction on human handling as opposed to reactions towards being restrained by objects.

A **weighing test** records cattle behaviour while entering a scale and during the weighing procedure (Tulloh, 1961; Glenske et al., 2010). Scores are given subjectively from best to worse at entering and from docile to nervous or aggressive during the weighing procedure. Tulloh (1961) however concluded that the scores for entering a scale did not reflect the animals' behaviour, since both animals with good and bad behaviour could hesitate or rush. In the weighing procedure the animals' reactions where noted as for example amount of movement, vocalisation, tail flicking and head butting.

During a **flight speed test** conducted by Burrow et al. (1988) temperament was measured as the speed at which the animals exited a scale. The time was electronically measured for the animal to move between two predetermined places with a technique involving two light-beams. Animals with shorter times were considered to be more docile and the method used was confirmed by stockmen to identify problem animals. The method measures the animals' response to handling by humans and was found heritable.

In Ireland **subjective scores** for docility are conducted by trained linear scorers or by farmers (Evans et al., 2009). In the former case docility is recorded at the same time as linear conformation scoring. The scores are given from aggressive to docile on a ten-point scale. For

the farmers a scale of five is used for docility, from a very quiet to very difficult animal. The heritability for temperament was 0.245 and 0.44 by linear scorers and farmers respectively, and the traits were also found to be correlated.

In a review on temperament measurements by Burrow (1997) it was stated that the best methods for identifying fear response to humans are the methods were humans play an active role handling the animals. However these methods are often time-consuming, labour-intense and might propose risks for animals and handlers, making the test less efficient for producers. In this way the flight speed test is, according to the author, a good alternative since it is quick, objective, safe and easy to implement. However, the cost related to the test needs to be investigated. Restraint test, in for example weighing situations, might not always reflect an animal's fear according to Burrow, since a fearful animal might freeze in the position and thereby get better scores then deserved. When selecting for animals that are easy to handle, animals will also be better in restrained situations, due to positive correlations between the tests (Fordyce et al., 1982).

Genetic mapping

In recent years, Quantitative trait loci (QTL) involved in behaviour of beef cattle have been studied (Schmutz et al., 2001, Glenske et al., 2010). Schmutz et al. (2001) found several QTL related to temperament scores at chromosomes 1, 5, 9, 11, 14 and 15. In 2011, Glenske et al. concluded that the chromosome BTA29 in beef cattle has a putative QTL and a candidate gene, dopamine receptor D4 gene (DRD4), that are important in the regulation of temperament. In the review, the authors conclude that the candidate gene, DRD4, has been related to novelty seeking behaviour in other species.

Genetic evaluation

Temperament is today not included in the Swedish breeding evaluation for beef breeds (Taurus, 2012a). In various countries, such as North America (North American Limousine Foundation, 2013), Australia (Breedplan, 2013a) and Ireland (Irish Cattle Breeding Federation, 2013), the trait is implemented in the within-breed genetic evaluations. The driving force has been the society for Limousin breeders, but has in some cases spread to include more breeds and crossbreds (Evans, 2009).

North American Limousine Foundation, NALF, developed a docility score system in 1998 to be used on calves at the time for weaning (Hyde, 2010). The scores are set by breeders and are given individually when the calves are handled in a cattle chute. Scores are given on a subjective scale from docile (1) to very aggressive (6) and by 2010 nearly 200 000 animals had taken part of the test. The heritability is estimated to 0.40 and the percentage of animals classified as calm has increased from 80 to 95 percentage in 12 years. The docility scores are used to give expected progeny difference (EPD) for breeding stock, stating how great the probability is that the offspring of that animal will score 1 or 2 at the docility test. A similar method is used in Australia, and the test is performed around weaning when calves are between 60 to 400 days (Breedplan, 2013b). The scoring can be performed either in a yard or in a crush test. In the yard test, the animals are put individually in a square area and tried to be handled during 30 seconds. The crush test works similar to the test in North America and the animals are handled in a crush. The scoring system is similar between the nations but with the highest score, very aggressive, removed in some countries. There is also a trial period for inclusion of flight time as a breeding value in Australia (Breedplan, 2013c). In Ireland a different system is used where subjective scores are given by trained personnel in relation to the linear conformation scoring or the farmers set the scores themselves (Evans, 2009).

Cow weight

Weight of beef cattle is important to consider for beef producers due to its close relationship with production costs (Golden et al., 2000). The mature cow weight is related to its maintenance needs, where bigger cows generally require more feed per day than smaller cows (Evans et al., 2002). In beef production, the costs related to feeding and maintenance of suckler cows are a large part of the expenses in the production (Golden et al., 2000). It can be hard for producers to value the real cost for feed and maintenance due to problems in estimating the value of forage, and therefore the cost is sometimes overlooked or underestimated. The cows maintenance needs are, in addition to mature cow weight, further affected by for example the cow's milk production and body condition score (Evans et al., 2002). Direct selection on maintenance need is not possible today and therefore cow weight is often used as an indicator trait instead (Golden et al., 2000).

There is a strong relationship between big mature cow weight and higher potential growth of calves, that can reach greater slaughter- and market-weights earlier (Jones et al., 1984; Marshall et al., 1984; Philips, 2004). The time it takes for producing an animal ready for sale or slaughter is a highly relevant economic trait (Golden et al., 2000). Until it is possible to record individual feed consumption, total growth is the best measure available. A bigger cow also has a higher cull cow value, resulting in higher returns from slaughter (Golden et al., 2000; Hugh et al., 2011). Breeds with a heavier mature weight additionally take longer time to reach puberty, giving them the possibility to gain more weight before the maturity for slaughter occurs (Laster, 1976; Nadarajah et al., 1984).

Mature cow weight is correlated to lifetime productivity (Stewart & Martin, 1981; 1983; Marshall et al., 1984). Heavier cows get calves with higher average weaning weights, but on the other hand, have lower longevity and fertility when observing factors such as years in the herd, number of calves produced and total calf weight weaned. Selection only focusing on weight gain can therefore have detrimental effects, making it important to have a broad breeding goal including also fertility and longevity in the selection index. Monteiro (1969) discussed the effect of cow size on calving difficulty and found in several studies that the number of difficult calving increased when the calf size was disproportional to the size of the cow's pelvic, for example when the sire breed was oversized. Even though the author claims that the size of cow has some effect on what calf size it can manage, the author could not find a good index to use preventatively. Maternal ability for easy calving is, however, measured and included directly in the Swedish breeding values (Näsholm, 2009).

Heavier animals require, according to Swedish animal welfare legislation, more space around the feed table as well as larger areas in cubicles and open shed (SJVFS 2010:15 Saknr L 100). The space required is set in weight classes for young animals up to 400 kg, 600 kg or more than 600 kg, and for cows up to 500 kg, 650 kg or more than 650 kg. With larger cows, the farmers need to consider the more space required when using or building stalls for use in beef production. Poor knowledge about the animals' weight and body condition amongst farmers, and thereby feed requirements, can further lead to difficulties in calculating an appropriate feed ratio (Fjelkner, 2007). If so, malnutrition or overweight in cows can lead to problems in animal welfare and health. The knowledge is also useful for medical treatments to dose correctly (Birgersson et al., 2011).

In an economic calculation for mature cow size based on Swedish conditions by Stenberg (2008), it was estimated that bigger sized cows were equally profitable as smaller sized cows, if managed satisfactory. Stenberg therefore emphasizes that the choice in mature cow size

should match the farm's condition, in order to be able to reach a good economical result. This is supported by Marshall et al. (1984) who concluded that "the optimal cow size is dependent on breed, previous selection history, environment and management system."

Genetic background

Mature cow weight is commonly defined as when "any further increase in live weight […] only results in increased fatness" (Philips, 2004). Brinks et al. (1962) found that cows continued to gain weight until eight years of age, which is supported by Arango et al. (2002a) who found that cows continued growing through seven years of age. At the age of five years the cows are near their mature weight (Brinks et al., 1962; Arango et al., 2002a). Since mature cow weight is an intermediate to highly heritable trait, selection pressure can easily be put on the trait resulting in smaller or bigger animals to fit the breeders' purposes in a short period of time (Brinks et al., 1962; Arango et al., 2002b; Philips, 2004).

Brinks et al. (1962) found heritability estimates of 0.73 for fall weights when multiple recordings were used over the years. When only a single record was used, the heritability was lowered to 0.62. The repeatability was high for fall weights and estimated to 0.84. During the period from fall to spring the cattle increased or loosed weight differently between years and individuals, giving lower repeatability for the spring values. This opposes the results of Arango et al. (2002b) who could not find any difference in heritability or repeatability between spring and fall values. Newer heritability estimates for mature cow weight are estimated to 0.49 and 0.40 with repeatability at 0.65 and 0.77 (Arango et al., 2002b; Choy et al., 2002). The heritability was higher for mature cow weights when adjusted for body condition score (Stewart & Martin, 1981; Nadarajah et al., 1984; Arango et al., 2002b).

Measurements for hip height can be used as estimates for mature cow weight, where the heritability for hip height was 0.68 and 0.62 with repeatability at 0.75 and 0.81 (Arango et al., 2002b; Choy et al., 2002). The genetic correlation between hip height and mature cow weight adjusted for condition score is high and estimated to 0.86 (Arango et al., 2002b). Already at the age of two years, the hip height adjusted for condition score is accurate enough to be able to function well as an indicator trait for mature cow weight.

Arango et al. (2002a) found that mature cow weight differs between crossbreds of different sire breeds mated to Angus and Hereford dams. The differences were mostly consistent over age groups, except during maturity in a few breeds. From the breeds studied by Arango the lightest was Jersey, followed by Hereford-Angus crosses, Limousin, South Devon, Simmental and the heaviest was Charolais. Ranking was similarly followed when hip height was studied and when weights were adjusted for condition scores. The differences between breeds were increased when adjustment for condition score was made, whilst the ranking of breeds stayed the same. In the review made by the authors, the mean weight for Angus cows found cited in literature at the age of two, three, four, five, six and seven years old, were 411, 437, 468, 485, 510, and 499 kg. For Hereford cows the corresponding weights were 402, 455, 487, 498, 518, and 523 kg. In the authors' own study and review, Angus cows were heavier before maturity but were outweighed by Hereford after that period. Heavier breeds such as Charolais have been reported to have mature weights of 640 kg (Johnson et al., 2000) and 599 kg (Nadarajah et al., 1984). Different breeds are used by farmers to match their diverse needs depending on market, climate and feed resources available, and crossbreds are used to maximize the benefits given by the heterosis effect (Cundiff et al., 1993).

The heterosis, in the study performed by Arango et al. (2002a), was 5.7 %, making the Hereford-angus crosses on average 29 kg heavier than the purebred when full grown. This is supported by data from Stewart and Martin (1981) who found similar heterosis effects of 3-7 % and increase in 15-28 kg in mature cow weight. Crossbreds also had about 22 % higher weaning weights during their lifetime than purebreds (Stewart & Martin, 1981). A heterosis effect of about 1 % have also been found for hip height by Arango et al. (2002a), but the effect is much smaller when compared to the effects of heterosis on mature cow weight.

Selection and measurements

The most common way to measure mature cow weight is by weighing the cows on a scale (Brinks et al., 1962; McLaren et al., 1982; Arango et al., 2002a). It has been suggested that quarterly weights the first year and a single weight each year until the age of five is enough for good estimates of mature cow weight (McLaren et al., 1982). For correct estimations from these measurements it is important that the age of the cow, season and reproductive performance is included. However, also a single adult weight can be sufficient for satisfactory heritability (Brinks et al., 1962) and between mature weights and immature weights genetic correlations exists, which to some extent can be used for prediction (Northcutt & Wilson, 1993). According to Nadarajah et al. (1984), the animals should reach 42.5 % of their mature weight before any estimation of their mature weight can be given. This is due to that weights at early years are more influenced by the environment, making the models for estimation of weight less accurate.

Measuring with the use of scales is the most precise way to estimate the cows live weight, however, the method is not easily available for all farmers due to the high costs of investing in a scale (Birgersson et al., 2011). Measuring-tapes (Hessle et al., 2010) and formulae calculated on measurements for sacrum-height and chest circumference were suggested as cheaper alternative methods (Birgersson et al., 2011). Although, these methods require close contact with animals, for example in a cattle chute, and are not as accurate as a scale. High correlations to hip height additionally adds the possibility to indirectly measure mature cow weight by only measuring that value and, preferably but not exclusively, also include corrections for body condition score for higher accuracy (Arango et al., 2002b). These measurements could be gathered for example at the same time as linear conformation scoring (Widebeck, 2013a). During the linear scoring another option for judging animals' size is also possible, where the scorer divides the animals into different frame score types according to visible size and measurements compared to its breed (Svensk köttrasprövning, 2013b).

MacNeil (2005) concluded that the use of a ratio of calf weaning weight to cow weight is not a good selection criterion for the dam's efficiency. Even though the relationship is significantly positive, it is mainly due to the effect of high maternal influence since the genetic regression line for the trait is nonlinear. The author concludes that it is difficult to use a ratio in this case, since phenotypes are measured at two separate individuals based from both direct and maternal effects. It is suggested that selection index is a better measurement.

Genetic evaluation

Adult cow weight or frame score is currently not a part of the Swedish beef breed evaluation (Taurus, 2012a). The International beef recording scheme has its base in Australia but is active in more countries, such as New Zealand, Namibia, United States, Canada, United Kingdom and more (Breedplan, 2013d). In their genetic evaluation system, mature cow weight is included and estimated breeding values are given for the trait (Breedplan, 2013e). The breeding values estimated by Breedplan are used to see what weights the animals inherit

for use in the breeding herds, and no optimal value is given. The breeding value reflects a cow's weight at five years of age. The trait is registered on a scale each year after the cow has reached 2.4 years, at the same time as the weaning weight of calves are registered. The weights can be recorded four times per cow. Cow condition score is at the moment not corrected for in the evaluation.

