Genetic parameters of linear type traits for beef cattle and their correlation with production of Simmental cows
by David Paul Kirschten

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal and Range Sciences
Montana State University

Abstract:
Data provided by ABS Global were used to estimate genetic parameters of linear type traits for Simmental females. Scores were collected by 36 evaluators from 1988 to 2000. Body traits evaluated were stature, body length, muscle, capacity, femininity, rear leg set, and feet and pasterns. Udder traits evaluated were udder attachment, udder depth and, teat size. Body condition score was also included. Scores were assigned based on a 50 point linear scale. Body condition was assigned based on a 9 point scale. The number of animals evaluated for body traits ranged from 14,317 to 14,322. The number of animals evaluated for udder traits ranged from 8,046 to 8,052. The number of animals evaluated for body condition score was 9,230. All traits were analyzed using an animal model and MTDFREML procedures to estimate genetic parameters. The statistical model for all traits included the additive direct genetic (animal) effect and the fixed effects of age of cow and contemporary group. Heritability estimates ranged from 0.12 to 0.60. Genetic and phenotypic correlations differed in magnitude and sign among traits. In general, parameter estimates were within the range of those previously reported in the literature. Results from the study established. that with selection it is possible to change type traits in Simmental cattle. Measures of production in Sinunental cattle were regressed on linear type traits. Measures of production considered in the study were: number of calves, calving interval, calf adjusted birth weight, calf average adjusted weaning weight, and total calf adjusted weaning weight. Results from this study established that there were significant ($P < .05$) relationships among the traits and many measures of production. The relationships differed in magnitude and sign among the traits and measures of production.

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APPROVAL

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David Paul Kirschten

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date 8/10/2001

This work is dedicated to my dad, James D. Kirschten.

I think he would appreciate this project.

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I have had opportunities to express my appreciation for people that have had an effect in my life several times over the years. At any time that I have had an opportunity to do so, I invariably and unintentionally left someone out. I do have a few people that I would like to take this opportunity to thank, however.

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I want to thank my Godfather R. W. (Dobs) Sonsalla for reminding me of the basics (graze 'em boys, graze 'em; it takes so much grass to make a pound of beef; bulls are the best hired men we ever had; and last, the cows don't always read the same book we do).

To the rest of my friends, instructors, and colleagues: I hope that I have shown you how important you are to me and how much I appreciate your friendship, by treating you in such a manner that you know it.

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ABSTRACT

Data provided by ABS Global were used to estimate genetic parameters of linear type traits for Simmental females. Scores were collected by 36 evaluators from 1988 to 2000. Body traits evaluated were stature, body length, muscle, capacity, femininity, rear leg set, and feet and pasterns. Udder traits evaluated were udder attachment, udder depth and, teat size. Body condition score was also included. Scores were assigned based on a 50 point linear scale. Body condition was assigned based on a 9 point scale. The number of animals evaluated for body traits ranged from 14,317 to 14,322. The number of animals evaluated for udder traits ranged from 8,046 to 8,052. The number of animals evaluated for body condition score was 9,230. All traits were analyzed using an animal model and MTDFREML procedures to estimate genetic parameters. The statistical model for all traits included the additive direct genetic (animal) effect and the fixed effects of age of cow and contemporary group. Heritability estimates ranged from 0.12 to 0.60. Genetic and phenotypic correlations differed in magnitude and sign among traits. In general, parameter estimates were within the range of those previously reported in the literature. Results from the study established that with selection it is possible to change type traits in Simmental cattle. Measures of production in Simmental cattle were regressed on linear type traits. Measures of production considered in the study were: number of calves, calving interval, calf adjusted birth weight, calf average adjusted weaning weight, and total calf adjusted weaning weight. Results from this study established that there were significant ($P < .05$) relationships among the traits and many measures of production. The relationships differed in magnitude and sign among the traits and measures of production.

CHAPTER 1

INTRODUCTION

The question of whether type is related to production has been of interest to breeders for many generations. Since man has tried to improve his cattle, he has usually selected on the basis of subjective evaluation of their usefulness for different purposes by visual appraisal (Brown et al., 1953). The importance of desirable conformation was recognized early by dairy breeders on the Island of Jersey when the first score card or scale of points was made in 1834 (Copeland, 1938). Not only has conformation been important to dairy producers, beef producers have used visual appraisal as well. Robert Bakewell used visual assessment in the selection of breeding stock for his experiments (Miles, 1893).

