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Estimadores de parámetros genéticos para características de crecimiento predestete de bovinos. Revisión

Estimates of genetic parameters for preweaning growth traits of cattle. Review

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RESUMEN

En la presente revisión, se presentan 2,689 estimadores reportados en la literatura para cinco parámetros genéticos y tres características de crecimiento de bovinos. Estos estimadores provinieron de 89 grupos raciales localizados en 38 países. La media, el rango y el número de estimadores fueron calculados para cada parámetro genético por característica. Tres cientos treinta y siete (337) artículos publicados en la literatura fueron usados para esta revisión. Para peso al destete, las medias de los estimadores de heredabilidad directa, heredabilidad materna, correlación genética entre efectos directos y maternos, y heredabilidad total fueron: 0.27, 0.17, -0.23 y 0.25. Los estimadores de parámetros genéticos variaron grandemente para cada característica. Los rangos de los estimadores fueron de: -0.01 a 0.95, 0.00 a 0.76, -1.00 a 1.00, y de 0.01 a 0.81, respectivamente. Para peso al destete, las medias de los estimadores de heredabilidad total para Angus, Charolais, Brahman, Hereford, Limousin, Nelore y Simmental fueron, en general, similares. Para peso al destete, la media de los estimadores de heredabilidad directa obtenidos mediante el método de correlación entre medios hermanos paternos tendió a ser más grande que las medias de los estimadores de heredabilidad directa obtenidos con modelos animal, semental y semental-abuelo materno. Las medias de los estimadores de heredabilidad directa y de heredabilidad materna indican que el genotipo del becerro fue más importante que el genotipo de la vaca para determinar características de crecimiento predestete. Sin embargo, las medias de los estimadores de heredabilidad total confirman que la selección podría ser efectiva para mejorar dichas características.

PALABRAS CLAVE: Correlación genética, Heredabilidad directa, Heredabilidad materna, Heredabilidad total, Peso al nacimiento, Peso al destete, Bovinos.

ABSTRACT

Two-thousand six-hundred eighty-nine (2,689) estimates published for five genetic parameters and three growth traits of cattle are presented. Those estimates arose from 89 breed groups located in 38 countries. The mean, the range and the number of the estimates were calculated for each genetic parameter and trait. Three-hundred thirty-seven (337) papers published in the literature were used for this review. For weaning weight, the means of the estimates of direct and maternal heritability, direct-maternal genetic correlation, and total heritability were: 0.27, 0.17, -0.23 and 0.25, respectively. Estimates of genetic parameters varied greatly for each trait. The ranges of the estimates were from: -0.01 to 0.95, 0.00 to 0.76, -1.00 to 1.00, and from 0.01 to 0.81, respectively. For weaning weight, the means of the estimates of total heritability for Angus, Brahman, Charolais, Hereford, Limousin, Nelore and Simmental were, in general, similar. For weaning weight, the mean of the estimates of direct heritability obtained with paternal half-sib analyses tended to be greater than the means of the estimates of direct heritability obtained with animal, sire, and sire-maternal grand sire models. The means of estimates of direct and maternal heritability indicate that the genotype of the calf was more important than the genotype of the dam to determine preweaning growth traits. However, the means of the estimates of total heritability confirm that selection would be effective to improve preweaning growth traits.

KEY WORDS: Direct heritability, Maternal heritability, Total heritability, Genetic correlation, Birth weight, Weaning weight, Cattle.

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INTRODUCCIÓN

Extensas revisiones bibliográficas de estimadores de parámetros genéticos para características de crecimiento de ganado bovino han sido realizadas alrededor del mundo por varios investigadores. En una amplia revisión, Mercadante *et al*(1) presentaron estimadores individuales de parámetros genéticos junto con sus medias ponderadas para características de crecimiento pre y posdestete de ganado bovino. Sin embargo, los estimadores reportados por estos investigadores fueron solamente para razas *Bos indicus* o Cebú. Por otro lado, la revisión realizada por Davis(2) incluyó estimadores de parámetros genéticos para razas tropicales *Bos taurus* y *Bos indicus*, pero los estimadores fueron para ganado criado en el norte de Australia. En un estudio previo, cuyo objetivo fue estimar parámetros genéticos para características de crecimiento de ganado australiano para producción de carne, Meyer(3) resumió estimadores de parámetros genéticos adicionales (e.g., la covarianza entre efectos genéticos directos y maternos como proporción de la varianza fenotípica) publicados en la literatura para características de crecimiento. Sin embargo, las fuentes de información (artículos), así como el número de estimadores, fueron limitados porque el propósito de su breve revisión fue comparar los estimadores obtenidos en su evaluación genética con estimadores de parámetros genéticos publicados en la literatura.

Los análisis de los estimadores de parámetros genéticos y fenotípicos publicados en la literatura realizados por Mohiuddin(4) y Koots *et al*(5) fueron para una amplia variedad de razas y características económicamente importantes. Sin embargo, la información publicada de estimadores de parámetros genéticos ha aumentado considerablemente en los últimos trece años para crecimiento predestete y otras características debido al aumento de la capacidad y eficiencia de las computadoras, permitiendo el uso de nuevos algoritmos. La presente revisión de literatura fue realizada para 1) actualizar estimadores individuales de parámetros genéticos para características de crecimiento predestete de bovinos y 2) reportar medias totales y rangos, así como también medias marginales de dichos

INTRODUCTION

Comprehensive reviews of estimates of genetic parameters for growth traits of cattle have been carried out around the world by several researchers. In an extensive review, Mercadante *et al*(1) presented individual estimates of genetic parameters along with their weighted means for pre- and post-weaning growth traits of cattle. However, reported estimates by those researchers were for *Bos indicus* or Zebu breeds only. On the other hand, the review by Davis(2) included estimates of genetic parameters for tropical *B. indicus* and *B. taurus* breeds, but estimates were for cattle reared in Northern Australia. In a previous study, whose objective was to estimate genetic parameters for growth traits of Australian beef cattle, Meyer(3) summarized estimates of additional genetic parameters (e.g., direct-maternal covariance as a proportion of phenotypic variance) published in the literature for growth traits. Sources of information (papers) as well as the number of estimates, however, were limited because the purpose of her brief review was to compare estimates obtained in her genetic evaluation with published estimates of genetic parameters.