Statistical analysis

Material and method

Temperament

Description of the farm

Registrations of temperament were gathered on a farm situated in Södermanland in the midst of Sweden. The farm had about 300 suckler cows, half of them were Simmental and Angus purebreds kept for breeding, whilst the other half were crossbreds kept for beef production. The crossbred group consisted of Angus and Simmental crosses, which were bred to a terminal breed such as Limousin or Charolais to produce calves for slaughter. The farm was organic and had calving spread throughout the year. There were four animal keepers at the farm.

Collection of data

Cow temperament was registered at three occasions; when the cow had just calved, on pasture, and as an overall manageability. For each occasion a scale with three scores was used. Temperament was scored as calm (1), nervous (2) or aggressive (3). All observations of cow temperament were based on the cow´s reaction towards the animal responsible person. To avoid variance between observers the same person performed all the temperament judgements. The data was collected during five years, from the autumn of 2007 to the summer of 2012.

At calving, the cow's temperament was registered according to its reaction when an approaching person came to tag and weigh its newborn calf. A cow considered as calm (1) was calm throughout the procedure and the observer tagged the calf without any problem. A cow that was anxious, paced back and forth and was jittery was considered as nervous (2) and a cow that guarded the calf and/or lunged towards the observer was regarded as aggressive (3).

During the grazing period, the cows' temperament were registered whilst the observer walked around in the herd to monitor the animal´s wellbeing at pasture, and the behaviour when the observer came near its calf was judged. A cow regarded as calm (1) continued with grazing or what it was doing when the observer entered. The cow could also seek contact or want to be patted. A cow judged as nervous (2) was uncomfortable with the human walking in the herd, displayed flight behaviour, was jittery and/or was anxious. This behaviour was not only looked upon when approaching the calf, but also when the observer moved around in the herd. A cow judged as aggressive (3) was guarding and/or lunged towards the observer when coming near its calf.

Manageability was judged in situations where the cow normally needed to be handled, such as when the animals were changed between groups, at gestation examination, at hoof trimming etc. A cow judged as calm (1) was continuing normally in a calm pace and did not show any flight or aggressive behaviour when handled in the same situation. A cow judged as calm could also be so unaffected that it hardly moved. A cow judged as nervous (2) was hard to manage, got easily stressed and ran back and forth. It showed great anxiety and could show flight behaviour; preferably the cow wanted a distance longer than five to ten meters to the observer. A cow scored as aggressive (3) lowered its head when being approached and displayed threatening behaviour, and could launch if the observer continued forward in the situation.

Data was collected on a total of 346 cows, where some cows had repeated registrations of temperament during the years 2007 to 2012. For temperament at calving there was a total of 867 observations, at pasture 865 observations, and for manageability 740 observations.

Temperament of the cow was completed with information on age, breed, year and season of recording, and sex of calf. Analyses have been done to see if differences in temperament could depend on any of the above mentioned factors.

Analysis

Analysis of variance of temperament at calving, pasture and manageability was done using PROC GLM in SAS software 9.3 (SAS, 2011). The effects of animal, sex of calf, and age of cow were excluded from the final model, since initial analyses showed that these effects were not significant.

The following model was used in the analyses:

$$Y_{ijk} = \mu + breed_i + year\ season_j + e_{ijk}$$

where

Y_{ijk} = observation of temperament at calving, pasture or manageability.
μ = overall mean
$breed_i$ = fixed effect of breed, i = 1,…,5
$year\ season_j$ = fixed effect of combination of year and season, j = 1,…,15 or j = 1,…,12
e_{ijk} = random residual effect, ~IND (0, $\sigma^2_{e)}$

The year of registration was grouped according to the five years that registration took place. One year stretches from autumn to the following summer. Season was grouped according to three calving seasons: autumn (August to November), winter (December to February) or spring (March to July). The registrations in June and July were grouped into spring, and the registrations in August were grouped into autumn because of low numbers of calving registrations at summertime.

Breed was registered as Angus, Simmental, Angus-Simmental or Simmental-Angus. For the crosses the breed stated first is the sire breed and the second is the maternal breed. The other crossbred animals, which are cows from other combinations then above, were analysed together as one group. At calving, there were a total of 166 observations on Angus, 564 observations on Simmental, 82 observations of Angus-Simmental, 27 observations on Simmental-Angus and 28 observations on crossbred animals.

The Pearson correlation coefficients were calculated between residuals for temperament at calving, on pasture and for manageability.

Cow weight

Description of the farms

Cow weights were registered at two Swedish farms. Farm A was located in Skåne, in the south of Sweden. The farm had about 40 suckler cows of the breed Angus kept for breeding purposes. The calving season was centred to early spring. The farm was conventional and the farmer had agriculture as main occupation. Farm B was the same farm as used for registrations of temperament.

Collection of data

The cows have been weighted on a scale. At farm A the weights were gathered for heifers in August 2006 and for the whole herd in January 2007. After this, farm A weighted their cows regularly during 2010 and 2011 in both April and in October/November. For farm B weights were gathered at the same time as the hoof trimming in November 2011.

The dataset contained 366 observations on 256 cows, where some cows have several weights registered since one of the farms weighted cows repeated times. Weight of the cow was completed with information on age, breed, herd and weighing date. Analyses have been done to see if differences in weights could depend on any of the above mentioned factors.

Analysis

Analysis of variance of cow weight was done using PROC GLM in SAS software 9.3 (SAS, 2011). The effect of animal was excluded from the final model, since initial analyses showed that the effect was not significant.

The following model was used in the analyses:

$$Y_{ijk} = \mu + age_i + \text{breed herd occasion}_j + e_{ijk}$$

where

Y_{ijk}	= observation of cow weight
μ	= overall mean
age_i	= fixed effect of age, i = 1,2,3
breed herd occasion$_j$	= fixed effect of combination of breed, herd and occasion, j = 1,…,9
e_{ijk}	= random residual effect, ~IND (0, $\sigma^2_{e)}$

Age of the cow was calculated by taking the date of the weighing occasion minus the cow's birth date, and grouped into 1 year (2), 2 years (3), 3 years (4), 4 years (5), 5 years (6) and above 6 years old (7). In the analysis of variance the age groups were further grouped together into 1-2 years, 3-4 years, and above 5 years because of low number of animals in some of the age groups.

Breed was registered as Angus, Simmental or crossbred animals. There were 219 observations on Angus, 106 observations on Simmental and 41 observations on crossbred animals.

Results

Temperament

Frequency

Results of the temperament scores are given for each occasion and breed/cross in Table 1.

Table 1. Number of observations (N) of temperament registrations[1] at calving, pasture and manageability

	Temperament at calving				Temperament at pasture				Manageability			
	∑	1	2	3	∑	1	2	3	∑	1	2	3
Angus	166	58	70	38	164	154	10	0	137	112	25	0
Simmental	564	266	232	66	564	516	42	6	470	392	76	2
Angus-Simmental	82	52	28	2	82	82	0	0	82	81	1	0
Simmental-Angus	27	2	9	16	27	24	3	0	27	11	16	0
Other crosses	28	5	17	6	28	22	5	1	24	18	4	2
Total no. of obs.	867	383	356	128	865	798	60	7	740	614	122	4

[1)] 1=calm; 2=nervous; 3=aggressive.

Figure 1 shows how the temperament frequencies were distributed amongst the occasions. There was a higher percentage of nervous and aggressive cows at calving compared to at pasture and overall manageability. At pasture the cows had least registrations of nervous behaviour. The percentage of aggressive cows was also low for overall manageability.

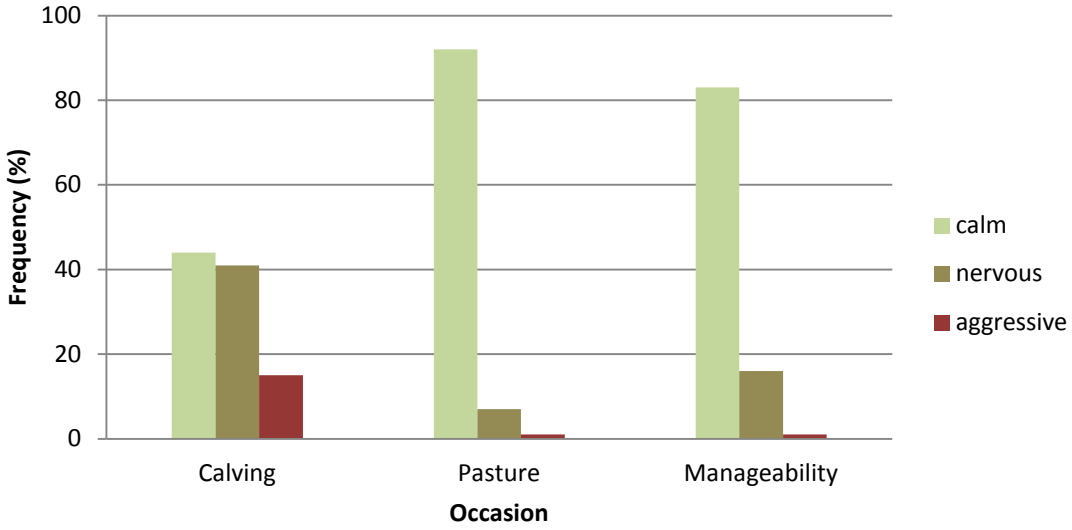

Figure 1. Temperament frequency (%) for number of animals that were calm, nervous or aggressive for the occasions calving, pasture and manageability.

The temperament frequencies distribution within breeds at calving is given in Figure 2, at pasture in Figure 3 and for manageability in Figure 4. At calving the overall calmest breeds were Angus-Simmental followed by Simmental respectively Angus. The crossbred group had a high percentage of nervous cows, whilst Simmental-Angus had a high percentage of aggressive cows. The Simmental-Angus crosses and the crossbred group had low number of calm cows at calving. At pasture the Angus-Simmental crosses were the calmest. The crossbred group had most registrations of nervous and aggressive cows at pasture, even if the numbers were low. When looking on manageability, the Angus-Simmental crosses had the highest number of calm animals and the lowest number of nervous cows. The Simmental-Angus crosses had the highest number of nervous cows and the least number of calm cows on manageability. The crossbred cows had the highest number of aggressive cows at this occasion.

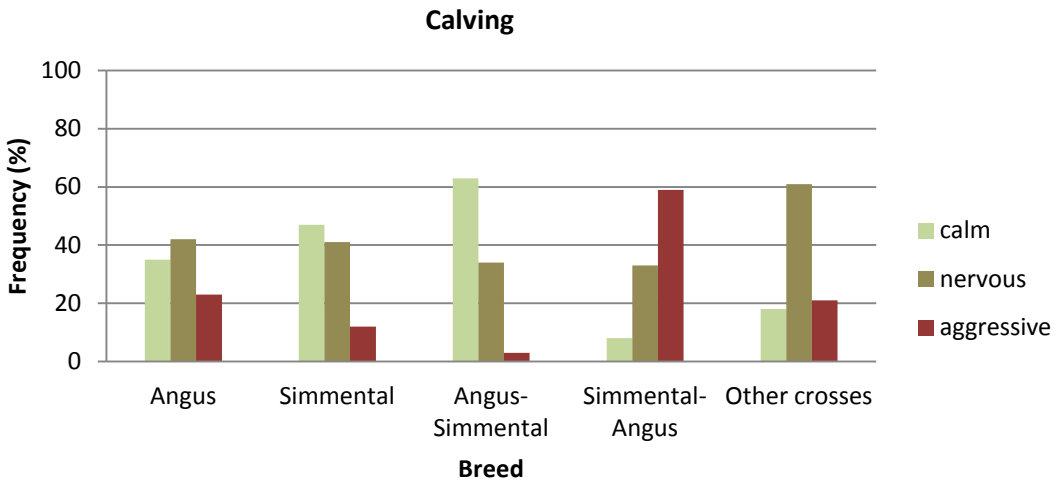

Figure 2. Temperament frequency (%) at calving, distributed per breed.

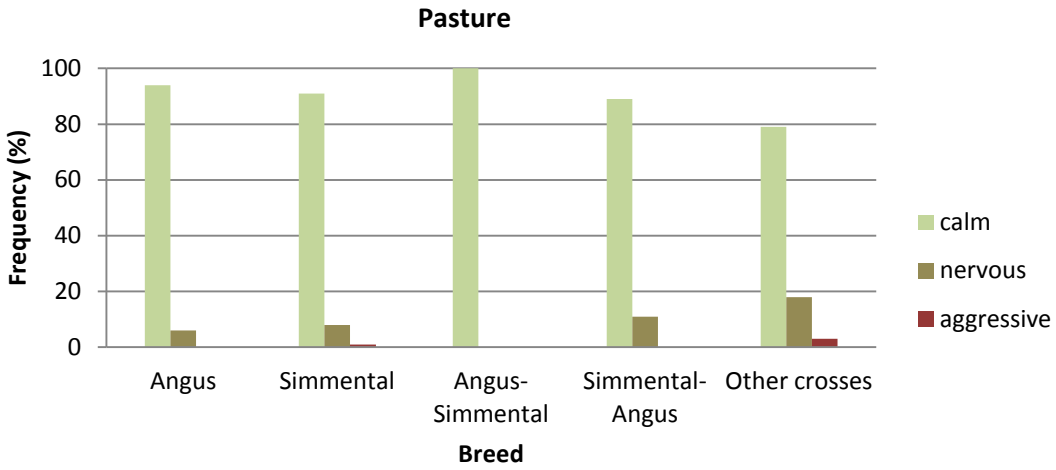

Figure 3. Temperament frequency (%) at pasture, distributed per breed.