In a USDA Audit (Table 1), producers ranked 10 factors that they used to determine desirability of purchased seedstock. The top ranking factor, structural soundness/appearance, was rated very or extremely important by 94.5% of producers who completed the survey. In contrast, factors generally considered scientifically proven to be of economic value such as weaning and yearling weights, birth weight, scrotal circumference, and Expected Progeny Differences (**EPD**), were ranked as very or extremely important by 64.1%, 59.7%, 57.2% and 44.2% of producers, respectively.

Table 1. Factors considered in purchasing or selecting a bull.

Factor	Rating Very or Extremely Important, %
Structural soundness/appearance	94.5
Breed	88.0
Temperament	86.3
Price	68.2
Weaning and Yearling Weights	64.1
Reputation of the Breeder	61.9
Birth Weight	59.7
Hip Height/Frame score	58.8
Scrotal circumference	57.2
EPD	44.2

Taylor and Field (1999) ranked the economically important traits in beef cattle as: 1) reproductive performance, (2) weaning weight, (3) yearling weight, (4) feed efficiency, (5) carcass merit, (6) longevity, (7) conformation, (8) freedom from genetic defects, (9) disposition, and (10) adaptability. There is a definite disparity between the traits that have been scientifically proven to be of economic importance and the traits for which producers are actually selecting.

There may be important relationships between conformation/linear type traits and economically important performance traits. In the same USDA Audit, producers ranked the reasons they replaced bulls in the following order: infertility, structural unsoundness or physical injury, size, quality of the calves sired, temperament, disease, too many daughters in the herd, and age (Coe, 1999).

In response to producers' questions about how the progeny of a particular bull looked or what bull to use to correct conformational problems, Keith G. Vander Velde of American Breeders Service (now ABS Global) presented a plan of action to the

International Stockmen's Educational Foundation in 1989. American Breeders Service decided to evaluate those traits about which most producers asked questions: udder attachment, udder depth, teat size, stature, femininity, capacity, body length, muscling, rear leg set, and feet and pasterns. Body Condition Score (**BCS**) was evaluated as well because earlier studies indicated that BCS was important in changing type scores. In May 1988, ABS launched the Beef Genetic Trait Summary (**GTS**) program (Pope, 1989). By May 2001, 53 trained evaluators had evaluated over 120,000 animals. There were approximately 80,000 Red and Black Angus, 21,000 Simmental and 20,000 other animals consisting of Hereford, Polled Hereford, Limousin, and Gelbvieh that had been evaluated (D. Frank, personal communication). It is important to note that ABS evaluators scored progeny of ABS bulls as well as progeny of bulls from other AI studs and progeny from natural service and clean-up bulls. Progeny of these bulls were evaluated, not the bulls themselves.

In July 1998, ABS Global and the American Simmental Association (ASA) forged a partnership to jointly fund a project to evaluate the Simmental GTS data. The objectives were to determine: a) heritability of the GTS traits, b) the correlations among the traits, and c) the economic importance of the traits as they relate to production measures.

A review of the literature revealed several significant findings (Chapter 2). The bulk of the literature concerning linear type evaluation is based on dairy cattle. Some European literature contains linear type evaluation for breeds that are used as beef breeds in the United States but maintained under traditional dairy or dual-purpose status on their native continent. Upon review of these studies, the following characteristics were discovered: 1) generally, there was close agreement among dairy studies with regard to estimated genetic parameters, 2) there was agreement between studies with dairy breeds and studies with dual-purpose breeds on some but not all traits, and 3) a nearly identical statistical model was used to estimate genetic parameters in all studies.

CHAPTER 2

LITERATURE REVIEW

Introduction

This literature review is intended summarize the available published information concerning linear type evaluation. The first objective will be to define the ABS GTS Traits that will be evaluated in this study. Second, literature estimates of heritabilities and of genetic and phenotypic correlations among linear type traits will be summarized. Different breed associations and research institutions use dissimilar definitions for the same linear type trait, hence there will some literature reviewed that does not exactly describe the ABS GTS Traits.

ABS GTS Traits

Stature

Evaluation of progeny frame size, based on hip height. Higher score indicates taller size.