The analyses of published estimates of genetic and phenotypic parameters carried out by Mohiuddin(4) and Koots *et al*(5) were for a broad spectrum of beef breeds and economically important traits. However, published information on estimates of genetic parameters has increased considerably in the last thirteen years for preweaning growth and other traits due to increased capacity and efficiency of computers, allowing the use of newer algorithms. The present review of literature was conducted 1) to update individual estimates of genetic parameters for preweaning growth traits of cattle, and 2) to report overall means and ranges as well as marginal means of estimates of such genetic parameters, by breed of cattle and by statistical model, to investigate possible differences in mean estimates between breeds and between models.

MATERIALS AND METHODS

Three-hundred thirty-seven (337) papers published in the scientific literature from 1946 to 2006, that estimadores, por raza bovina y por modelo estadístico, para investigar posibles diferencias en estimadores promedio entre razas y entre modelos.

MATERIALES Y MÉTODOS

Se utilizaron 337 artículos publicados en la literatura científica de 1946 a 2006, que reportaron estimadores de parámetros genéticos para características de crecimiento predestete de bovinos. Las características de crecimiento predestete fueron peso al nacimiento, peso al destete y ganancia diaria de peso, mientras que los parámetros genéticos analizados fueron: heredabilidad directa, heredabilidad materna, correlación entre efectos genéticos directos y maternos, heredabilidad total, y varianza del ambiente materno permanente como proporción de la varianza fenotípica. El número, la media no ponderada y el rango de los estimadores de cada parámetro genético se calcularon para cada una de las tres características de crecimiento predestete. Además, para peso al nacimiento y peso al destete, la media no ponderada de los estimadores de cada parámetro genético fue calculada por raza, para las razas (Angus, Brahman, Charolais, Hereford, Limousin, Nelore y Simmental) con más estimadores de parámetros genéticos. De modo similar, las medias no ponderadas de los estimadores de heredabilidad directa para peso al nacimiento y para peso al destete fueron calculadas por modelo estadístico, para los modelos (animal, semental y semental-abuelo materno) con más estimadores de heredabilidad directa.

Los errores estándar de muchos estimadores no se reportaron en varios de los 337 artículos científicos revisados. Además, diferentes métodos de estimación se usaron para estimar los parámetros genéticos. Ha sido reportado[5] que medias ponderadas y no ponderadas de estimadores de parámetros genéticos son similares para peso al nacimiento, peso al destete y ganancia diaria de peso. Por lo tanto, las medias ponderadas de los estimadores de los parámetros genéticos no se calcularon. Cuando los estimadores de heredabilidad total no fueron reportados en los artículos científicos revisados, los estimadores de heredabilidad total (h_t^2) se calcularon a partir de la heredabilidad directa (h_d^2), la heredabilidad

reported estimates of genetic parameters for preweaning growth traits of cattle, were used for this review. Preweaning growth traits were birth weight, weaning weight and average daily gain, while reviewed genetic parameters were direct heritability, maternal heritability, genetic correlation between direct and maternal effects, total heritability, and maternal permanent environmental variance as a proportion of phenotypic variance. The number, the unweighted mean and the range of the estimates of each genetic parameter were calculated within each of the three preweaning growth traits. In addition, the unweighted mean of the estimates of each genetic parameter for birth weight and weaning weight was calculated by breed, for the breeds (Angus, Brahman, Charolais, Hereford, Limousin, Nelore and Simmental) with the most estimates of genetic parameters. Similarly, the unweighted means of the estimates of direct heritability for birth weight and for weaning weight were calculated by statistical model, for animal, sire, and sire-maternal grand sire models, to investigate if estimates of direct heritability obtained with different procedures are comparable.

Standard errors for many estimates were not reported in several of the 337 papers reviewed. In addition, several different methods of estimation were used to estimate genetic parameters. It has been reported[5] that weighted and unweighted means of estimates of genetic parameters are similar for birth weight, weaning weight and average daily gain. Therefore, weighted means of the estimates of genetic parameters were not calculated. When estimates of total heritability were not reported in reviewed papers, estimates of total heritability (h_t^2) were estimated from direct heritability (h_d^2), maternal heritability (h_m^2), and direct-maternal genetic correlation (r_{dm}) with the following formula:

$$h_t^2 = h_d^2 + 0.5\,h_m^2 + 1.5\,r_{dm}\,h_d\,h_m .$$

RESULTS AND DISCUSSION

Table 1 contains individual estimates of direct heritability, maternal heritability, genetic correlation between direct and maternal effects, fraction of phenotypic variance due to maternal permanent environmental effects, and total heritability, materna (h^2_m) y la correlación genética entre efectos directos y maternos (r_{dm}), usando la siguiente fórmula: $h^2_t = h^2_d + 0.5\, h^2_m + 1.5\, r_{dm}\, h_d\, h_m$.

RESULTADOS Y DISCUSIÓN

El Cuadro 1 contiene estimadores individuales de heredabilidad directa, heredabilidad materna, correlación genética entre efectos directos y maternos, fracción de la varianza fenotípica debida a efectos del ambiente materno permanente y heredabilidad total, paralelamente con información del autor, modelo estadístico, método de estimación, grupo racial y país, para peso al nacimiento, peso according to author, model, method of estimation, breed group and country information, for birth weight, weaning weight and average daily gain. The number, the unweighted mean and the range (minimum and maximum value) of estimates of each genetic parameter within growth trait also are shown in Table 1, at the end of the table. A total of 2,689 individual estimates are presented in this table. Those estimates arose from 89 breed groups located in 38 countries.