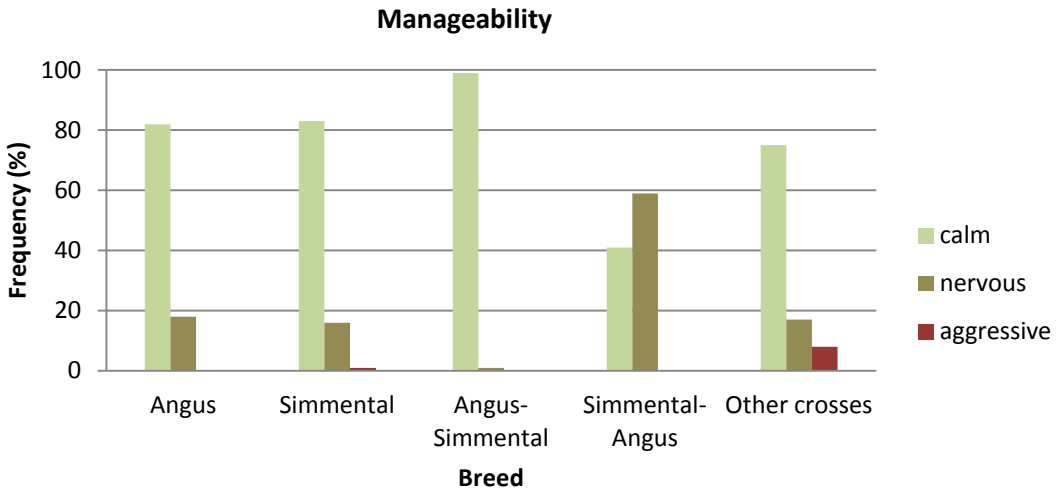

Figure 4. Temperament frequency (%) for manageability, distributed per breed.

Analysis of variance

The following tables present the analysis of variance for temperament at calving (table 2), pasture (table 3) and for manageability (table 4). The analysis showed that the breed and the combination of year and season influenced temperament significantly at all occasions ($p<0.001$).

Table 2. Analysis of variance for temperament at calving

Source of variation	Degrees of freedom	Mean square
Breed	4	9.6***
Combination of year and season	14	1.4***
Error	848	0.4

$R^2 = 0.13$, *** $p<0.001$

Table 3. Analysis of variance for temperament at pasture

Source of variation	Degrees of freedom	Mean square
Breed	4	0.3***
Combination of year and season	14	0.5***
Error	846	0.1

$R^2 = 0.11$, *** $p<0.001$

Table 4. Analysis of variance for temperament as manageability

Source of variation	Degrees of freedom	Mean square
Breed	4	1.6***
Combination of year and season	11	0.8***
Error	724	0.1

$R^2 = 0.14$, *** $p<0.001$

Table 5, 6 and 7 present the least square means (LSM) and the significance of the differences between the different LSM-values for temperament at calving (Table 5), pasture (Table 6) and for manageability (Table 7). At calving all breeds differed significantly from each other except for purebred Angus and the crossbred group. The highest LSM was recorded for the Simmental-Angus crosses at calving, and the lowest for the Angus-Simmental crosses. At pasture there were significant differences between the crossbred group and Angus, Simmental and Angus-Simmental crosses. The Crossbred group had a higher LSM then the other groups. When looking on manageability most breeds differed significantly from each other, except Angus and Simmental, and Angus and the crossbred group. The highest LSM were recorded for Simmental-Angus crosses and the least for Angus-Simmental on manageability.

Table 5. Breed least squares means (LSM) for temperament at calving with standard errors as subscripts and the significance of the difference between the different LSM-values

		Significance level of differences				
	LSM	Angus	Simmental	Angus-Simmental	Simmental-Angus	Crosses
Angus	$1.8_{0.1}$		***	***	***	NS
Simmental	$1.6_{0.0}$	***		***	***	**
Angus-Simmental	$1.3_{0.1}$	***	***		***	***
Simmental-Angus	$2.5_{0.1}$	***	***	***		**
Crosses	$2.0_{0.1}$	NS	**	***	**	

*** $p<0.001$. ** $p<0.01$. NS = not significant.

Table 6. Breed least squares means (LSM) for temperament at pasture with standard errors as subscripts and the significance of the difference between the different LSM-values

		Significance level of differences				
	LSM	Angus	Simmental	Angus-Simmental	Simmental-Angus	Crosses
Angus	$1.1_{0.0}$		NS	NS	NS	**
Simmental	$1.1_{0.0}$	NS		NS	NS	**
Angus-Simmental	$1.0_{0.0}$	NS	NS		NS	***
Simmental-Angus	$1.1_{0.1}$	NS	NS	NS		NS
Crosses	$1.3_{0.1}$	**	**	***	NS	

*** p<0.001. ** p<0.01. NS = not significant.

Table 7. Breed least squares means (LSM) for temperament as manageability with standard errors as subscripts and the significance of the difference between the different LSM-values

		Significance level of differences				
	LSM	Angus	Simmental	Angus-Simmental	Simmental-Angus	Crosses
Angus	$1.2_{0.0}$		NS	**	***	NS
Simmental	$1.2_{0.0}$	NS		**	***	*
Angus-Simmental	$1.1_{0.0}$	**	**		***	***
Simmental-Angus	$1.6_{0.1}$	***	***	***		*
Crosses	$1.4_{0.1}$	NS	*	***	*	

*** p<0.001. ** p<0.01. * p<0.05. NS = not significant.

The correlation between temperament at calving and manageability was moderate (0.49). The correlations between temperament at calving and on pasture (0.38) and between temperament at pasture and manageability (0.29) were low. All correlations were different from zero.

Cow weight

Mean value

Mean value was calculated for cow weights and given according to their age group, breed, herd and weighing occasion. The number of observations in each group and their standard deviation is stated. Average weights for cows of the various breeds at different ages and occasion and in different herds are given in Table 8 and shown in Figure 5.

Table 8. Number of observations (N) and means, with standard deviations as subscripts, for cow live weight (kg) at different ages (days). Values are given for each breed, herd and weighing occasion

	Age group																	
	1 year			2 years			3 years			4 years			5 years			>6 years		
	N	weight	age	N	weight	age	N	weight	age	N	weight	age	N	weight	age	N	weight	age
Farm A, Angus																		
August 2006	13	445_{51}	510_{29}															
January 2007	13	530_{60}	639_{29}	4	746_{148}	1035_{14}	3	760_{5}	1399_{12}	8	832_{72}	1748_{29}	2	997_{210}	2132_{9}	10	816_{89}	3191_{1209}
April 2010				6	485_{41}	772_{10}	5	568_{37}	1129_{15}	7	658_{41}	1537_{111}	8	694_{64}	1850_{13}	3	733_{39}	3449_{749}
November 2010	9	501_{36}	573_{55}	5	601_{50}	983_{12}	5	684_{36}	1339_{15}	6	768_{33}	1703_{16}	9	760_{62}	2042_{28}	2	809_{13}	2620_{278}
April 2011	4	531_{45}	682_{31}	7	567_{64}	763_{26}	6	632_{74}	1144_{11}	5	710_{27}	1499_{15}	7	771_{40}	1906_{111}	7	795_{81}	2323_{288}
October 2011				6	617_{44}	942_{39}	5	692_{53}	1342_{7}	4	741_{29}	1699_{13}	5	793_{38}	2064_{14}	10	772_{54}	2510_{263}
Farm B, November 2011																		
Angus				5	627_{38}	980_{33}	1	760.	1363.	10	754_{50}	1659_{73}	2	755_{10}	2072_{17}	17	791_{84}	3016_{619}
Simmental	1	589.	664.	9	663_{67}	983_{32}	15	754_{91}	1353_{70}	33	761_{64}	1710_{41}	20	795_{73}	2046_{54}	28	806_{63}	3117_{461}
Crosses	1	579.	671.	13	648_{54}	1034_{57}	16	696_{75}	1257_{112}	11	760_{58}	1531_{78}						

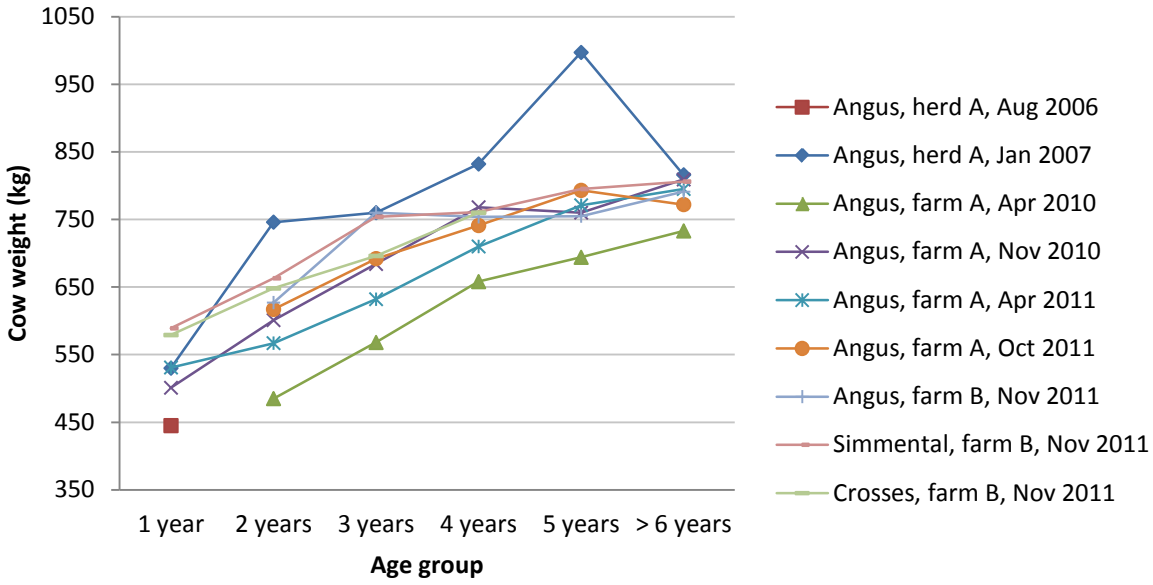

Figure 5. Average weights (kg) for Angus, Simmental and crossbred cows.

Differences between weighing occasions can be seen in Figure 5. In August 2006 there were only young heifers weighted. These heifers had an average age of 510 days, which is lower than the average age for the other 1 year old, ranging between 573 to 682 days. In January 2007 there were a few heavier cows that greatly affected the mean value in the age groups with few observations. One example is in age group 5 where the mean value was based on only two cows. Before the weighing of 2010 and 2011, the farmer had selected medium sized cows and culled the extremes, which could be a reason why the weights were lower than in January 2007. The cow weights differ between spring and autumn registrations in farm A 2010. Figure 6 thereby only includes weights gathered during the autumn 2010-2011 to illustrate the weights according to breed and herd at the same season. It shows that autumn weights are similar at the two farms and amongst the breeds.

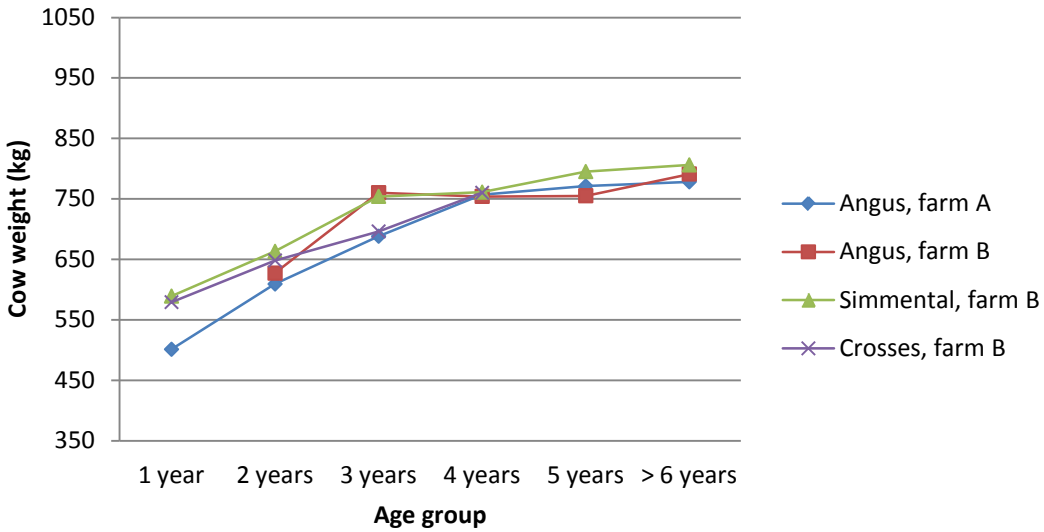

Figure 6. Average weights (kg) for Angus, Simmental and crossbred cows per herd for autumn 2010 and 2011.

Analysis of variance

Table 9 presents the analysis of variance for cow live weight. The analysis showed that the age and the combination of breed, herd and occasion influenced the weight significantly ($p<0.001$).

Table 9. Analysis of variance for cow live weight

Source of variation	Degrees of freedom	Mean square
Age group	2	900205.8***
Combination of breed, herd and occasion	8	88196.0***
Error	355	5355.0

$R^2 = 0.65$, *** $p<0.001$

Table 10 present the least squares means (LSM) and the significance of the differences between the different LSM-values for cow weight. There were no significant differences between breeds at farm B. Angus in farm A at autumn 2011 had no significant difference from breeds at farm B. Within farm A many of the weighing occasions differed significantly from each other. However, the weighing of autumn 2011 do not have any significant difference from weights gathered at the same farm in autumn 2010 and spring 2011, but differed significantly from August 2006, January 2007 and April 2010. The result indicates that differences on weights were depending less on breed whilst year and season had a greater effect.