Body Length

Evaluation of progeny from withers to pins. High score indicates longer body length.

Muscling

Progeny evaluation combines width of rump and hindquarter, with secondary consideration given to forearm muscling. Higher score indicates more muscling.

Capacity

Progeny evaluation combines depth of fore rib along with spring of rib and width of chest floor as well as depth of flank. Higher score indicates greater capacity.

Femininity

Evaluation of daughters' angularity and their ability to carry condition without becoming coarse and masculine. Higher score indicates more femininity.

Rear Leg Set

Evaluation of progeny rear leg structure, with scores near 25 being ideal. Higher scores tend towards sickle-hocked: lower scores tend toward post-legged.

Feet and Pasterns

Evaluation of progeny length and strength of pastern and foot angle. Higher score indicates stronger pastern with more depth of heel.

Udder Attachment

Daughter evaluation combines fore udder attachment, rear udder height, rear udder width, and center support. Higher score indicates stronger attachment.

Udder Depth

Evaluation of daughters' udder depth from top of fore udder to udder floor. Higher score indicates higher, better supported udders.

Teat Size

Evaluation of daughters' teat size, including length and diameter. Higher score indicates smaller teat size.

Accuracy of Evaluation

Brown et al. (1953) evaluated a type scoring system for beef cattle, although not specifically the same traits as the Beef GTS traits. The traits evaluated were general appearance, fore quarters, body, head and neck, hindquarters, breed type, and over-all rating. They concluded that judges with a basic knowledge of desirable conformation of beef cattle gave similar ratings to a particular animal at a particular time. Ratings of the judges appeared to be in closer agreement on items of conformation for which they considered only a part of the animal.

Frey et al. (1972) concluded that classifiers were not a significant source of variation in total classification scores. However, significant interactions of classifiers with both cows and seasons indicated the classifiers were not consistent in their scoring.

Estimates of Heritability

Table 2 summarizes literature estimates of heritability for dairy and dual purpose linear type traits that were used in this study.

Table 2. Heritabilities of linear type traits.

GTS Trait	Representative Trait[1]	Author	Heritability
Stature	Stature	Foster et al. (1988)	0.36
		VanRaden et al. (1990)	0.37
		Harris et al. (1992)	0.53
		Short and Lawlor (1992)	0.40
		Holstein Association USA (2001)	0.42
	Height at Withers	Casanova (1993)	0.56
	Height at Hip	Casanova (1993)	0.55
	Size	Nielsen and Willham (1974)	0.37 - 0.58
Body Length	Body Length	Casanova (1993)	0.43
Muscle	Muscle	Koch et al. (1974)	0.24, 0.30
	Loin	Nielsen and Willham (1974)	0.25 - 0.30
	Rump		0.24 - 0.38
	Rear quarters		0.40 - 0.66
	Muscularity	Casanova (1993)	0.29
		Interbull (1996)	0.24 - 0.25
	Muscularity at Thighs	Larroque (2000)	0.29
	Muscularity at Withers		0.28
	Muscularity of Back		0.13
	Muscularity of Loin		0.21
	Muscularity at Rump		0.18
	Muscularity at Thigh		0.21
	Overall Muscle Score		0.19
Capacity	Capacity	Kliewer (1971)	0.43 - 0.70
		Van Doormaal and Burnside (1987)	0.21, 0.23
	Strength	Foster et al. (1988)	0.23
	Body Depth		0.30
	Strength	VanRaden et al. (1990)	0.26
	Body Depth		0.32
	Strength	Harris et al. (1992)	0.26
	Body Depth		0.31
	Strength	Short and Lawlor (1992)	0.26
	Body Depth		0.31
	Strength	Holstein Association USA (2001)	0.31
	Body Depth		0.37
	Body Width	Casanova (1993)	0.17
	Body Depth		0.21
Femininity	Dairy Form	Foster et al. (1988)	0.25
		VanRaden et al. (1990)	0.23
		Harris et al. (1992)	0.25
		Short and Lawlor (1992)	0.24
		Holstein Association USA (2001)	0.29
Rear Legs -Side View	Rear Legs - Side View	Foster et al. (1988)	0.17
		VanRaden et al. (1990)	0.16
		Harris et al. (1992)	0.12
		Short and Lawlor (1992)	0.15
		Ral et al. (1995)	0.12 - 0.35
		Holstein Association USA (2001)	0.21