Authors repeated two or more times in Table 1 reported estimates of genetic parameters for different categories of a factor. For example, estimates for a

Cuadro 1. Estimadores de heredabilidad directa (h^2_d), heredabilidad materna (h^2_m), correlación genética entre efectos directos y maternos (r_{dm}), fracción de la varianza fenotípica debida a efectos del ambiente materno permanente (c^2), y heredabilidad total (h^2_t) publicados en la literatura científica para características de crecimiento predestete de bovinos

Table 1. Published estimates of direct heritability (h^2_d), maternal heritability (h^2_m), direct-maternal genetic correlation (r_{dm}), fraction of phenotypic variance due to maternal permanent environmental effects (c^2), and total heritability (h^2_t) for preweaning growth traits of cattle

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Meyer (3)	0.41	0.08	0.04	0.05	0.46	0.14	0.13	-0.59	0.23	0.08						AM	DFREML	HE	AUS
Meyer (3)	0.36	0.07	0.29	0.03	0.46	0.20	0.14	0.22	0.04	0.32						AM	DFREML	AN	AUS
Meyer (3)						0.58	0.36		0.11	0.23						AM	DFREML	AX,AXBX	AUS
Rosales-Alday et al. (6)	0.05	0.09				0.23	0.11									SD	AIREML	SI, BR,SB	MEX
Rosales-Alday et al. (6)	0.84					0.63	0.33									SD	AIREML	SI, BR,SB	MEX
Rosales-Alday et al. (6)	0.03	0.15				0.22	0.17									SD	AIREML	SI, BR,SB	MEX
Gregory et al. (7)	0.45					0.26					0.00					PHS	---	HE	USA
Gregory et al. (7)	1.00					0.52					0.45					PHS	---	HE	USA
Ríos-Utrera et al. (8)	0.22	0.16	-0.65		0.12	0.33	0.17	-0.72	0.04	0.16						AM	AIREML	CH	MEX
Martínez and Galíndez (9)	0.31	0.09	0.16		0.40	0.17	0.11	0.12	0.13	0.25						AM	DFREML	BR	VEN
Carter et al. (10)	0.40					0.22					0.16					SM	REML	AN	NZ
Eriksson et al. (11)	0.48	0.11	-0.34		0.42											AM	AIREML	CH	SWE
Eriksson et al. (11)	0.51	0.12	-0.39		0.43											AM	AIREML	CH	SWE
Eriksson et al. (11)	0.51	0.06	-0.27		0.47											AM	AIREML	HE	SWE
Eriksson et al. (11)	0.50	0.07	-0.31		0.45											AM	AIREML	HE	SWE
Mackinnon et al. (12)	0.61	0.11	0.01		0.67	0.20	0.32	0.00		0.36						AM	DFREML	AX,AXBX	AUS
Knights et al. (13)	0.70					0.46										SM	REML	AN	USA
Martínez et al. (14)	0.17	0.01	-0.89	0.04	0.17	0.21	0.05	-0.13	0.04	0.24						AM	DFREML	CT	COL
Nelsen et al. (15)	0.36	0.61	-0.42													PHS	---	HE	USA
Nelsen et al. (15)	0.36	1.02	-0.60													PHS	---	HE	USA
Nelsen et al. (15)	0.26															OSR	---	HE	USA
Nelsen et al. (15)	0.47															ODR	---	HE	USA
Nelsen et al. (15)	0.32															OMR	---	HE	USA
Pico et al. (16)	0.28	0.11	-0.36		0.24	0.14	0.06		0.07							AM	AIREML	BR	SAF
Elzo et al. (17)	0.26	0.29	-0.16		0.34	0.10	0.11	-0.48		0.13						SMGS	EMREML	SM	COL
Elzo et al. (17)	0.30	0.26	-0.31		0.30	0.08	0.10	-0.53		0.11						SMGS	EMREML	ZE	COL
Núñez-Domínguez et al. (18)	0.31	0.34				0.48	0.00									AM	DFREML	AN	MEX
Núñez-Domínguez et al. (18)	0.32	0.33				0.45	0.00									AM	DFREML	AN	MEX
Núñez-Domínguez et al. (18)	0.33	0.33				0.45	0.01									AM	DFREML	AN	MEX
Núñez-Domínguez et al. (18)	0.06	0.03				0.09	0.07									AM	DFREML	TC	MEX
Núñez-Domínguez et al. (18)	0.07	0.02				0.10	0.08									AM	DFREML	TC	MEX
Núñez-Domínguez et al. (18)	0.06	0.03				0.12	0.12									AM	DFREML	TC	MEX
Kriese et al. (19)	0.22	0.55	-0.53		0.22	0.21	0.21	-0.06		0.30						SMGS	PEA	BM	USA
Kriese et al. (19)	0.34	0.26	-0.58		0.21	0.25	0.18	-0.43		0.20						SMGS	PEA	SG	USA
Kriese et al. (19)	0.37	0.18	-0.15		0.40	0.23	0.16	0.15		0.27						SMGS	PEA	BR	USA
Kriese et al. (19)	0.28	0.12	-0.52		0.20	0.21	0.15	-0.23		0.22						SMGS	PEA	BA	USA
Cantet et al. (20)	0.16	0.18	-1.03		-0.01	0.31	0.33	-0.79		0.10						---	---	HE	USA
Cantet et al. (20)	0.27	0.63	-0.86		0.05	0.26	0.67	-0.63		0.20						---	---	HE	USA
Cantet et al. (20)	0.18	0.21	-1.05		-0.02	0.32	0.27	-0.57		0.20						---	---	HE	USA
Naazie et al. (21)	0.40															SM	REML	MB	CAN
Migose et al. (22)	0.05	0.05	0.99		0.15						0.08	0.05	-0.43		0.06	AM	DFREML	SA	KEN
Snelling et al. (23)	0.30	0.14	0.13	0.01	0.41	0.17	0.23	-0.08	0.14	0.26						AM	DFREML	HE	USA
Snelling et al. (23)	0.51	0.12	0.04	0.03	0.58	0.20	0.11	0.13	0.26	0.28						AM	DFREML	HE	USA