Table 10. Breed, herd and occasion least squares means (LSM) for cow weight with standard errors as subscripts and the significance of the differences between the different LSM-values

			Significance level of differences								
		LSM	1	2	3	4	5	6	7	8	9
Farm A, Angus											
August 2006	(1)	557_{21}		***	NS	***	***	***	***	***	***
January 2007	(2)	739_{12}	***		***	***	***	*	NS	NS	NS
April 2010	(3)	604_{14}	NS	***		***	***	***	***	***	***
November 2010	(4)	676_{12}	***	***	***		NS	NS	*	***	*
April 2011	(5)	671_{12}	***	***	***	NS		NS	*	***	**
October 2011	(6)	699_{13}	***	*	***	NS	NS		NS	NS	NS
Farm B, November 2011											
Angus	(7)	715_{13}	***	NS	***	*	*	NS		NS	NS
Simmental	(8)	728_{7}	***	NS	***	***	***	NS	NS		NS
Crosses	(9)	716_{12}	***	NS	***	*	**	NS	NS	NS	

*** $p<0.001$. ** $p<0.01$. * $p<0.05$. NS = not significant.

Qualitative interviews

Material and methods

Qualitative interviews

In order to complement the literature review and statistical analysis with the perspective of the farmers, qualitative interviews have been performed as a part of this thesis work. The aim of the interviews was to get an in-depth understanding for farmers' viewpoints regarding breeding goals and registrations in beef cattle, and the effect they think that new registrations could have on their production. In addition, the interviews were performed to document farmers' view on how breeding works in practice and what changes that are needed and seem reasonable in the area. Interviews can be used to gain a colourful picture and discover theories which can be hard to obtain by quantitative questions, as such questions often tend to be too narrow (Trost, 2010). The approach of using interviews in this study should be looked upon as a way to find theories of possible viewpoints and how it could work in practice.

Collection of data

Selection process

The interviews took place during autumn of 2012 with the statistical analyses performed afterwards. Nine individual interviews were performed with farmers selected in order to gain as much different aspects and viewpoints as possible in the field of beef breeding. The farms were found through tips, searches in newspapers, internet and on homepages of breed organizations. Farmers were selected to participate based on differences in breeds, goals of breeding, sizes of farms, age and sex of farmers etc. This resulted in the farms having a total representation of seven breeds; Charolais, Simmental, Limousin, Hereford, Angus, Highland Cattle and Belted Galloway. On the farms selected to participate in the study, either one or two breeds were held for breeding purposes. One farm with breeding stocks also kept a commercial herd with crossbred animals. Another farm had a commercial herd consisting of three breed crosses as its only cattle production. The interviews were held with both male and female farmers, from young to old and with different levels of academic background. The farm sizes varied from 25 to 300 cows, with the other farms represented in between. Some of the farms were increasing or had recently increased their production, whereas others were in the process of declining their number of animals. One of the farms had recently quit the production with suckler cows but was included in the study due to its valuable information in the field. Both organic and conventional farms were represented. The farms were located across the southern to the middle parts of Sweden, from Skåne to Uppsala, the areas of Sweden where most of the farms are located. Most of the farmers had agriculture as their main occupation, except for the farmer who had recently quit with suckler cows.

In addition to the interviews with farmers, Helena Stenberg was interviewed. Helena is a specialist in Swedish beef breeding and has through her work at Taurus come into contact with numerous farmers and learnt their diverse viewpoints on breeding. Taurus is a Swedish organization working to increase beef producers' profitability through skill development and knowledge transfer (Taurus, 2012b). Helena has worked at the company since its establishment and is responsible for questions regarding breeding and production. Her knowledge as a key informant (a person that has gathered extensive knowledge in an area of interest) was used to get a broader picture on how farmers often reason in questions regarding breeding.

Environment

Most of the interviews took place in the informants' home environment and/or at their farm. This was done to increase the comfort of the informant allowing more open answers to be obtained (Trost, 2010). The setting in the home or at the farm also made it easier to interpret the answers obtained, as the environment gave a good picture of the personality of the person being interviewed and how the production at the specific farm is conducted. In the case of the farm that recently stopped its production, the interview took place at the person's office, but this did not seem to influence the openness of the answers. During two of the interviews, a family member joined in, this worked well and the answers appeared relaxed, open and did not appear to affect the informants' ability to express his or her own opinions as has been suggested could happen by Trost (2010). Even in cases when family members joined in, each person was given the opportunity to speak equally much and not being interrupted even if a contradictory viewpoint was expressed. This could be seen as one of the key points for interviews to work when more people are present at the interview.

Interviews and initial contact

The initial contact with the informants was made through a phone call, in which all necessary information was given. The informants were asked if they wanted to participate and were able to choose a time that was most suitable for them. Afterwards they received a confirmation letter via email, which included information about the interviews, contact information and date for the interview. Initially informants were positively interested in participating, and there was only one farmer that turned down the offer to participate due to lack of time.

All farmers were informed about their confidentiality, meaning that information that could reveal their identity has been removed from the thesis. This can, according to Trost (2010), enable informants to speak more freely about their opinions. They did not get the opportunity to read through their answers afterwards since that would propose a risk that they would want to change them. The key informant's answers were not handled confidentially since she is a well-known person in Swedish breeding for beef breeds and there was a risk that she could be recognized despite the use of anonymity-measures. Instead she has had the option to read through and comment on the material, so that she could be able to give answers without fear of being interpreted wrong.

Each interview took between 1 and 2.5 hours, depending on how long answers that were obtained. Some farmers were during the initial contact given the information that the subject was mainly about new registrations in beef cattle breeding; whilst some got more details that the interview would include the subject of temperament and cow weight. This depended on how many questions they asked about the thesis work. The answers in the interview do not seem to be influenced by this. An interview guide was used, to ensure that all questions were asked, see appendix 1. The interviews were recorded by audio and written down by hand. This made it easy during the analysis to go back and listen to the interviews when needed.

Objectivity and reflection

A researcher's goal is to be as objective and neutral as possible, in order to not influence the results of the study. However, during qualitative interviews, focus during the interviews often has to be shifted, in order to make the interviewed feel comfortable, and to obtain as deep and nuanced answers as possible (Trost, 2010). Thus, although the goal is to limit the interviewers own beliefs, it can sometimes be necessary to show empathy and subjectively participate in the discussion, in order to get deeper explanations of their opinions. During the analysis of the

interviews, the degree of subjectivity has been accounted for by taking into account what the answers were depending on how the questions were asked. Open questions were used, meaning that opinions have come forward as a process. Questions were therefore not asked in the same order or formulated in the same way, as well as the environments between the interviews have differed. On the other hand, there are often different environments and questions that can give shades of opinions that are valuable for the study. How informants have interpreted the questions might therefore have differed, and have been interwoven into the analysis. During qualitative interviews the author's own background could influence the interviews and the reflection of them. In this case, the author has grown up on a small farm with a commercial beef production, situated in the north of Sweden; an area that has not been included because of the distance. To limit the subjectivity of the author, a thorough analysis and validation of the material has taken place.

The material from the interviews was read several times before it was analysed and interpreted. As the interviews had clear goals with question areas set from the beginning (see interview guide), summarising the answers into beforehand decided themes was a good way to compile the answers. The interviews were analysed in themes by being subject to meaning condensation, where viewpoints of the farmers are formulated to shorter and concise formulations (Kvale, 1997). Secondly, the interviews were subject to meaning categorization, making the opinions easier to compare when addressed in categories (Kvale, 1997), for example by stating if a person was positively or negatively interested in a trait. Some of the categories were designed beforehand whilst others became visible ad hoc as the analysis progressed. Eventually the material was interpreted and validated by comparing the interviews against each other, to data and viewpoints found in literature, through discussion with supervisors and ideas given by the key informant. In the validation it was checked if informants could understand and recognise viewpoints of others and that the results seems reasonable based on how they were gathered, analysed and interpreted. The reliability of this study was maintained by thoroughly having described the research process, so that each person could follow how data have been collected and analysed (Trost, 2010).

Results and analysis of the interviews

During the analysis of the interviews below, the interviewed persons have been named farmers or informants. When it is needed to differ between production types, the breeding stock owners have been named breeders, whilst the commercial herd owners have been called producers. This is done to keep their confidentiality. The key informant additionally has been named expert and Stenberg. Themes discussed in the analysis are; the farmers breeding goals, registration of data and breeding values, temperament and cow weight. To see the guide used for the interviews see appendix 1.

The themes given are the author's interpretation of the answers, posing a risk that answers might have been misinterpreted despite the use of voice recorder and written summary. The interviews were initially held in Swedish and their answers have been translated to English in the report. The translation might risk some shades of opinions, which is good to be familiar with when reading the results. As a measure to minimize the sources of error the answers have been listened to, read and reflected upon several times.

Breeding goals

Breeding strategies

When farmers were asked about their breeding strategies, many mentioned that it was important for them to produce cattle that were attractive to sell as breeding stock, both to other breeders and to producers. The customers demand could thereby affect the goals of the breeders, a point of view which was confirmed by the expert. The traits often asked for by commercial herd owners, according to the breeders and the key informant, were good temperament, easy calving, good growth and high production. Stenberg and a few breeders mentioned that producers regarded some traits to be included in the breeds, and therefore did not ask for them, for example milk and growth-traits. Some commercial herd owners also wanted exclusively polled animals, which could be hard to meet for some producers who had really good animals but with horns. Since these animals often were not as desirable, some farmers had to cull good animals only because of their horn status, even though they themselves would have wanted them in their production. Because of this, some breeders kept both horned and polled animals to meet the demands of their customers as well as their own goals. The commercial herd owner which participated in the study did conversely keep some cows even though they had horns and used dehorning instead, because of their good production. This was not a problem for the owner of highland cattle, since it is desirable to have horns in that breed.

The interviewed producer had similar goals as the breeders described above, but had also an interest in the cows' exterior, such as legs and hooves, and maternal abilities. One of the breeders described that generally producers got more interested in breeding as their production site got bigger. With more cows, they are willing to pay more for a better bull, and are thereby more interested in breeding traits. The expert added that breeders are generally more interested in the individual breeding traits of their own cows than the producers, mainly because many producers have little knowledge of what their cows produce for example by not monitoring calf weight or calving interval. She added that the producers often look more upon if the cow gave a calf or not and not how much it produced.

In the Highland Cattle breed, one farmer described the breeders as differing considerably in their breeding goals. Some were only keeping the breed as a hobby and had no requirements of their production, whilst some had production as a goal. Although this farmer had the highland cattle for production, the opinions expressed still matches the view of the owner of the Belted Galloway, who mainly kept the breed as a hobby and had a second breed on the farm which was kept for production.

Other important breeding strategies for all farmers were to have highly functional and sustainable cows with a good production. For the farmer of the commercial herds it was also important that the cows gave good animals for slaughter. This factor was not mentioned initially by the breeders, but it was included when their breeding goals were discussed in more detail. Probably, this factor gets more focus in commercial herds, whilst the breeders have many more factors that have to be prioritized. Another reason stated by one farmer could be that most of the breeds held in Sweden are used as general purpose breeds; meaning that the breeds are used both for maternal and paternal usage, leading to that maternal traits need to be focused on in almost all breeds. One informant pointed out that it would have been interesting to interview a breeder of Blonde d'Aquitaine, since they are a more pronounced terminal breed, and their breeding goal might have differed from the general answers.

Breeding goals

The traits that were mentioned most often as part of the breeders own breeding goals were temperament, maternal abilities, growth, milk and a functional exterior. The expert confirmed that these traits are commonly prioritized. All farmers mentioned temperament as a highly prioritized goal, as bad temperament in their livestock both could ruin their rumour as a serious breeder and cause unnecessary risks in their daily work. On the other hand, what was considered a good and bad temperament could differ, as discussed under the headline Temperament below.

All farmers wanted good maternal abilities. Some stated that it saved a lot of time if the cow took good care of their calf. It was important, according to farmers and the expert, that the cows had easy calving, and produced one live calf per year. However, a few farmers stated that the need for only using bulls giving low birth weights to give easy calving often was exaggerated, since their breeds often had no problem giving birth to bigger calves. Calves that are bigger at birth often get a higher slaughter weight. By this they meant that producers sometimes should look more on their cow material and choose a bull that fit the cows, instead of just asking for low birth weights because they are taught by organisations to do so. A few farmers mentioned that one live calf per year was an important trait to stay in the herd as well as good fertility. When discussing with the farmers however, some farmers could overlook an empty cow one year with regards to otherwise good breeding material. The commercial herd owner did not keep any empty cow regardless of their other traits. This might show on a difference in importance of fertility traits between breeders and producers.

All farmers mentioned that it was important that the cattle had a good production and high growth of the calves. Though some of the farmers, as well as the key informant, stated that this trait often came with the breeds chosen, and that they specifically did not have to search for animals with these traits, meaning that they could lay more focus on other traits. Many stated that growth had to include growing on a high forage diet and on pasture. Some wanted the cows not to thin out during the summer because of overproduction of milk or by not being able to feed on the pasture, whilst some farmers thought that this was okay as long as their calves grew well; they meant that to get calves that got good scores at the slaughter was more important for some, than the cows body score at the end of summer. Generally farmers regarded good growth as including good conformation and fat group. A few farmers were also interested in meat and eating quality, and agreed that it was a difficult subject that needs more research. One informant did not like the idea of measuring eating quality and thought of this as a trend that will pass. A few farmers discussed feed efficiency and its importance, however concluding that in Sweden we had no individual way of estimating this today.