Table 2. Continued

GTS Trait	Representative Trait[1]	Author	Heritability
Rear Legs -Side View	Feet and Legs		
	Angle of Hock	Casanova (1993)	0.18
Feet and Pasterns	Foot Angle	Foster et al. (1988)	0.09
		VanRaden et al. (1990)	0.10
		Harris et al. (1992)	0.09
		Short and Lawlor (1992)	0.14
		Ral et al. (1995)	0.08 - 0.53
		Holstein Association USA (2001)	0.15
	Feet and Legs	Nielsen and Willham (1974)	0.32 - 0.52
	Pastern Angle	Casanova (1993)	0.25
	Depth of Heel		0.18
	Heel Height	Ral et al. (1995)	0.07 - 0.34
	Toe Angle		0.14 - 0.41
Udder Attachment	Fore Udder Attachment	Foster et al. (1988)	0.18
		VanRaden et al. (1990)	0.18
		Harris et al. (1992)	0.12
		Short and Lawlor (1992)	0.22
		Holstein Association USA (2001)	0.29
	Rear Udder Height	Foster et al. (1988)	0.19
		VanRaden et al. (1990)	0.18
		Harris et al. (1992)	0.28
		Short and Lawlor (1992)	0.20
		Holstein Association USA (2001)	0.28
	Rear Udder Width	Foster et al. (1988)	0.15
		VanRaden et al. (1990)	0.16
		Harris et al. (1992)	0.21
		Short and Lawlor (1992)	0.18
		Holstein Association USA (2001)	0.23
	Rear Udder Attachment	Casanova (1993)	0.21
	Strength of Attachment		0.25
Udder Depth	Udder Depth	Foster et al. (1988)	0.24
		VanRaden et al. (1990)	0.25
		Harris et al. (1992)	0.26
		Short and Lawlor (1992)	0.28
		Holstein Association USA (2001)	0.28
	Fore Udder Depth	Casanova (1993)	0.34
	Rear Udder Depth		0.28
	Udder Capacity	DeNise et al. (1987)	0.12
	Udder Shape		0.15
Teat Size	Teat Length	Harris et al. (1992)	0.32
		Casanova (1993)	0.22
		Holstein Association USA (2001)	0.26
	Teat Shape	Casanova (1993)	0.40
Body Condition Score	Condition	Marlowe and Morrow (1985)	0.31

[1]A representative trait is one that approximates the ABS GTS traits while not being exactly the same

Stature

In a study of Angus classification scores on 149,147 animals, Nielsen and Willham (1974) divided animal evaluations into four age-sex groups: mature males, preliminary males, mature females, and preliminary females. Preliminary males and females were yearling animals that had not sired or given birth to progeny at the time of the evaluation. Accompanying the scores on each animal was a herd code designation, the herd code is a number dependent on three variables: classifier, day of classification and herd. If any one of the variables changed, the herd code changed. All scores in the study were assigned by official classifiers of the American Angus Association. Heritabilities were estimated using three different models: within herd and herd code, within herd and across codes, and across herds and herd codes. Because the estimate of heritability across herds and herd codes is most appropriate to this review, only the third model will be discussed. Heritability estimates were generated using Paternal Half-sib analyses and least squares procedures. Estimates of heritability for size were 0.49, 0.58, and 0.37 for mature females, preliminary males, and preliminary females, respectively. The simple average of the heritability estimates was 0.48. Foster et al. (1988) estimated the heritability of stature to be 0.36 based on 43,428 records from daughters of Holstein bulls at 21st Century Genetics. VanRaden et al. (1990) estimated the heritability of stature in Holsteins to be 0.37 based upon 1,241,310 records. In an evaluation of genetic parameters for Guernsey type traits based upon 12,996 records, Harris et al. (1992), estimated the heritability of stature to be 0.53. Short and Lawlor (1992) reported a heritability of 0.40 based on 128,601 registered Holsteins. In a study of 4,137 first lactation Swiss Braunvieh, Casanova (1993) estimated heritabilities of 0.56 and 0.55 for height at withers and height at hips, respectively. The Holstein Association USA reported the heritability of stature to be 0.42 based upon Holsteins indexed with the Association (2001).