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Snelling et al. (23)	0.55	0.03	-0.14	0.09	0.54	0.19	0.17	-0.22	0.10	0.22						AM	DFREML	HE	USA
Snelling et al. (23)	0.50	0.14	0.03	0.02	0.58	0.30	0.21	-0.19	0.21	0.33						AM	DFREML	HE	USA
Snelling et al. (23)	0.49	0.18	-0.27	0.04	0.46	0.24	0.23	-0.28	0.02	0.26						AM	DFREML	HE	USA
Plasse et al. (24)	0.42	0.07	0.06	0.01	0.47	0.13	0.14	0.28	0.09	0.25						AM	DFREML	BR	VEN
Ribeiro et al. (25)	0.16	0.09	-0.39	0.75	0.13	0.13	0.10	-0.53	0.67	0.09						AM	DFREML	SG	BRA
Hetzel et al. (26)	0.47	0.05		0.07	0.49	0.14	0.29		0.06	0.29	0.11	0.33		0.06	0.27	SDMGS	---	AX	AUS
Hetzel et al. (26)	0.23	0.03		0.18	0.24	0.20	0.12		0.19	0.26	0.21	0.15		0.15	0.29	SDMGS	---	HS	AUS
Hetzel et al. (26)	0.45	0.14		0.00	0.52	0.12	0.08		0.21	0.16	0.11	0.09		0.20	0.15	SDMGS	---	BX	AUS
Tosh et al. (27)	0.34	0.13	0.67	0.00	0.67	0.21	0.10	1.00	0.11	0.48						AM	DFREML	CSL	CAN
Grotheer et al. (28)	0.38	0.16	-0.49		0.28	0.25	0.21	-0.54		0.17						AM	DFREML	CH	GER
Grotheer et al. (28)	0.24			0.00		0.31			0.12							AM	DFREML	AN	GER
Marcondes et al. (29)	0.24	0.11	0.22	0.00	0.35											AM	DFREML	NE	BRA
Norris et al. (30)	0.36	0.13	-0.43	0.00	0.29	0.29	0.16	-0.52	0.17	0.20						AM	AGREML	NG	SAF
Corbet et al. (31)	0.23	0.10	-0.09	0.00	0.26	0.14	0.19	-0.21	0.16	0.18	0.13	0.18	-0.12	0.17	0.19	AM	AIREML	MBC	SAF
Andries et al. (32)	0.69	0.21	-0.14		0.72	0.61	0.13	0.00		0.68						AM	DFREML	MBC	USA
Maiwashe et al. (33)	0.32	0.13	-0.44	0.09	0.25	0.25	0.18	-0.54	0.12	0.17						AM	AIREML	BN	SAF
Trus and Wilton (34)	0.37	0.13	-0.34		0.32											SMGS	MHM4	AN	CAN
Trus and Wilton (34)	0.39	0.13	-0.39		0.32											SMGS	MHM4	HE	CAN
Trus and Wilton (34)	0.27	0.20	0.55		0.56											SMGS	MHM4	SH	CAN
Trus and Wilton (34)	0.42	0.17	-0.39		0.35											SMGS	MHM4	CH	CAN
Trus and Wilton (34)	0.34	0.20	-0.22		0.36											SMGS	MHM4	SI	CAN
Ferreira et al. (35)	0.35	0.14	-0.05	0.04	0.40	0.18	0.17	-0.34	0.18	0.18						AM	DFREML	HE	USA
Lee and Bertrand (36)	0.55	0.17	-0.42		0.44	0.25	0.23	-0.36	0.18	0.24						AM	EMREML	HE	USA
Lee and Bertrand (36)	0.56	0.20	-0.49		0.41	0.22	0.19	-0.40	0.15	0.19						AM	EMREML	HE	USA
Lee and Bertrand (36)						0.21	0.19	-0.50	0.17	0.16						AM	EMREML	HE	USA
Lee and Bertrand (36)	0.54	0.16	-0.29		0.49	0.23	0.21	-0.44	0.19	0.19						AM	EMREML	HE	CAN
Lee and Bertrand (36)	0.55	0.21	-0.40		0.45	0.21	0.19	-0.41	0.17	0.18						AM	EMREML	HE	CAN
Lee and Bertrand (36)						0.20	0.16	-0.36	0.22	0.18						AM	EMREML	HE	CAN
Lee and Bertrand (36)	0.51	0.19	-0.51		0.37	0.18	0.19	-0.37	0.17	0.17						AM	EMREML	HE	ARG
Lee and Bertrand (36)	0.57	0.18	-0.46		0.44	0.16	0.16	-0.31	0.16	0.17						AM	EMREML	HE	ARG
Lee and Bertrand (36)						0.18	0.15	-0.43	0.20	0.15						AM	EMREML	HE	ARG
Lee and Bertrand (36)						0.18	0.16	-0.43	0.16	0.15						AM	EMREML	HE	URU
Lee and Bertrand (36)						0.21	0.17	-0.50	0.17	0.15						AM	EMREML	HE	URU
Lee and Bertrand (36)						0.21	0.17	-0.52	0.18	0.15						AM	EMREML	HE	URU
Mwansa et al. (37)	0.48	0.11	-0.09		0.50	0.19	0.18	-0.42		0.16						AM	DFREML	HE	CAN
Brown et al. (38)	0.42	0.22	-0.12		0.48	0.63	0.16	-0.36		0.54	0.57	0.15	-0.32		0.50	SDMGS	REML	AN	USA
Brown et al. (38)	0.58	0.22	-0.13		0.62	0.66	0.43	-0.08		0.81	0.58	0.39	-0.05		0.74	SDMGS	REML	HE	USA
Swiger et al. (39)	0.30					-0.01					-0.02					PHS	HM2	MBC	USA
Swiger et al. (39)	0.37					0.20					0.14					PHS	HM2	MBC	USA
Quintanilla et al. (40)						0.33										SMGS	AIREML	CH	FRA
Quintanilla et al. (40)						0.26										SMGS	AIREML	CH	FRA
Quintanilla et al. (40)						0.30										SMGS	AIREML	CH	FRA
Quintanilla et al. (40)						0.33										SMGS	AIREML	CH	FRA
Quintanilla et al. (40)						0.34										SMGS	AIREML	CH	IRL
Quintanilla et al. (40)						0.95										SMGS	AIREML	CH	ITA
De Mattos et al. (41)						0.21	0.15	-0.36	0.14	0.19						AM	EMREML	HE	USA
De Mattos et al. (41)						0.21	0.17	-0.41	0.14	0.18						AM	EMREML	HE	USA
De Mattos et al. (41)						0.18	0.17	-0.31	0.19	0.18						AM	EMREML	HE	CAN
De Mattos et al. (41)						0.17	0.17	-0.33	0.19	0.17						AM	EMREML	HE	CAN