Almost all farmers were interested in good or normal milk production to support the calves, which was confirmed by the expert. It was also mentioned several times that the exterior of the udder is very important for the ability of young calves to find and easily use the teats. Some farmers stated that they have had to cull cows because of bad udder in the beginning of their production, but that the trait was “easy” to get rid of by selecting for cows with good udder shape. Conformation is at the moment a hot topic and many breeders wanted the breeding animals’ exterior to be judged, if all animals in the herd or only a few selected individuals should be judged differed between farmers’ opinions. Some farmers were highly interested in conformation scores of the bulldams, stating that the mother line of the bulls at the performance testing station are often overlooked even though they have a high genetic importance. One of the farmers already used an evaluator from Denmark. The cattle legs and hooves were an important trait for many farmers, but when asked how often the cows’ hooves

were trimmed the answers differed from once per year to that it should not be needed at all. Initially barely anyone mentioned the size of the cows. The ones that did had very separate view over how important it was. Two stated that they selected for a certain size, one for the medium sized since they were the most effective cow material, another wanted the really big cows because of them having a good exterior. Another mentioned size but said that it did not affect the choice of breeding at all, and kept all sizes for breeding, see more under the headline Cow weight.

Additional factors

A lot of farmers had thought well before choosing a heavy or light beef breed to fit their production, and they felt that some traits came along with the breeds chosen such as growth, size and milk. Choosing a breed to fit their production is confirmed to be common according to the key informant. However other traits require more effort regardless of breed. Many farmers choose bulls to fit their cows, and had separate breeding lines to fulfil the needs of customers who often came back several years in a row. When asked about how they chose bulls themselves, many of them stated that they needed to see the bull in reality, since not all traits are documented. A few farmers stated that it had to "feel right". It was mentioned by some that there was also a need to look at the interaction with environment, for example if the calves had concentrate in the diet or not, which could affect how the animal's records developed. Overall the farmers and the expert agreed that breeding values could not give the whole truth about if an animal would be good for breeding or not, since there were more factors that had to be looked upon, for example temperament.

Registration of data and breeding values

Usage of monitoring program

All farmers were users of the KKPC program to register data of their herds. According to Stenberg it is mainly the breeders who are users of the program and only a few of the producers. The beef breeds newly merged into the dairy cows' database in May 2012. Earlier they existed in a separate breeding program, PC-KAP. During the transition process there have been problems for the farmers who generally feel that they have not had the time to learn to use the new program as much as they would have wanted. Most of the farmers used the old program to a great extent and were satisfied with it. The new program presents many separate views, where some were satisfied and feel open to how the program can be extended in the future. Whilst some were dissatisfied mainly because of the limited data output, reducing the usefulness of the program. The key informant, as well as some farmers, pointed out that the limited output has resulted in that commercial herds are no longer provided the same applicability for the program. The views of how user-friendly the program was, ranged from easy to use to complicated, some expressing the need of attending a course to learn its functions better, including comments that it should be possible to have real-life courses and that these should be free during the transition process.

The key informant had recognized that it was a big difference in how farmers used the monitoring program. Most of the interviewed farmers could find some use of the program, conversely two of the farmers wanted to leave it having comments such as that it only cost them money but barely gave anything in return. All farmers used the program to register and report cows to the CDB register and to register data compulsory for purebred animals such as weights. Many farmers wanted to use it to monitor their production; however the use they could find for the program differed. A few used it a lot, whilst some did not use the program at all for monitoring, finding it easier to register data in other ways such as files in excel. A

common reflection was that the program could not be used for slaughter data. Some additional uses could be to group and handle animals in the program and to print out pedigree certificates. The use of breeding values differed; many farmers used them to plan their breeding in combination with other factors, whilst a few did not use breeding values at all but instead looked upon other traits when selecting animals. The key informant and some farmers expressed that breeding values could be hard to understand, reducing the function of them. More education could improve the use of existing breeding values.

When discussing improvements that would give the farmers more use of the program, it was the output data in general that was firstly mentioned. Most of them miss the old function "free lists" which was confirmed by the expert. This function made it possible to set together traits that the farmer wanted the cows listed after. The informants felt that it could give a great overview over the production traits and show selected groups of animals after the farmers' prerequisite. Many wanted to get information of cows on individual pages, and additionally a column where they could add free comments. Further on, some examples of enhancements could be improvements in handling groups of animals in the program, handle the information from slaughter and be able to suggest selected bulls after search criteria on cows. Many found the web reports given today limited, some looking forward to their expansion, whilst some found that the information they wanted could not be given only in templates because of their limited form.

Traits in breeding and breeding values

In general the farmers liked the breeding values that are present today, a common reflection that the expert recognizes. The view of how many additional breeding values that can be included differs. The farmers agree in that the values need to be safe with regard to the limited population to be included. Some however feel that there is room for more breeding values, whilst some farmers as well as the key informant feel that there is a risk with more breeding values; that they will not be useful since they already can be difficult to understand, especially for many producers. The key informant added that it had been a good measure to include the summarizing breeding-index, giving the farmers a choice to look at an overall value if they found the individual values difficult.

All farmers were interested in including conformation judgements in breeding; however the extent of included animals and the significance of the trait differed. This is a trait that the expert confirmed some farmers' devoted interest in. The bulls on the testing station are already conformation judged, however many farmers were additionally interested in the conformation of bull dams because of their genetic influence on many of the bulls mainly used for breeding in Sweden today. Some farmers were further interested in judging all breeding animals, preferable to be able to calculate breeding values or to show the animals standard. Some thoughts given on conformation judgements were that there need to be an organisation responsible for the judgements, with trained personnel on the different breeds, for it to be possible in Sweden. Opinions regarding if the trait should be calculated into breeding values or just stated with the animals differs equally among the informants.

Some farmers and the key informant showed interest in fertility measurements, a breeding value that is currently under development by the Swedish Dairy Association. This trait could include age at first calving and calving interval. Another breeding value mentioned by farmers is hoof and leg-health, in which they would want to include the reports given by the hoof trimmer and some also wanted the results from conformation to be included. Everyone agreed that hoof diseases should be minimized, but how often the hoofs need to be trimmed differs

from once per year to that it never should be needed. The goal for the trait thereby needs to be discussed to find what is reasonable to strive for in the populations. A few farmers expressed interest in including longevity as a breeding value; they felt that it was important for suckler cows to last long in the production to be profitable. A hot topic at the moment was meat and eating quality. Most of the farmers wanted to know more about the subject and follow the discussions on the topic before stating an opinion. Other traits that were suggested were feed efficiency for the bulls at the testing station with regard to that it is a very important trait but expensive to measure for the individual farmer. A few expressed hopes or dislikes for genomic selection in the future, but stated that it needed to be improved before being applicable.

All farmers initially expressed the importance of temperament, where some wanted it to be included as a breeding value whereas some felt uncertain of the possibility to include it as a breeding value because of the difficulty of recording it objectively. Additionally some felt that it worked fine to handle the trait as it is today. The opinions about cow weight were separate, from it being a very important trait to not important at all, and multiple factors such as the cows body condition score, feed efficiency, frame score, height etc. have been included in the discussion. Opinions about temperament and cow weight can be read below under each headline.

Temperament

All farmers as well as the key informant agree that temperament is one of the most important traits in breeding, half of them even stating that it is the most important. A common statement is that if a cow has a bad temperament, it will be culled immediately without regard for other traits or breeding values. However, many of the farmers and the expert mention that what is considered a “good” or “bad” temperament differs between persons, complicating the issue. They meant that even though a common thought is that everyone actively works against bad temperament, there are differences between what kinds of animal behaviours that are accepted at the farms. Some states that selling animals proven to have bad temperament would ruin their reputation. This is probably one of the reasons why people are so eager to state that all their animals have good temperament, and also increases the farmers need to actually sell good animals for breeding purposes. Nevertheless, some farmers can tell of others keeping animals that have bad temperament but have other qualifications as they in those cases regard higher. One example is an aggressive cow that defends her calf both around calving and at pasture, but is still kept because of her good production traits and in the hopes of producing high-quality offspring.

There are probably some farms keeping some animals with “bad” temperament because of the different judgements of what temperament is, as well as the problem with people not feeling free to talk about cows with less good temperament for the fear of a ruined reputation. This makes it hard to estimate an animal’s temperament, and many farmers states that they “need to see the animals themselves before buying”, an informant stated that “otherwise you have no idea what you get”. The producer stated that it “felt like one did not know what one got until after it was bought”, resulting in having to cull one bull intended for breeding directly after receiving it because of bad temperament. Everyone agreed that it is both genetic and environmental factors that can affect cows’ temperament. With environmental they both mean the environment that the animals grow up in as well as the staff handling the animals. Some also stated that cows could change temperament during lifetime due to some vital experience.

Description of temperament

Farmers describe cows with good temperament as having a fundamental calmness which makes them manageable, an argument that the expert often have heard. Some stated that they should work well within the herd and additionally some wanted them to function well also when separated from the herd for treatment, training etc. A cow with a good temperament should be possible to move when you need to handle it. Farmers describe cows considered to have a bad temperament to be nervous, jittery and vigilant. They can display flight behaviour in normal handling situations, or on the other hand be too intrusive. Many informants mentioned that nervous cows could be unpredictable and stressed when grouping animals, moving in other directions then intended. Moreover a few added that it was irritating when these cows took their calf with them too often so that the calves learnt to be afraid of humans. One interviewed however, never had problem with nervous cows not moving in the right direction when handled. A bad behaviour is further considered when a cow displays aggressive behaviour during for example handling, such as lowering their heads, show signs of attacking etc. Additionally, one farmer considered a bad behaviour when a cow was unnecessarily mean to other cows. A few meant that it was easiest to spot animals with bad behaviour by looking for the ones that differ in behaviour towards the rest of the herd.

The farmers as well as the key informant agreed on the temperament of the breeding bull; a bull with a good behaviour should move away when the farmer needs space and should not hinder the farmer when working in the herd. A bull considered to have a bad temperament can guard the herd from the farmer and/or be intrusive, butt with their heads etc. One farmer stated that it was unusual for the bull calves to be aggressive, since that behaviour often is displayed when they are older; the bull calves with bad behaviour are instead either too intrusive or nervous.

When asked what temperament is considered good and bad around calving; all stated that a cow with good temperament should want her calf and take care of it. When it comes to how much the cow is allowed to guard their calf the opinions are divided. About half of the farmers' state that the cows are never allowed to guard their calf from the owner and that the farmer should be able to weigh and tag the calf without any problems. Additionally one adds that even though they should not guard against the people working at the farm, it can be okay that they guard against strangers during the first days. One farmer states that it is okay that the cows guard their calves towards the farmer, however they should not attack. A few farmers found it acceptable that the cows guarded their calves with some small charges during the first days as long as they only guarded around their calf. One stated that preferable these cows should not do anything as long as you did not come between the cow and its calf. Some stated that cows are not allowed to guard the calves on pasture, one added that he had never herd of cows doing that, and one stated that it was okay that they guarded on pasture but that they should not attack. Generally informants stated that cows' temperament around calves are strongest the first days after calving.

Effects on production

The informants and the expert agree that the cows' temperament can affect the production, in which cows with bad temperament proposes safety risks for the persons working with the animals. These animals also take more time to handle increasing the labour costs. Many informants further agree that a cow with bad temperament influences the rest of the herd, changing their behaviour to the worse. One stated that "if a group of nervous cows gets out of the fence, they might be impossible to capture, which is one of the worst things that could happen". No farmer mentioned the concept of animal welfare initially, although when asked,

most of them said that it probably could affect the animals negatively because of cows with bad temperament being more stressed. A few stated that there probably was not much effect on their welfare; instead it was more a management problem that needed to be considered. When asked for traits that they could have seen being related to temperament, a few mentioned that possibly nervous animals had lower growth. Eating quality, DFD and feed efficiency was further mentioned by one informant. A few had not thought of the question at all earlier.

Selection on temperament

Selection on temperament is performed on the informants' farms and confirmed by the expert. It was hard for them to give a number on how many they culled due to bad temperament; generally they stated that there were few severe cases during the years they had been farmers. Many answered that they generally culled 1-2 mild cases because of bad temperament per year. This could often be heifers or young bulls that were selected to the slaughter group instead of kept or sold for breeding purposes, when showing signs of being too nervous or intrusive. Many pointed out that most of the animals that were not kept for breeding were excluded based on a decision on the overall impression, and that there were few that had all the other qualities and failed singly on temperament. When asked, most of the informants stated that they always reflected on the animals temperament when being around them, one stated that reflection about their temperament took place only if something happened in the herd. Almost all farmers stated that they had culled a cow that showed aggressiveness around calving, which was confirmed by the expert to be one of the common reasons for culling based on temperament. Additional reasons could be nervous animals, where two informants mentioned cows that bound their calves too tight to them, taking the calf away from humans, resulting in that the calves barely got any human contact. One brought up an example of a cow that had been aggressive both around calving but also at pasture, and one mentioned a cow being too aggressive toward other cows. Many mentioned that they culled calves after cows with bad temperament for fear of them turning out as their mothers. One farmer said that calves were not automatically culled for having a bad tempered mother, since her temperament could be the result of experience. Furthermore, one reason brought up for culling was a cow lacking maternal behaviour, not wanting her own calf. Other examples of culled animals because of temperamental reasons could be young bulls and one exemplified a breeding bull. One the other hand, many of the farmers could save one cow that had lower production if it had a really good temperament The reason was that it could fill some other purpose, such as being guidance for heifers at the pasture, resulting in a calmer, more well-functioning group, or keeping one for being their favourite cow. The key informant added that cows at producer's farms could be saved on their good temperament even if their production was a bit lower, because they often had little knowledge of what the cows actually produce and it saved a lot of time. A few farmers stated that they never saved a cow simply on its temperament, mainly because they felt that the cows overall were good and did not see any need for it.