Body Length

Literature concerning visual appraisal of body length is very limited. Casanova (1993) estimated the heritability of body length to be 0.43 based upon 4,137 evaluations in Swiss Braunvieh.

Muscling

The Angus classification system evaluated by Nielsen and Willham (1974) considered muscle shape at three different locations: loin, rump, and an overall rear-quarters score. Loin muscling score was estimated to have heritabilities of 0.25, 0.30, and 0.24 for mature females, preliminary bulls, and preliminary females. Heritability of rump score was estimated to be 0.26, 0.38, and 0.24 for the three groups. Overall rear-quarters scores were estimated to have heritabilities of 0.43, 0.66, and 0.40 for mature females, preliminary males, and preliminary females, respectively. Koch et al. (1974) reported heritability estimates of 0.24 and 0.30 for a visual muscling score in Hereford bulls and heifers, respectively. Larroque (2000) estimated genetic parameters for muscling traits from records in 442,545 French Montbeliarde cattle. Muscularity at withers was estimated to have a heritability of 0.28, muscularity at thighs was estimated to have a heritability of 0.30. Additionally, Larroque estimated the heritability of muscle scores from 209,665 Normande cattle. Estimates of heritability were 0.13, 0.21, 0.18, 0.21, and 0.19 for muscularity on the back, loin, rump, thigh, and an overall muscle score, respectively. Heritability of muscularity in Irish Holstein-Friesian cattle was estimated to be 0.25 (Interbull, 1996). In an Austrian study, the heritability of muscularity in the Fleckvieh, Braunvieh, Pinzgauer, Shwarzbunte and Grauvieh breeds was estimated to be 0.24 (Interbull, 1996). Casanova (1993) reported an estimate for heritability of 0.29 for muscularity in the Braunvieh breed.

Capacity

The dairy literature contains very few estimates for capacity. Van Doormaal and Burnside (1987) reported an estimate for capacity of 0.21 for grade Holsteins and 0.23 for registered Holsteins based on an evaluation of 175,693 Canadian Holsteins. In an earlier study by Kliewer (1971), capacity for Holsteins was estimated to have a heritability of from 0.43 to 0.70 depending on age, with older cows having higher heritabilities. Capacity as it relates to beef GTS, is simply a composite of the dairy traits strength and body depth. The Holstein Association (2000) estimated heritabilities of 0.31 and 0.37 for strength and body depth. Harris et al. (1992) reported heritabilities of 0.26 for strength and 0.31 for body depth. Foster et al. (1988) reported estimates of 0.23 for strength and 0.30 for body depth. VanRaden et al. (1990) reported estimates of 0.26 and 0.32 for strength and body depth, which is in close agreement with the estimates of 0.26 and 0.31 reported by Short and Lawlor 1992). In Europe, much visual assessment work has been done with dairy and dual-purpose breeds. These studies may hold some interest to beef cattle producers since the European dual-purpose breeds studied are used as beef breeds in the USA. Casanova (1993) reported heritability estimates of 0.21 and 0.17 for body depth and body width, which are somewhat lower than most estimates found in the dairy literature.

Femininity

There is very little information available in the literature with regard to femininity. The trait that may be thought of as most comparable to femininity is dairy form. The Holstein Association (2001) reported heritability of dairy form to be 0.29. Foster et al. (1988), VanRaden et al. (1990) and Short and Lawlor (1992) all reported similar estimates of 0.25, 0.23, and 0.24 respectively. Harris et al. (1992) estimated the heritability of dairy form in Guernsey's to be 0.25.

Rear Leg Set

Neilsen and Willham (1974) reported heritabilities of 0.42, 0.52, and 0.36 for mature females, preliminary males, and preliminary females, when rear legs and feet were evaluated as one trait. The Holstein Association (2001) reported a heritability estimate of 0.21 for rear legs-side view. Harris et al. (1992) estimated the heritability of rear leg-side view to be 0.12 for Guernsey cattle. Short and Lawlor (1992), VanRaden et al. (1990), and Foster et al. (1988) reported very similar estimates of 0.15, 0.16, and 0.17, respectively. Ral et al. (1995) reviewed many papers concerning the genetic aspects of leg and hoof traits in cattle and reported estimates of heritability for rear legs set from 0.12 to 0.35. Casanova (1993) reported heritability of hock angle to be 0.18.