De Mattos et al. (41)						0.22	0.15	-0.48	0.14	0.16						AM	EMREML	HE	URU
De Mattos et al. (41)						0.19	0.16	-0.51	0.17	0.14						AM	EMREML	HE	URU
Cabrera et al. (42)						0.25	0.10	-0.20	0.17	0.25						AM	DFREML	NE	BRA
Fahmy and Lalande (43)	0.21					0.35										PHS	---	SH	CAN
Fahmy and Lalande (43)	0.21					0.13										ODR	---	SH	CAN
Wasike et al. (44)	0.36					0.40										AM	AIREML	BO	KEN
Gutierrez et al. (45)	0.40	0.22	-0.35		0.35	0.43	0.12	-0.40		0.35	0.32	0.01	-0.73		0.26	AM	DFREML	AV	SPA
Gutierrez et al. (45)	0.34	0.21	-0.27		0.34	0.31	0.09	-0.20		0.30	0.23	0.01	-0.52		0.20	AM	DFREML	AV	SPA
Carolino et al. (46)	0.56	0.17	-0.79		0.28	0.50	0.21	-0.81		0.21						AM	DFREML	AL	POR
Gengler et al. (47)						0.55										AM	DFREML	BB	BEL
Northcutt and Wilson (48)	0.16					0.62										SM	DFREML	AN	USA
Pang et al. (49)	0.65	0.19	-0.11		0.69	0.07	0.76	-1.00		0.10	0.07	0.70	-0.27		0.33	AM	DFREML	HE	CAN
Pang et al. (49)	0.71	0.36	-0.54		0.48	0.15	0.29	0.05		0.32	0.14	0.49	-0.53		0.18	AM	DFREML	SY1	CAN
Pang et al. (49)	0.26	0.23	0.20		0.45	0.09	0.36	-0.71		0.08	0.20	0.53	-0.28		0.35	AM	DFREML	DS	CAN
Pang et al. (49)	0.16	0.17	-0.99		0.04	0.11	0.48	-0.99		0.01	0.25	0.09	-0.98		0.07	AM	DFREML	DM	CAN
Diop et al. (50)	0.08	0.03	-0.17	0.04	0.08	0.20	0.21	-0.58	0.15	0.13						AM	AIREML	GO	SEN
Gutierrez et al. (51)	0.32	0.13				0.60	0.30	-0.73		0.29	0.49	0.37	-0.87		0.12	AM	DFREML	AV	SPA
Ribeiro et al. (52)						0.16	0.36	-0.70		0.09						AM	DFREML	NE	BRA
Hohenboken and Brinks (53)						0.23	0.34	-0.28		0.28						---	---	HE	USA
Hohenboken and Brinks (53)						0.27	0.40	-0.28		0.34						---	---	HE	USA
Wright et al. (54)						0.21	0.47	-0.57		0.18						SDMGS	REML	SE	USA
Fridrich et al. (55)						0.02	0.31	1.00		0.29						AM	DFREML	TA	BRA
Fridrich et al. (55)						0.17	0.19	-0.18		0.22						AM	DFREML	TA	BRA
Fridrich et al. (55)						0.20	0.09	0.00		0.25						AM	DFREML	TA	BRA
Fridrich et al. (55)						0.06	0.16	0.00		0.14						AM	DFREML	TA	BRA
Rasali et al. (56)	0.51	0.10	-0.09		0.53	0.70	0.20	-0.61		0.46						AM	GIBBS	AN	CAN
Rasali et al. (56)	0.45	0.18	-0.08		0.51	0.70	0.24	-0.30		0.64						AM	DFREML	AN	CAN
Nephawe et al. (57)	0.30	0.05	-0.33	0.04	0.27	0.10	0.26	0.05		0.24						AM	AGREML	BN	SAF
Nephawe et al. (57)	0.26	0.09	-0.41	0.03	0.22	0.11	0.18	-0.20		0.16						AM	AGREML	BN	SAF
Nephawe et al. (57)	0.44	0.08	-0.30	0.04	0.42	0.07	0.24	0.09		0.20						AM	AGREML	BN	SAF
Nephawe et al. (57)	0.30	0.09	-0.26	0.03	0.29	0.11	0.18	0.11		0.23						AM	AGREML	BN	SAF
Núñez-Domínguez et al. (58)	0.61	0.06	-0.08	0.15	0.62	0.41	0.22	0.38	0.08	0.69						AM	DFREML	MB	USA
Núñez-Domínguez et al. (58)	0.51	0.18	-0.01	0.02	0.60	0.46	0.30	0.03	0.04	0.63						AM	DFREML	MC	USA
Núñez-Domínguez et al. (58)	0.47	0.20	0.12	0.10	0.63	0.37	0.19	0.30	0.14	0.58						AM	DFREML	MF1	USA
Núñez-Domínguez et al. (58)	0.40	0.19	0.27	0.11	0.61	0.34	0.22	0.17	0.11	0.52						AM	DFREML	MF1	USA
Ishida and Mukai (59)	0.22	0.38	-0.18		0.33	0.25	0.10	0.89		0.51	0.24	0.19	0.55		0.16	AM	AIREML	JB	JPN
Crews and Kemp (60)	0.28	0.21	-0.55	0.09	0.18	0.16	0.40	-0.37	0.02	0.22	0.12	0.22	-0.95	0.28	0.00	AM	DFREML	MC	CAN
Lee et al. (61)						0.19	0.07	-0.05	0.10	0.22						AM	DFREML	SI	USA
Lee et al. (61)						0.25	0.12	-0.20	0.08	0.26						AM	DFREML	SI	USA
Meyer et al. (62)	0.43	0.11		0.09		0.19	0.14		0.20							AM	DFREML	PHE	AUS
Meyer et al. (62)	0.52	0.05		0.04		0.27	0.07		0.11							AM	DFREML	WO	AUS
Cyrillo et al. (63)	0.37	0.05	0.00	0.07	0.40	0.07	0.11	0.00	0.35	0.13						AM	AIREML	NE	BRA
Phocas et al. (64)						0.31	0.10	-0.21	0.10	0.30						AM	AIREML	LI	FRA
Phocas et al. (64)						0.22	0.13	-0.12	0.13	0.25						AM	AIREML	LI	AUS/NZ
Kars et al. (65)	0.41	0.16	-0.49		0.44	0.29	0.20	-0.39		0.40						AM	DFREML	NG	SAF
Mello et al. (66)	0.39	0.03	-0.04	0.06	0.40	0.48	0.04	0.01	0.14	0.50						AM	DFREML	CC	BRA
Silva et al. (67)											0.77					PHS	---	NE	BRA
Silva et al. (67)											0.60					PHS	---	NE	BRA
Burrow (68)	0.57	0.18	-0.25		0.54	0.17	0.34	-0.19		0.27	0.14	0.30	-0.17		0.24	AM	DFREML	AX,AXBX	AUS
Miller and Wilton (69)											0.22	0.24	-0.35		0.22	AM	DFREML	MB	CAN