Not many of the informants or the key informant had heard of others measuring temperament in Sweden. Most of the farmers initially told that they themselves had not measured temperament either. However, as the dialogue continued some of them had a system for measuring temperament at the same time as they weighed the calves, often documenting the extremes by noting them on a paper. The few informants who instantly told that they registered cows' temperaments additionally looked at temperament in situations where the cows were handled as well as when the calves were weighed. One of these farmers had previously used the old PC-KAPs function for listing temperament on the cow's individual

page. The ones not having a system for measuring temperament felt that it had worked well for them to select on temperament without testing or documenting it, a common way recognised by the expert. When asked, many of the informants felt that it was possible for them to linearly judge their cows' temperament, if there was a gain in doing so and a well-defined scale to use.

Overall, the informants and the key informant found that the method of measuring calves temperament individually through a box test was not transferable to Swedish conditions, due to the extra labour and the difference in upbringing. However, many were generally positive to a method were temperament could be looked upon whilst registering other traits, such as while weighing the calves. Some farmers had found registrations of temperament to be more reliable if it was possible to register data at several occasions, such as a few weighing's. A few found that if linear scoring of the animals' exterior was judged, then temperament could be registered at the same time. Some farmers pointed out that to be able to register the animals' behaviour it was important for them to be picked out of the herd, since their behaviour whilst being in the herd is often concealed. A few was keen on that if measurements would take place, then it had to be judged objectively by an external person, fearing that it would be too easy for people to misuse the scale. One expressed a hope for introducing registration of temperament at the bull performance testing station in Sweden, since their genes are widely spread to the population. One way, described by an informant, of how to show an animal's behaviour around humans was to video record the event. In that way it was possible for others to watch the film and give their own judgement over the animal's temperamental response.

Temperament as a breeding value

Many farmers express a satisfaction with the animals they can get hold of today, and find that farmers generally work towards better temperament. They feel that temperament of beef cattle today is overall very good in Sweden, and that good results can be obtained by continuing on as previously; with people selecting for good temperament by culling and not selecting the ones with bad temperament for breeding. The key informant confirms that she has heard many farmers reason in this way. Nevertheless, most of the farmers were additionally interested in a breeding value for temperament, as long as there was a labour and cost effective method that gave reliable and beneficial results. A few were not interested in a breeding value; mainly stating that there was a need for it but was sceptical that there were any trustworthy methods to use under Swedish conditions, one not feeling the need at all stating that temperaments were good as they were today. A few farmers mentioned that it was a common discussion amongst farmers to choose temperament by the choice of breed, a reflection that also the key informant have heard, however concluded that it was important not only to look on the breed as a whole but also on the individuals within.

Cow weight

The views on how important cow weights are differ greatly among the informants, a reflection supported by the expert. Some states that it is an important trait whilst a few claims the opposite. In addition, the key informant amongst a few others states that the trait is important in theory but do not have much importance in today's breeding, referring upon practical factors such as grouping animals according to maintenance needs. One difficulty when discussing cow live weight with farmers is that there are several associated factors involved affecting the weight. One of these factors that were mentioned by some of the farmers was the muscular development and carcass abilities, exemplifying that their impression over the cows' optimal size was not only affected by how large or small the cow was in height but also by its

muscular development. Some stated that good muscular development was more important than the cows' body size. Furthermore it was mentioned that weight could be affected by body condition score and frame score. The cows' weight could also be affected by the feed and pasture, stating that animals grazing on semi-natural pastures could give more economical benefits, even if they produced less and took longer time to reach their goal weights. The farmers' inclusion of several associated traits, upon discussing cow weights, makes it complicated to reach an answer of how important cow live weight is for them.

Description of cow weight

Most of the farmers are theoretically interested in the medium sized cows; mentioning a live weight of 800 kg on the heavy breeds, and about 50-150 kg lighter weight on the smaller breeds such as Hereford and Angus, There is an estimated difference of about 400 kg from the small individuals at 600 kg (550 kg light breed) to the heavy ones at 1000 kg (900-950 kg light breed). However, a few farmers found that practically the difference in size did not matter at all and a few found that all sizes were as good depending on their buyers' prevalence's. One farmer was more positive to the cows being slightly lighter because of less maintenance cost whereas another was more interested in the heavier ones since they were more appealing to the eye. The key informant had recognized that many farmers mainly discussed weight in relation to choice of breed, and less depending on individuals.

Effects on production

Almost all farmers think that the size of the cows will affect production factors in different ways, a fact confirmed by the expert. One general aspect is that heavier cows need more maintenance feed and some state that they need more space. On the other hand the farmers state that heavier cows produce more meat when slaughtered and give calves that reach higher slaughter weights. A few found that heavier cows got calves with higher birth weights, but many could not see any difference in that the smaller cows had any more problems around calving. A common reflection by many of the farmers was that a difference in size made the cows suitable for different types of pastures and conditions at farms, and a few thereby wanted to keep different types of cows to be able to meet their customers' diverse needs.

Selection on cow weight

There were few farmers stating that they culled cows depending on cow size. The expert agrees that culling cows for that reason is an uncommon practise in Sweden. However, one farmer stated that he culled about 1-2 animals per year due to size. Reflection on cow size only took place occasionally, for example when noticing the extremes. Regarding the weight depending on the cows body condition score; one opinion is that cows that feed their calf so much that they themselves lose too much weight get culled, whilst another stated that well grown calves at the cost of body condition is acceptable. Examples given of culled animals are the ones that are extreme in size.

There are about equal number of informants that only rarely have measured cow weight as there are farmers that have never measured it. This is consistent with the key informant who states that it is unusual to measure weight of the cows. Two informants have weighed their cows to a higher extent, in which one have used a live weight scale and one have got frame scores at the same time as the animals have been conformation judged. A few find that weights given from scales are a good measurement, whilst some find that the weights given are too biased because it does not reflect the animals body condition, conformation or height. Some examples of ways that were suggested to minimize this problem was to measure the animals height, measure height in combination with weight or conformation judge the animals

to calculate an overall frame score. When discussing a method of measuring cow weights at weaning of the calves in the autumn in Sweden, many find that it would be too expensive and labour demanding if no other activity was performed at the same time.

Cow weight as a breeding value

There were only few farmers interested in having cow weight as a breeding value, which accords with the impression the expert has, mainly because farmers in general have a hard time seeing what such a value could contribute with. Some are satisfied handling cow weight as today without the use of breeding value, whereas some additionally expresses that the choice of breed affect cow size more than the individual animals, reasoning that the effort could instead be put in choice of breed. However, a few express that cows today generally weigh more than what is shown in the books, giving problems when calculating feed costs. One of the informants interested in a breeding value on weights states that it could be interesting if both weight and height is included, and another if the method could be performed objectively or look at indirect measures such as growth and carcass data. A few states that focus could be put on only measuring the cow live weight of the bulldams, since it would result in a more cost effective method still giving an important genetic effect on the whole population. Some suggests that frame score could be given at the same time as conformation judgement, thereby no extra time for measuring weights would be taken. Some states that a higher interest in cows live weight could be achieved by introducing efficiency measures such as how much kg calf that is produced per kg live weight on the cow. One reflection is that when selecting for higher growth we indirectly get bigger animals, and that focus in breeding instead could be put on residual feed intake which would increase the number of animals possible to feed per hectare. Residual feed intake is expensive to measure, but could be added by genomic selection in the future or by measuring the bulls at the testing station.

Discussion

Interest for new registrations

Swedish farmers generally have a pronounced interest in breeding and selection of their beef cows, both in production and breeding herds, where some farmers describe an increased interest of the producers as their production sites get bigger. The farmers are aware that many production traits are heritable and know their importance for a functional production. In Sweden there is a long history of reporting data into a national database (Taurus, 2012a). Regardless of this, all farmers do not use breeding values to plan their breeding work. Many, but not all, of the farmers participating in the interviews for this thesis were using breeding values, and the practice is higher amongst breeders than producers. One important reason for this is that the values sometimes are hard to understand, and knowledge transfer to increase the usage is performed by Taurus continuously (Taurus, 2012a). Another reason, brought forward during the interviews, is that the breeding values cannot give the whole picture whether an animal is suitable for breeding or not, as an example they stated that temperament and longevity are today not accounted for by the values even though these traits are regarded very high in their work. This demonstrates a mismatch between the breeding goals given by the breeding organizations (Alarik & Hansson, 2009) and the breeding values (Näsholm, 2009), which could make farmers feel that the breeding values are less effective and less worth time spent learning. Additionally, some felt that traits automatically came with the breed, such as growth, temperament and milk production, and forgets the importance of within-breed differences and selection.

When asked, farmers state that they are satisfied with the breeding values given today. In addition, they express an interest to include more values in the breeding index if they have acceptable levels of accuracy, are important for production, are cost efficient and are easy to measure. There is an expressed fear that farmers will be more confused if too many values are present. However this problem is reduced with the newly introduced total merit index, where farmers can choose to only observe an overall value for each animal, and for the ones interested figures are given for each trait. This methodology, greatly reduced the risks for confusion, but makes it important that the total merit index captures as many traits important for production as possible for it to be a reliable resource.

Good maternal abilities and one life calf per year and cow is stated as very important for farmers. However, a tendency for differences between producers and breeders is observed for fertility traits. This is because some breeders could overlook a cow being empty for one year due to high merit in other traits, whilst for producers it is essential for their income. Longevity in the herd is based on productive life length of cows, and is similarly important for both producers and farmers. On the other hand, it has been seen in literature that when selecting for high growth which is correlated to high mature weight, longevity and fertility traits are reduced (Stewart & Martin, 1981; 1983; Marshall et al., 1984). Fertility and longevity are thereby recommended to be included in the breeding index to not deteriorate as an effect of a too narrow breeding index; where selection is focused on high growth and knowledge of farmers breeding work for fertility is lacking. There is work in progress to make fertility and longevity available as Swedish breeding values in the near future (Carlén, 2013, personal communication; Widebeck, 2013b).

The farmers consider the above traits as very important, as well as they express interest in temperament, feed efficiency, hoof and leg-health, and usage of linear conformation scores in breeding. Temperament is further described below. For feed efficiency, and hoof and leg-

health, no plans are given to include these traits in the evaluation in the near future due to difficulties in measuring these traits. Linear conformation scoring is recently introduced to Sweden (Widebeck, 2013a), and in the future breeding values given from the scores might come available. Many farmers follow the debate of marbling and want to learn more about it before it is introduced.

Since Swedish farmers generally have a pronounced interest in breeding and selection, but all farmers involved in the breeding activities are not using the breeding values available, the genetic progress of the breeds and at individual farms is not optimized. A suggested way, given in this thesis, to increase the usage of breeding values is to increase the trust in the total merit index by adding traits that better reflect the farmers' needs. Suggested additional values are measurements of fertility, longevity and temperament. Including these traits is seen as vital for an efficient production by Swedish farmers, and would result in a total merit index and breeding values that better reflects the breeding goals given by the breeders and the breeding societies.

Inclusion of temperament in the genetic evaluation

Interest in selection on the trait

Farmers in Sweden state that good temperament is one of their most important breeding goal, some also stating that it is their most important. Generally, they are satisfied with the temperament of the animals they can get hold of today, and agree that all farmers work towards better temperament. However, there is also another side of the trait, where farmers state that they often wish to observe the animals themselves before buying. This is because what is considered a "good" temperament differs between farmers, as well as farmers might be afraid of talking about animals having less attractive behaviour due to fear of a ruined reputation. Many farmers can still mention others keeping some cattle with poor temperament and also mention cases where themselves, neighbours or relatives have been closely involved in dangerous situations due to nervous or aggressive behaviour. Some cases are expressed during the interviews where animals are kept to produce offspring even though they have poor temperament.

That selection on temperament is needed is in accordance with literature study worldwide, as well as in agreement with the results of the temperament data presented in this thesis. The data revealed a high percentage of nervous but also aggressive behaviour of cows around calving, which is also described as one of the major threats for safety during handling of cattle in the system used today (Turner & Lawrence, 2007). The data further presented a low, but existing, number of aggressive cows during the manageability score and at pasture, where almost one fifth of the animals were nervous during handling. In this data no statistically significant effect of animal was found and it was therefore excluded from the model. This caused that repeatability could not be calculated for temperament. Reasons for the small effect of animal could be that the farm studied was in an expansion-phase and many of the cows did not have multiple recordings, that the observer was inconsistent in the recording or that the scale was not enough well defined. Today Swedish farmers are left to believe in the sellers' opinion about temperament, and no breeding values are estimated for the trait (Widebeck, 2012, personal communication). The method used for selection at herds in Sweden today is culling of the worst animals, which does not give as high genetic progress as if selection of only the best animals would occur due to the linear nature of the trait (Café et al., 2011).

Breed differences for temperament are prominent in the results of this thesis, and consistent with the experience of farmers and literature (Gauly et al., 2001; Café et al., 2011). In the result of this thesis, some breed groups had however low number of animals and therefore it is important to recognize that some breed effects might be a result of individual family lines and not representative for the whole Swedish population. Some farmers make decisions of temperament by their choice of breed, but during the interview Stenberg points out that selection on individual level is as important.