Feet and Pasterns

The Holstein Association (2001) estimated the heritability of foot angle to be 0.15. Harris et al. (1992) reported an estimate of 0.09 for the Guernsey breed. In Swiss Braunvieh, Casanova (1993) estimated the heritability of pastern angle to be 0.25 and depth of heel to be 0.18. Foster et al. (1988) and VanRaden et al. (1990) reported heritability of foot angle to be 0.09 and 0.10, respectively. Short and Lawlor (1992) reported an estimate of 0.14. Ral et al. (1995) summarized five papers concerning foot angle and the average heritability was 0.24 with a range from 0.08 to 0.53. They also summarized four papers concerning toe angle with estimates ranging from 0.14 to 0.4, with an average estimate of heritability of 0.25. Additionally, five papers concerning heel height were reviewed by Ral et al. (1995) with an average heritability estimate of 0.19 and range from 0.07 to 0.34.

Estimates of Heritability for Udder Traits

A review of beef literature for udder attachment, udder depth, and teat size revealed no reports of heritability. DeNise et al. (1987) reported heritability of udder capacity to be 0.12 based on 460 records of Hereford cows. DeNise et al. (1987) also reported heritability of udder shape to be 0.15 based on 362 records.

Udder Attachment

The Holstein Association (2001) reported heritabilities of 0.29, 0.28, and 0.23 for fore udder attachment, rear udder height, and rear udder width, respectively. Harris et al. (1992) reported heritabilities of 0.12, 0.28, and 0.21 for fore udder attachment, rear udder height and rear udder width, respectively, in Guernsey cattle. Foster et al. (1988) reported estimates of 0.18, 0.19, and 0.15 for fore udder attachment, rear udder height and rear udder width, which is in close agreement with the estimates from VanRaden et al. (1990) and Short and Lawlor (1992) (Table 2). Casanova (1993) reported estimates of heritabilities in Swiss Braunvieh cattle to be 0.21 and 0.25 for fore udder attachment and strength of attachment, respectively.

Udder Depth

VanRaden et al. (1990) reported heritability of udder depth to be 0.25. Harris et al. (1992) estimated the heritability of udder depth to be 0.26 in Guernsey cattle. The Holstein Association (2001) reported the heritability of udder depth to be 0.28. Foster et al. (1988) and VanRaden et al. (1990) reported heritabilities of 0.24 and 0.25 for udder depth. Short and Lawlor (1992) estimated the heritability to be 0.28. Casanova (1993) estimated the heritability of fore udder depth to be 0.34 and rear udder depth to be 0.28.

Teat Size

The Holstein Association (2001) estimated the heritability of teat length to be 0.26. Harris et al. (1992) reported an estimate of 0.32 for teat length. Casanova (1993) estimated the heritability of teat length and teat shape to be 0.40 and 0.22, respectively.

Body Condition Score

Marlowe and Morrow (1985) estimated genetic parameters for weight, grade, and condition of 1,371 Angus cows and reported a heritability for condition of 0.31.

The Holstein Association (2001) estimated the heritability of teat length to be 0.26. Harris et al. (1992) reported an estimate of 0.32 for teat length. Casanova (1993) estimated the heritability of teat length and teat shape to be 0.40 and 0.22, respectively.

Body Condition Score

Marlowe and Morrow (1985) estimated genetic parameters for weight, grade, and condition of 1,371 Angus cows and reported a heritability for condition of 0.31.

Genetic and Phenotypic Correlations among Traits

Table 3 presents literature estimates of genetic and phenotypic correlations. The table is based upon averages of United States dairy literature and European dairy and dual-purpose literature. No estimates of correlations with regard to these traits in beef cattle were found in the literature. Many estimates were near zero, and phenotypic correlations were generally low. There were some genetic correlations that may be of interest to beef producers.

Table 3. Genetic and phenotypic correlations among linear type traits.

GTS Traits	Representative Traits[1]	Author	Genetic Correlation	Phenotypic Correlation
Stature and Body Length				
	Wither Height and Body Length	Casanova (1993)	0.79	0.57
	Height at Hip and Body Length	Vukasinovic et al. (1995)	0.92	0.69
Stature and Muscle		Casanova (1993)	-0.50	0.02
		Vukasinovic et al. (1995)	-0.30	0.09
Stature and Capacity				