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
DeNise et al. (70)	0.18					0.33					0.32					PHS	---	HE	USA
DeNise et al. (70)	0.20					0.38					0.37					PHS	---	HE	USA
Shibata and Kumazaki (71)	0.74					0.36					0.42					PHS	---	JBR	JPN
Salgado and Franke (72)	0.36	0.14	0.25		0.51	0.54	0.27	-0.37		0.46	0.55	0.31	-0.48		0.41	AM	DFREML	MBC	USA
Magaña et al. (73)	0.42	0.06	0.06	0.02	0.47	0.46	0.17	-0.59	0.11	0.30	0.60	0.23	-0.89	0.17	0.22	AM	DFREML	BR	MEX
Sapp et al. (74)	0.39	0.09	-0.13		0.40						0.27	0.14	-0.35		0.24	AM	GIBBS	GX	USA
Roso et al. (75)											0.32	0.20	-0.63		0.18	AM	AIREML	MBC	CAN
Stålhammar and Philipsson (76)											0.19	0.05	0.01	0.09	0.21	AM	DFREML	SI	SWE
Stålhammar and Philipsson (76)											0.22	0.09	-0.26	0.08	0.21	AM	DFREML	SI	SWE
Stålhammar and Philipsson (76)											0.18	0.11	-0.49	0.16	0.13	AM	DFREML	CH	SWE
Stålhammar and Philipsson (76)											0.29	0.13	-0.51	0.14	0.20	AM	DFREML	CH	SWE
Stålhammar and Philipsson (76)											0.10	0.18	-0.48	0.30	0.09	AM	DFREML	HE	SWE
Stålhammar and Philipsson (76)											0.18	0.15	-0.48	0.27	0.14	AM	DFREML	HE	SWE
Stålhammar and Philipsson (76)											0.18	0.24	-0.54	0.13	0.13	AM	DFREML	LI	SWE
Stålhammar and Philipsson (76)											0.32	0.31	-0.54	0.03	0.22	AM	DFREML	LI	SWE
Stålhammar and Philipsson (76)											0.30	0.10	-0.22	0.19	0.30	AM	DFREML	AN	SWE
Stålhammar and Philipsson (76)											0.16	0.13	-0.17	0.11	0.19	AM	DFREML	AN	SWE
Deese and Koger (77)											0.18	0.15	0.00	0.08	0.25	---	---	BR	USA
Deese and Koger (77)											0.40	0.46	-0.72	0.07	0.17	---	---	SH-BR	USA
Gusso et al. (78)											0.40	0.11	-0.79	0.17	0.21	AM	DFREML	HE	BRA
Eriksson et al. (79)											0.31	0.17	-0.51		0.22	AM	AIREML	CH	SWE
Eriksson et al. (79)											0.41	0.21	-0.32		0.37	AM	AIREML	HE	SWE
Eriksson et al. (79)											0.34	0.12	-0.63		0.21	AM	AIREML	SI	SWE
Cardoso et al. (80)	0.29			0.05	0.29						0.25	0.16	-0.51	0.12	0.18	AM	DFREML	AN	BRA
Shi et al. (81)	0.31	0.08	-0.40	0.05	0.26	0.26	0.13	-0.24	0.08	0.26	0.25	0.13	-0.25	0.09	0.25	SDMGS	THA	LI	FRA
Fernandes et al. (82)	0.54	0.12	-0.57		0.38						0.12	0.05	-0.05		0.14	AM	DFREML	CH	BRA
Gunski et al. (83)						0.26	0.10	-0.24	0.09	0.25	0.25	0.08	-0.36	0.06	0.21	AM	DFREML	NE	BRA
Prayaga and Henshall (84)	0.38	0.17			0.46	0.23	0.12		0.19	0.29	0.19	0.11		0.22	0.24	AM	AIREML	MBC	AUS
Johnston et al. (85)	0.25					0.09										SM	REML	CH	CAN
Demeke et al. (86)	0.14	0.07	0.47		0.25	0.08	0.04			0.09	0.06	0.04			0.08	AM	AIREML	MBC	ETH
Simonelli et al. (87)											0.20	0.06	-0.24		0.19	AM	DFREML	NE	BRA
Miller et al. (88)	0.48	0.21	-0.20		0.49						0.32	0.26	-0.20		0.36	AM	---	MBC	CAN
Aaron et al. (89)	0.32					0.42										PHS	HM3	SG	USA
Abdullah and Olutogun (90)	0.27															SM	REML	ND	NGR
Ahunu et al. (91)	0.45				0.45	0.38	0.32	-0.29		0.39						AM	DFREML	MBC	GHA
Albuquerque and Meyer (92)	0.28	0.01		0.03	0.29											AM	AIREML	NE	BRA
Albuquerque and Meyer (93)	0.32	0.02					0.20									RRAM	REML	NE	BRA
Alenda and Martin (94)	0.51					0.30										PHS	---	AN	USA
Alenda and Martin (94)	0.41					0.21										PHS	---	AN	USA
Andrade et al. (95)						0.24										PHS	---	GU	BRA
Ap Dewi et al. (96)						0.15	0.07		0.18	0.19						AM	DFREML	WB	UK
Armstrong et al. (97)	0.48	0.21	-0.20		0.49											AM	REML	MBC	CAN
Arnason and Kassa-Mersha (98)	0.11	0.02				0.22	0.11									SD	---	BO	ETH
Arnold et al. (99)						0.09										SM	REML	HE	USA
Arthur et al. (100)	0.53	0.18	-0.35		0.46	0.06	0.41	-0.98		0.03						AM	DFREML	HE	CAN
Arthur et al. (100)	0.68	0.16	-0.44		0.54	0.14	0.27	-0.45		0.14						AM	DFREML	SY1	CAN