Effect on production

Many farmers recognize that cattle with poor temperament proposes safety risks for handlers and take longer time handling, which is confirmed also by research (Grandin, 1989). That poor temperament also causes lowered average daily gain, lowered meat quality (Voisinet et al., 1997; Café et al., 2011), and might cause reduced animal welfare due to unnecessary stress and safety risks for the animal itself (Grandin, 1989), is less known by farmers and therefore important to bring forward in the discussion of the trait. Good temperament is also positively correlated to good maternal behaviour (Le Neinde et al., 2002; Phocas et al., 2006). The reduced number of escape trials of animals with good temperament is positive for the handler and animal, but a supervision of the trait is needed to ensure that selection for calm animals does not lead to risks for animal fitness traits, such as good health and physical condition; especially since fitness has a high value for Swedish producers due to the pasture based systems and strict animal welfare legislations (DF 1988:539).

Selection and methodologies

Temperament is known to have a moderate heritability, and in many countries worldwide it is included in the genetic evaluation, and shown to greatly improve the trait after inclusion (Hyde, 2010). Several of these methodologies are cost and time effective, and could be applicable to Swedish conditions.

The “docility test”, used by for example Australia (Breedplan, 2013a) and North America (NALF, 2013), is especially interesting due to the similarities with Swedish conditions described below. Measurements are taking place at the same time as the weaning weighing is registered, and therefore reduces the time needed. The scorer is the farmer himself but the heritability for the trait measured is regardless of this still proven to be high enough for an efficient selection due to corrections for handler effects with BLUP-methodology. The scale used for registering temperament is easy to use and descriptive, including a five grade scale from calm to aggressive. When interviewing Swedish farmers many were already observing the calves temperament during the weighing, making the test situation easy applicable for them. The farmers have also stated that they could, if they had access to a well-defined scale, easily judge temperament of their animals on a linear scale. The method measures the calves when separated from the herd at a young age and previous contact to humans have been scarce, which in literature is described to increase the heritability. Also, the method directly measures an animal’s response to human handling, which has been seen to be one of the most efficient ways of improving cattle behaviour (Burrow, 1997). The animal’s age, sex, handler, time spent indoor, year and season affect the results of the registrations, but this is easily adjusted for in the BLUP-evaluation (Taurus, 2012a). A recommendation based on these findings, is that temperament, defined as handling by humans, should be included in the genetic evaluation of Swedish beef cattle. The method suggested is the docility test. For the flight speed test to be used, more research has to be done in order to see if it is suitable for Swedish conditions. The registrations recorded at pasture in this study are not good enough to use as temperament measurements since they present low variation. This is probably due to

the test situation were animals are not separated from the herd; making it difficult to observe individual animal behaviour (Le Neindre et al., 1995). The overall manageability score gave greater differences in behaviour, but is measured at old animals in non-specified environments. Informants during the interview points out, and literature confirms, that values based on these conditions gives lower heritability (Le Neindre et al., 1995; Boissy et al., 2005; Café et al., 2011).

Selection against aggressive behaviour around calving is important in order to further increase the safety of farmers (Turner & Lawrence, 2007). Aggression due to maternal defence is a heritable trait, which probably cannot be observed during for example a docility test. Turner & Lawrence (2007) suggested that this trait was possible to measure by farmers at the same time as ear tagging, which is supported by the results of this thesis where differences in temperament reactions easily could be observed. If the scale should consist of two (aggressive or non-aggressive), three- (calm, nervous, aggressive) or more grades must be discussed before implementation. The choice of scale depends on if nervousness can be considered as a linear form of aggression, and on how well the scale can be applicable and understood. In Swedish rearing models cows often calve indoor or in enclosed areas, which diminishes the risk for predator attacks and extreme flight instincts where cows leave their calves permanently when calves are handled. Therefore selection against aggressive behaviour of the cow, when handling the calves, will not risk calf survival. It is important when breeding for this trait, to continue the selection for cows that exhibit good maternal behaviour and not premier cows that do not take care of their calves. Aggression around calving is described by farmers and in literature, as well as the results of the statistical analysis, to be one of the most risky events in handling of animals. A recommendation based on the finding in this study, in addition to the docility test, is to also include a separate breeding value for defensive aggressiveness around calving. This would greatly reduce the safety risks for farmers upon handling cows with newborn calves.

Inclusion of mature cow weight in the genetic evaluation

Interest in selection on the trait

Already in 2003, Fjelkner described a low priority for cow weight amongst the breeders in Sweden, and today this is still true. Although weight is considered an important trait by some, the difference of what informants includes in the trait, their goal with it and how it could be measured, is at the moment too disperse to be able to construct a successful single breeding value out of the answers of the interview. Associated factors when describing the trait were; body condition score, height, frame score, muscular development, carcass abilities, milking abilities, maintenance needs, possibilities to feed on different pastures and grouping possibilities. The informants differences in describing cow weight, results in difficulties to reach a common description and goal for selection of the trait. This makes it hard to establish how the trait could be improved in the future to give the highest economical profit as possible for the farmers.

Few farmers measure the weight of their cows and selection based on size is an uncommon practise in Sweden. There is a risk that many farmers are not aware of the actual weight of their cows, giving problems estimating feed costs, especially since these figures are thought by some to be higher than stated in literature. Some farmers estimated a medium sized cow in Sweden to weight around 800 kg for the heavy breeds, and about 50 to 150 kg less for a light breed. This number is in accordance with data from this study, except for the breed differences. In the data, the mean weights for the breeds at the different occasions, in the age

group of five years or more, varied from 700 to 820 (taking away one cow that weigh more than 1000 kg). These values are much higher than the average values stated in literature for heavy breeds (Nadarajah et al., 1984; Johnson et al., 2000). The big difference in weights can differ between countries' breeding material and breeding goals. Nonetheless, it still needs to be recognised and questioned if these weights are optimal for Swedish conditions, or if they are high just because mature cow weight and its implications have not been given much thought by Swedish farmers.

In the literature there is a difference in weight between breeds and between heavy and light breeds (Arango et al., 2002a), which could not be observed in the results of this thesis. In the analysed data; Angus, Simmental and the crossbred group had similar autumn weights, showing that choice of breed did not affect the weight of the cows. Instead season and year had a greater effect in the study. Many farmers in the interview stated that they themselves and others choose size by choice of breed. However, due to lack of knowledge about the mature cows' weight in the Swedish population, it can be hard to know how much cows actually differ in size between breeds, and what the actual differences are between weights of light and heavy breeds. No significant differences were seen between breeds in the data and more studies have to be performed to see if breed differences still exist for the Swedish populations. When the differences between breeds are minimized, the benefits of choosing breed and use of crossbreeding schemes in beef production herds might be reduced (Cundiff et al., 1993).

Effect on production

Heavy mature cow weight does on one hand affect the production costs negatively due to higher maintenance needs (Evans et al., 2002) and larger space requirements in barns (SJVFS 2010:15 Saknr L 100), factors that might be overlooked in the Swedish production today due to limited knowledge of the cow weight in relation to difficulties in estimating the value of forage (Golden et al., 2000). On the other hand, high mature weight can give higher potential growth of calves (Jones et al., 1984; Marshall et al., 1984) and higher cull cow values (Golden et al., 2000), and these values are much more easily accessible through reports from slaughter houses. The optimal cow size to reach a good economical result depends on the farms conditions (Marshall et al., 1984; Stenberg, 2008). However, the different accessibilities between results of costs and incomes, makes it difficult for farmers to estimate their optimal cow size for a good economical result if no careful calculations are undertaken. The expert stated during the interviews that only a few farmers had this type of knowledge.

A risk when selecting for high growth, as performed during Swedish conditions, is that if not correlated traits are registered, such as mature cow weight, these traits can change in the populations without being noticed (Jones et al., 1984; Marshall et al., 1984). This could be one of the reasons why mature cow weight are much higher in this study of Swedish breeding stock, compared to literature of other countries. Similarly, traits that are negatively correlated to high growth, such as fertility and longevity, are important to consider since they could have detrimental effect if not simultaneously selected for (Stewart & Martin 1981; 1983). The negative sides of selecting for higher growth were not mentioned by the farmers in the interviews; one reason could be that the correlated relationships to other traits are not well-known by Swedish farmers today.

Selection and methodologies

Mature cow weight has an intermediate to high heritability and is easy to observe, which makes the trait easy to put selection pressure on (Brinks et al., 1962; Arango et al., 2002b).

There are many optional ways of measuring cow weight described in literature that could also be applicable to Swedish conditions. Some examples are by weighing the cows in the autumn at the same time as the calves 200 days weight is registered, or by measuring hip height in combination with body condition score at the age of two years. However, the interest for including the trait in the genetic evaluation is low amongst Swedish farmers taking into account the time it would take to measure it. The trait is moreover, not addressing the goal for reduced maintenance cost directly (Golden et al., 2000), reducing the usefulness of using mature cow weight as a breeding value. One possible way of still observing mature cow weight is by indirectly be aware of size differences, this could be done by using the size given in the linear conformation scoring which is newly introduced in Sweden (Widebeck, 2013a). Size given by scorers would give farmers the possibility to learn sizes of cows, but needs to be placed in relationship with what that size means in terms of weight and overall maintenance needs, to be able to use it for selection purposes. The best use for measuring cow weight would in theory be to estimate directly the feed efficiency (Evans et al., 2002), since that is what should be enhanced. However, at the moment this is not possible in Sweden.

Selection on mature cow weight could become increasingly important in the future if the consumers demand for products that give less effect on the climate increases. In the long term perspective this could benefit the human food production, resulting in more sustainable food resources. If more consumers request for a more environmentally friendly production, then it would be beneficial for farmers to breed for mature cow weight by setting goals of low maintenance needs and an optimal mature cow size per kilo meat produced for their production system. The farmers' knowledge of and interest in cow weight is currently low and no shift in breeding goal for the trait will occur until the debate is enhanced and there comes an increased need for farmers to select on this trait.

Based on this, it is not recommended to include mature cow weight in the Swedish genetic evaluation at this time. On the other hand, the knowledge of the cows' weight in the Swedish herds need to be improved to be able to select optimal cow sizes for different farm conditions, and also to ensure that light and heavy breeds keep their distinct characteristics separated from each other to function within crossbreeding programs. The high heritability and easiness to phenotypically observe the trait, makes it easy for farmers to breed towards a goal even though the trait would not be accounted for in the genetic evaluation. For this to occur, the breeders and breeding organisations need to know and address the goal weight of the cows more directly.

Conclusion

To achieve a higher interest for breeding values, it is suggested to include new recordings, such as temperament, longevity and fertility, since it would capture the interests of the farmers and their breeding goals better. By including temperament during handling and aggressive behaviour around calving in the genetic evaluation, the safety for workers, animal welfare and productivity at the Swedish farms could be improved. It is however not recommended to include mature cow weight in the genetic evaluation at present, due to lack of interest and thereof given benefits by inclusion of the trait. However, the knowledge amongst farmers of the cows' weights needs to be improved.

Reference list

Arango, J. A., Cundiff, L. V. & Van Vleck, L. D. 2002a. Breed comparisons of Angus, Charolais, Hereford, Jersey, Limousin, Simmental, and South Devon for weight, weight adjusted for body condition score, height, and body condition score of cows. Journal of Animal Science 80, 3123-3132.

Arango, J. A., Cundiff, L. V. & Van Vleck, L. D. 2002b. Genetic parameters for weight, weight adjusted for body condition score, height, and body condition score in beef cows. Journal of animal science 80, 3112-3122.

Bates, J. E. 1989. Concepts and measures of temperament. In: Temperament in childhood (eds. G. A. Kohnstamm, J. E. Bates & M. Klevjord Rothbart), 3-26. Wiley, NY.

Birgersson, M., Hjalmarsson, F. & Wätthammar, T. 2011. Dikors vikt och hull. Sveriges Lantbruksuniversitet, Institutionen för husdjursgenetik, Agrosystem, projektarbete.

Boissy, A., Fisher, A. D., Bouix, J., Hinch, G. N. & Le Neindre, P. 2005. Genetics of fear in ruminant livestock. Livestock Production Science 93, 23-32.

Bouissou, M.F. & Gaudioso, V. 1982. Effect of early androgen treatment on subsequent social behavior in heifers. Hormones and Behavior 16, 132-146.

Breedplan. 2013a. University of New England, Armidale, NSW, 2351, Australia. http://breedplan.une.edu.au/ (Online 2013-06-02).

Breedplan. 2013b. Recording Docility Scores. http://breedplan.une.edu.au/tips/Recording%20Docility%20Scores%20.pdf (Online 2013-06-02).

Breedplan. 2013c. Understanding Trial Flight Time EBVs. http://breedplan.une.edu.au/tips/Understanding%20Trial%20Flight%20Time%20EBVs.pdf (Online 2013-06-02).

Breedplan. 2013d. Overview. http://breedplan.une.edu.au/index.php?option=com_content&task=view&id=5&Itemid=28 (Online 2013-06-02).

Breedplan. 2013e. Understanding Mature Cow Weight EBVs. http://breedplan.une.edu.au/tips/Understanding%20MCW%20EBVs.pdf (Online 2013-06-02).

Brinks, J. S., Clark, R. T., Kieffer, N. M. & Quesenberry, J. R. 1962. Mature weight in Hereford range cows - heritability, repeatability, and relationship to calf performance. Journal of Animal Science 21, 501-504.

Burrow, H. M., Seifert, G. W. & Corbet, N.J. 1988. A new technique for measuring temperament in cattle. Proceedings of the Australian Society of Animal Production 17, 154-157.

Burrow, H. M. 1997. Measurements of temperament and their relationships with performance traits of beef cattle. Animal Breeding Abstracts 65, 477-495.

Burrow, H. M. 2001. Variances and covariances between productive and adaptive traits and temperament in a composite breed of tropical beef cattle. Livestock Production Science 70, 213-233.

Café, L. M., Robinson, D. L., Ferguson, D. M., McIntyre, B. L., Geesink, G. H., and Greenwood, P. L. 2011. Cattle temperament: Persistence of assessments and associations with productivity, efficiency, carcass and meat quality traits. Journal of Animal Science 89, 1452-1465.

Carlén, E. May 2013. Personal communication. Växa Sverige.

Choy, Y. H., Brinks, J. S. & Bourdon, R. M. 2002. Repeated-measure animal models to estimate genetic components of mature weight, hip height, and body condition score. Journal of Animal Science 80, 2071-2077.

Cundiff, L. V., Szabo, F., Gregory, K. E., Koch, R. M., Dikeman, M. E. & Crouse, J. D. 1993. Breed comparisons in the germplasm evaluation program at MARC. Proceedings Beef Improvement Federation 25th Anniversary Conference. Asheville, North Carolina.

Djurskyddsförordning 1988:539.

European Council regulation 1760/2000. Establishing a system for the identification and registration of bovine animals and regarding the labeling of beef and beef products and repealing Council Regulation (EC) No 820/97. The European Parliament and the Council of the European Union.

Evans, J. L., Golden, B. L., and Hough B. L. 2002. A new genetic prediction for cow maintenance energy requirements. Proceedings Beef Improvement Federation Symposium, Oklahoma State University, Stillwater, 79–88.

Evans, R. D., Pabiou, T., Kearney, F. & Mulder, H. A. 2009. Multi-breed genetic evaluation for docility in Irish suckler beef cattle. Proceedings of the Interbull Meeting in Barcelona 2009, Spain, Interbull Bulletin 40, 127-131.

Fjelkner, J. 2003. Underlag för konstruktion av ett urvalsindex för de svenska köttraserna. Sveriges Lantbruksuniversitet, Examensarbete 245.

Fjelkner, J. 2007. Att hullbedöma dikor (eds. Stenberg, H). Taurus Köttrådgivning AB, Lofta.

Fordyce, G., Goddard, M.E., Seifert, G.W. 1982. The measurement of temperament in cattle and the effect of experience and genotype. Proceedings of the Australian Society of Animal Production. 14, 329-332.

Fordyce, G., Howitt, C. J., Holroyd, R. G., O'Rourke, P. K. & Entwistle, K. W. 1996. The performance of Brahman-Shorthorn and Sahiwal-Shorthorn beef cattle in the dry tropics of northern Queensland 5. Scrotal circumference, temperament, ectoparasite resistance, and the genetics of growth and other traits in bulls. Australian Journal of Experimental Agriculture 36, 9-17.

Gauly, M., Mathiak, H., Hoffmann, K., Kraus, M., & Erhardt, G. 2001. Estimating genetic variability in temperamental traits in German Angus and Simmental cattle. Applied Animal Behaviour Science 74, 109-119.

Glenske, K., Brandt, H., Prinzenberg, E., Gauly, M., & Erhardt, G. 2010. Verification of a QTL on BTA1 for temperament in German Simmental and German Angus calves. Short Communication. Archiv Tierzucht 53, 388-392.

Glenske, K., Prinzenberg, E.-M., Brandt, H., Gauly, M. & Erhardt, G. 2011. A chromosome-wide QTL study on BTA29 affecting temperament traits in German Angus beef cattle and mapping of DRD4. Animal 5, 195-197.

Golden, B. L., Garrick D.J., Newman, S. & Enns, R.M. 2000. Economically relevant traits: A framework for the next generation of EPDs. Proceedings of the 32nd Research Symposium and Annual Meeting of the Beef Improvement Federation, 2-13.

Grandin, T. 1989. Behavioral principles of livestock handling. Professional Animal Scientists 5, 1-11.

Hessle, A., Olsson, I. & Englund, J-E. 2010. Samband mellan bröstomfång och levandevikt hos växande nötkreatur. Sveriges lantbruksuniversitet, Institutionen för husdjurens miljö och hälsa, Rapport 24.

Hyde, L. 2010. Limousin Breeders Tackle Temperament – Genetic trend shows power of selection. http://nalf.org/pdf/2010/aug19/tackletemperament.pdf (Online 2013-05-22)

Irish Cattle Breeding Federation (ICBF). 2013. Highfield house, Newcestown Road, Bandon Co. Cork, Ireland. http://www.icbf.com/ (Online 2013-06-02).

Johnson, Z. B., Brown, A. H., Rosenkrans, C. F. & Hornsby, J. A. 2000. The Professional Animal Scientist 16, 213-219.

Jones, S. D. M., Burgess, T. D., Wilton, J. W. & Watson, C. H. 1984. Feedlot performance, carcass composition and efficiency of muscle gain in bulls and steers of different mature size slaughtered at similar levels of fatness. Canadian Journal of Animal Science 64, 621-630.

Jordbruksverket. 2012. Nötkreaturssektorns uppbyggnad. Statistikrapport 2012:03.

Jordbruksverket. 2013. Antal nötkreatur i december 2012. JO 23 SM 1301.

Kvale, S. 1997. Den kvalitativa forskningsintervjun. Studentlitteratur, Lund, Sweden.

Laster, D. B., Smith, G. M. & Gregory, K. E. 1976. Characterization of biological types of cattle IV. postweaning growth and puberty of heifers. Journal of Animal Science 43, 63-70.

Le Neindre, P., Trillat, G., Sapa, J., Menissier, F., Bonnet, J. N., & Chupin, J. M. 1995. Individual differences in docility in Limousin cattle. Journal of Animal Science 73, 2249-2253.

Le Neindre, P., Murphy, P. M., Boissy, A., Purvis, I. W., Orgeur, P., Bouix, J. & Bibé, B. 1998. Genetics of maternal ability in cattle and sheep. Proceedings of the 6th world congress on genetics applied to livestock production 1998, Armidale, 23-30.

Le Neindre, P., Grignard, L., Trillat, G., Boissy, A., Menissier, F., Sapa, F & Boivin, X. 2002. Docile Limousine cows are not poor mothers. Proceedings of the 7th world congress on genetics applied to livestock production 2002, Montpellier, communication 14-13.

Lukkarinen, J. & Lannhard Öberg, Å. 2012. Svensk produktion och konsumtion. In: Marknadsöversikt – mjölk och mejeriprodukter. Jordbruksverkets Rapport 2012:7.

Lärn-Nilsson, J. 2006. Köttraser. In Naturbrukets husdjur, del 2, 430-433. Alfa print, Sundbyberg, Sweden.

MacNeil, M.D. 2005. Genetic evaluation of the ratio of calf weaning weight to cow weight. Journal of Animal Science 83, 794-802.

Marshall, T. E., Mohler, M. A. & Stewart, T. S. 1984. Relationship of lifetime productivity with mature weight and maturation rate in Red Poll cows. Animal Production, 39:383-387

Mc Hugh, N., Evans, R. D., Amer, P. R., Fahey, A. G. & Berry, D. P. 2011. Genetic parameters for cattle price and body weight from routinely collected data at livestock auctions and commercial farms. Journal of Animal Science 89, 29-39.

McLaren, J. B., Morrow, R. E. & Butts, W. T. 1982. Impact of numbers and frequency of weighings on bovine weight-age curve parameters. Journal of Animal Science 54, 51-57.

Monteiro, L.S. 1969. The relative size of calf and dam and the frequency of calving difficulties. Animal production, 11; 293-306.

Nadarajah, K., Marlowe, T. J. & Notter, D. R. 1984. Growth patterns of Angus, Charolais, Charolais-Angus and Holstein-Angus cows from birth to maturity. Journal of Animal Science 59, 957-966.

North American Limousin Foundation (NALF). 2013. 6 Inverness Court East Suite 260 Englewood, CO 80112-5595. http://nalf.org/ (Online 2013-06-02)

Northcutt, S. L. & Wilson, D. E. 1993. Genetic parameter estimates and expected progeny differences for mature size in Angus cattle. Journal of Animal Science 71, 1148-1153.

Näsholm, A. 2009. Avelsindex för de svenska köttraserna. Sveriges Lantbruksuniversitet, Institutionen för husdjursgenetik, rapport 146.

Näsholm, A. & Hansson, M. 2009. Avelsarbete med nöt i Sverige. In: Avel i ekologiska besättningar (eds. M. Alarik & M. Hansson), 11-13. Repro Ultuna, Uppsala, Sweden.

Philips, A. 2004. Genetic effects on the mature weight of cattle. Northern Territory Government, Department of Primary Industry, Fisheries and Mines. Agnote J78.

Phocas, F., Boivin, X., Sapa, J., Trillat, G., Boissy, A. & Le Neindre, P. 2006. Genetic correlations between temperament and breeding traits in Limousin heifers. Animal Science 82, 805-811.

Röken, B., Larsson, I. & Johansson I. A. 2006. En studie av kalla stallar för dikor och ungdjur. Länsstyrelsen Östergötland, rapport 2006:25.

SAS. 2011. SAS ® Proprietary Software, Version 9.3. SAS Institute Inc., Cary, NC, USA.

Schmutz, S. M., Stookey, J. M., Winkelman-Sim, D. C., Waltz, C. S., Plante, Y. & Buchanan, F. C. 2001. A QTL study of cattle behavioral traits in embryo transfer families. The Journal of Heredity 92, 290-292.

SJVFS 2010:15 Saknr L 100. Föreskrifter och allmänna råd om djurhållning inom lantbruket m.m.

Stenberg, H. 2008. Tunga eller lätta kor - det är frågan? http://www.taurus.mu/aciro/Websidor/VisaSida.asp?Idnr=C7vt1nDfFrDI0Jzjf10h752BT9bEHvWTONNuDO9Rdb7vDqnWL6aGQHqRuGFI (Online 2013-06-04).

Stewart, T.S. & Martin, T.G. 1981 Mature weight, maturation rate, maternal performance and their interrelationships in purebred and crossbred cows of Angus and milking Shorthorn parentage. Journal of Animal Science 52, 51-56.

Stewart, T.S. & Martin, T.G. 1983. Optimal mature size of Angus cows for maximum cow productivity. Animal Production 37, 179-182.

Stormwall, E. Nov 2012. Personal communication. Svensk Mjölk.

Svensk Köttrasprövning. 2013a. English. http://www.kottrasprovningen.se/english.html (Online 2013-05-1).

Svensk Köttrasprövning. 2013b. Exteriörbedömning. http://www.kottrasprovningen.se/extbed.html (Online 2013-06-04).

Svensk Mjölk. 2010. Limousin ökar igen. KAP Nyhetsbrev 2010, Nov.

Svensk Mjölk. 2012a. 2012 Husdjursstatistik. http://www.taurus.mu/aciro/bilddb/objektvisa.asp?Idnr=PHXaZ8BqZuYJITxLUcgVeL9gokCnsbj10o4PFVuFFuXvk74r6FipGKPLRGse&ext=.pdf (Online 2013-06-06).

Svensk Mjölk. 2012b. Trend mot tidigare kalvningar. KAP Nyhetsbrev 2012, Nov.

Svensk Mjölk. 2013. Avelsvärden för bruksegenskaper Gemensam Nordisk Avelsvärdering (NAV) 2005. http://www.svenskmjolk.se/Global/Dokument/EPi-tr%C3%A4det/Mj%C3%B6lkg%C3%A5rden/Avel/Avelsv%C3%A4rden%20f%C3%B6r%20bruksegenskaper%20NAV.pdf (Online 2013-05-13).

Taurus, 2012a. KAP. http://www.taurus.mu/sitebase/Default.aspx?idnr=6PkFtbBF26BGXTzLeBQ6iNpFibuNbP4eion8u4VgNbctgD6vbA02HaUCQ1XC (Online 2012-11-28).

Taurus. 2012b. Taurus köttrådgivning AB. http://www.taurus.mu/sitebase/default.aspx?idnr=jkmnGrCu0N3H68zBDGDGJNQTXadbehlorv259CFCFIMPSWZcahou5CBIPVcd (Online 2012-11-28).

Trost, J. 2010. Kvalitativa intervjuer. 4.uppl. Studentlitteratur, Lund, Sweden.

Tulloh, N. M. 1961. Behaviour of Cattle in Yards. II. A study of temperament. Animal Behaviour 9, 25-30.

Turner, S.P. & Lawrence, A.B. 2007. Relationship between maternal defensive aggression, fear of handling and other maternal care traits in beef cows. Livestock Science 106, 182-188.

Voisinet, B. D., Grandin, T., Tatum, J. D., O'Connor, S. F. & Struthers, J. J. 1997. Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. Journal of Animal Science 75, 892-896.

Widebeck, L. Nov 2012. Personal communication. Svensk Mjölk.

Widebeck, L. 2013a. Exteriörbedömning blir nytt verktyg i aveln. Nötkött 1.

Widebeck, L. 2013b. Avel för hållbara kor. Nötkött 1.

Widebeck, L. 2013c. Fogdegården sätter lynne främst. Nötkött 1.

Appendix 1. Guide for interviews

Farm and breeding goals

- Description of farm
- Interest in breeding
- Breeding goal
- Choice of breed

Registration of data and breeding values

- Monitor program
- Registration of traits
- Interest in new traits
- Breeding values

Temperament

- Interest in temperament
- Good/bad
- Effects on production
- Connection to other traits
- Selection
- Measurement methods
- Breeding value

Cow weight

- Interest in cow weight
- Good/bad
- Effects on production
- Connection to other traits
- Selection
- Measurement methods
- Breeding value

Additional thoughts

Regarding breeding and breeding values