Arthur et al. (101)						0.17	0.13	-0.17		0.20						AM	REML	AN	AUS
Aziz et al. (102)	0.38	0.04		0.03		0.49	0.06		0.03							RRAM	GIBBS	JB	JPN
Baharin and Beilharz (103)	0.34										-0.02					PHS	---	MBC	AUS
Bakir et al. (104)	0.13															PHS	HM3	HO	TUR
Barkhouse et al. (105)	0.32					0.20										SM	DFREML	CX	USA
Barlow and Dettmann (106)						0.21					0.21					PHS	---	AN	AUS
Barlow and O'Neill (107)	0.77					0.59					0.54					PHS	---	CX	AUS
Bennett and Gregory (108)	0.50	0.09	0.11	0.03	0.58	0.32	0.10	0.06	0.12	0.39						AM	DFREML	MB	USA
Benyshek and Little (109)	0.18					0.34										PHS	---	SX	USA
Bergmann et al. (110)						0.13										PHS	---	NE	BRA
Berruecos and Robison (111)	0.41					0.47					0.43					PHS	---	BR	MEX
Bertrand and Benyshek (112)	0.22	0.05	-0.16		0.22	0.16	0.15	-0.30		0.17						SDMGS	---	LI	USA
Bertrand and Benyshek (112)	0.25	0.13	-0.12		0.28	0.28	0.20	-0.29		0.28						SDMGS	---	BA	USA
Berweger Baschnagel et al. (113)						0.13	0.04		0.09							AM	DFREML	AN	SWL
Bishop (114)						0.19										AM	REML	HE	UK
Blackwell et al. (115)						0.08										PHS	HM2	HE	USA
Blackwell et al. (115)						0.31										PHS	HM2	HE	USA
Boldman et al. (116)						0.26	0.06	0.97	0.08	0.47						AM	DFREML	RP	USA
Boldman et al. (116)						0.32	0.04	0.89	0.08	0.49						AM	DFREML	BS	USA
Boldman et al. (116)						0.22	0.19	-0.45	0.34	0.18						AM	DFREML	HE	USA
Boldman et al. (116)						0.22	0.17	-0.09	0.16	0.28						AM	DFREML	AN	USA
Boldman et al. (116)						0.17	0.20	-0.01	0.18	0.27						AM	DFREML	SI	USA
Boldman et al. (116)						0.28	0.22	-0.30	0.15	0.28						AM	DFREML	LI	USA
Boldman et al. (116)						0.18	0.18	-0.32	0.19	0.18						AM	DFREML	CH	USA
Boldman et al. (116)						0.19	0.06	0.29	0.06	0.27						AM	DFREML	GE	USA
Boldman et al. (116)						0.39	0.03	0.19	0.10	0.44						AM	DFREML	PI	USA
Boldman et al. (116)						0.21	0.07	0.23	0.19	0.29						AM	DFREML	MIII	USA
Bourdon and Brinks (117)	0.43					0.63					0.60					PHS	HM3	MB	USA
Bourdon and Brinks (117)	0.35					0.69					0.66					PHS	HM3	MB	USA
Bradfield et al. (118)						0.18										AM	DFREML	SG	AUS
Bradfield et al. (118)						0.21										AM	DFREML	SG	AUS
Brinks et al. (119)	0.38					0.43					0.40					PHS	HM2	HE	USA
Brown and Galvez (120)	0.56	0.30	-0.58		0.36											---	---	HE	USA
Brown and Galvez (120)	0.14	0.25	-0.39		0.17											---	---	AN	USA
Buchanan et al. (121)	0.34					0.23					0.19					PHS	---	HE	USA
Buchanan et al. (121)	0.36					0.18					0.16					PHS	---	HE	USA
Bueno et al. (122)						0.26										AM	DFREML	CX	BRA
Bullock et al. (123)	0.49					0.24										SMGS	---	PHE	USA
Burfening et al. (124)	0.31					0.22					0.16					PHS	---	SX	USA
Burfening et al. (125)	0.32					0.28					0.28					---	---	SX	USA
Burfening et al. (126)	0.21	0.11	-0.24		0.21											---	---	SX	USA
Burris and Blunn (127)	0.22															PHS	---	MB	USA
Campêlo et al. (128)						0.15	0.17	-0.48		0.12						AM	DFREML	TA	BRA
Cantet et al. (129)						0.11	0.03	-0.31	0.02	0.10						AM	EMREML	AN	ARG
Cardellino and Cardellino (130)						0.02					0.01					PHS	HM3	HE	BRA
Cardellino and Castro (131)	0.28					0.28					0.25					PHS	HM3	NE	BRA
Carter and Kincaid (132)						0.08										PHS	---	---	USA
Carter and Kincaid (132)						0.69										PHS	---	---	USA
Choi et al. (133)	0.09	0.04	0.61	0.02	0.16	0.03	0.05	0.11	0.11	0.06						AM	DFREML	HW	KOR
Corrêa et al. (134)	0.32					0.12					0.17					AM	DFREML	SD	BRA
Crews et al. (135)	0.53	0.16	-0.49		0.40	0.23	0.10	-0.38	0.13	0.19						AM	AIREML	CH	CAN
Cubas et al. (136)						0.34										PHS	---	NE	BRA
Cubas et al. (136)						0.13										PHS	---	NE	BRA

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Cundiff et al. (137)	0.22					0.14					0.15					PHS	---	AN,HE	USA
Cundiff et al. (137)						0.14										OSR	---	AN,HE	USA
Cunningham and Henderson (138)											0.47					PHS	HM2	AN	USA
Cunningham and Henderson (138)											0.43					PHS	HM2	HE	USA
Dawson et al. (139)	0.11															PHS	---	SH	USA
de Alencar et al. (140)	0.53					0.69										PHS	---	CC	BRA
de Figueiredo et al. (141)	0.38					0.21					0.12					PHS	---	MB	BRA
de Freitas et al. (142)	0.33					0.77										SM	REML	CC	BRA
de los Reyes et al. (143)						0.18	0.36	-0.52		0.16						AM	AIREML	MBC	BRA
De Mattos et al. (144)						0.24	0.16	-0.42	0.16	0.19						AM	EMREML	HE	USA
De Mattos et al. (144)						0.20	0.16	-0.35	0.20	0.19						AM	EMREML	HE	CAN
De Mattos et al. (144)						0.23	0.18	-0.50	0.15	0.17						AM	EMREML	HE	URU
de Oliveira et al. (145)	0.11					0.20					0.20					PHS	---	GU	BRA
de Oliveira and Lôbo (146)	0.07															PHS	---	GU	BRA
de Souza et al. (147)						0.26										SM	DFREML	NE	BRA
Dickerson et al. (148)						0.30										PHS	---	MBC	USA
Dinkel and Busch (149)						0.40										PHS	HM2	HE	USA
Dodenhoff et al. (150)	0.45	0.10	0.15	0.01	0.55	0.18	0.34	-0.13	0.07	0.30						AM	AIREML	HE	USA
Dodenhoff et al. (150)	0.47	0.09	-0.07	0.04	0.49	0.14	0.31	-0.44	0.16	0.16						AM	AIREML	HE	USA
Dodenhoff et al. (150)	0.38	0.14	0.15	0.02	0.50	0.16	0.13	-0.11	0.29	0.20						AM	AIREML	HE	USA
Dodenhoff et al. (150)	0.39	0.11	0.29		0.54	0.10	0.20	-0.25	0.28	0.15						AM	AIREML	HE	USA
Dodenhoff et al. (151)						0.21	0.11	-0.27	0.10	0.20						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.32	0.13	-0.35	0.10	0.28						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.20	0.11	-0.10	0.05	0.23						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.18	0.24	0.06	0.07	0.32						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.17	0.19	-0.08	0.11	0.24						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.20	0.22	0.03	0.05	0.32						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.17	0.11	-0.14	0.11	0.20						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.20	0.14	-0.04	0.10	0.26						AM	AIREML	AN	USA
Dodenhoff et al. (151)						0.21	0.18	0.13	0.14	0.34						AM	AIREML	AN	USA
Domínguez-Viveros et al. (152)	0.12	0.10	-0.96		0.01	0.08	0.14									AM	DFREML	TC	MEX
Dong et al. (153)	0.18															SMGS	REML	SI	USA
Donoghue and Bertrand (154)	0.34	0.13	-0.24		0.33	0.22	0.12	-0.68	0.07	0.11						AM	EMREML	CH	AUS
Donoghue and Bertrand (154)	0.55	0.18	-0.39		0.46	0.27	0.15	-0.33	0.14	0.25						AM	EMREML	CH	CAN
Donoghue and Bertrand (154)	0.47	0.13	-0.29		0.43	0.25	0.14	-0.33	0.14	0.23						AM	EMREML	CH	USA
Donoghue and Bertrand (154)	0.31	0.18	-0.39		0.26	0.21	0.18	-0.58	0.17	0.13						AM	EMREML	CH	NZ
Duangjinda et al. (155)						0.23	0.12	-0.30	0.13	0.22						AM	METHOD R	HE	CAN
Duangjinda et al. (155)						0.27	0.07	-0.23	0.10	0.26						AM	METHOD R	GE	USA
Duangjinda et al. (155)						0.34	0.15	-0.47	0.15	0.26						AM	METHOD R	CH	USA
Dunn et al. (156)	0.85					0.18										PHS	---	MBC	USA
Dunn et al. (156)	0.46					0.34										PHS	---	MBC	USA
Eler et al. (157)	0.42					0.24										PHS	---	NE	BRA
Eler et al. (158)	0.29	0.08	-0.38	0.03	0.23	0.14	0.17	-0.13	0.05	0.20						AM	DFREML	NE	BRA
Elzo et al. (159)	0.16	0.18	-0.19		0.20	0.09	0.09	0.23		0.17						SMGS	EMREML	RO	COL
Elzo et al. (159)	0.24	0.14	-0.18		0.26	0.10	0.13	-0.50		0.08						SMGS	EMREML	BR	COL
Elzo and Wakeman (160)	0.22	0.17	0.01		0.31	0.25	0.18	-0.28		0.25						SMGS	EMREML	AN	USA
Elzo and Wakeman (160)	0.23	0.18	-0.05		0.30	0.29	0.21	-0.22		0.31						SMGS	EMREML	BR	USA
Elzo and Wakeman (160)	0.19	0.15	-0.02		0.26	0.22	0.16	-0.25		0.23						SMGS	EMREML	½AN½BR	USA
Elzo and Wakeman (160)	0.16	0.32	-0.08		0.29	0.18	0.35	-0.22		0.27						SMGS	EMREML	¾AN¼BR	USA
Elzo and Wakeman (160)	0.13	0.38	-0.11		0.28	0.15	0.41	-0.21		0.28						SMGS	EMREML	5/8AN3/8BR	USA
Eriksson et al. (161)	0.39	0.14	-0.48	0.08	0.29											AM	AIREML	CH	SWE
Eriksson et al. (161)	0.45	0.12	-0.47	0.08	0.35											AM	AIREML	CH	SWE
Eriksson et al. (161)	0.42	0.15	-0.16	0.03	0.43											AM	AIREML	HE	SWE
Eriksson et al. (161)	0.57	0.13	-0.37	0.07	0.48											AM	AIREML	HE	SWE
Eriksson et al. (161)	0.28	0.12	-0.15	0.06	0.30											AM	AIREML	SI	SWE
Eriksson et al. (161)	0.37	0.10	-0.38	0.07	0.31											AM	AIREML	SI	SWE
Euclides Filho et al. (162)	0.14					0.19										PHS	---	NE	BRA
Everett and Magee (163)	0.22															PHS	---	HO	USA
Everitt and Jury (164)	0.31															PHS	---	MBC	NZ
Everling et al. (165)						0.23	0.29	-0.45		0.20	0.25	0.28	-0.45		0.21	AM	DFREML	AN-NE	BRA,ARG
Fan et al. (166)						0.46										AM	DFREML	HE	CAN
Fan et al. (166)						0.16										AM	DFREML	AN	CAN
Ferraz et al. (167)	0.16	0.09	-0.39		0.13	0.13	0.10	-0.53		0.09						AM	DFREML	SG	BRA
Ferraz et al. (168)	0.33	0.05		0.03	0.27	0.26	0.20		0.07	0.22						AM	DFREML	MBC	BRA
Ferraz Filho et al. (169)						0.16	0.10	-0.42		0.13						AM	DFREML	TA	BRA
Ferraz Filho et al. (170)						0.16	0.10	-0.42	0.04	0.15						AM	DFREML	TA	BRA
Ferreira et al. (171)						0.16	0.09	0.09		0.22						AM	DFREML	NE	BRA
Ferreira et al. (171)						0.24	0.15	-0.09		0.29						AM	DFREML	NE	BRA
Fouilloux et al. (172)						0.25	0.16	-0.40	0.08	0.21						AM	AGREML	CH	FRA
Franke and Burns (173)	0.25					0.35					0.38					PHS	---	BR	USA
García et al. (174)	0.59	0.17				0.29	0.19									SD	DFREML	NE	MEX
Garrick et al. (175)	0.44	0.12	-0.38		0.37	0.36	0.19	-0.32		0.33						SMGS	EMREML	SI	USA
Graser and Hammond (176)						0.10	0.13	0.04		0.17						SMGS	REML	SI	AUS
Gregory et al. (177)	0.25					0.34					0.35					PHS	HM3	MB	USA
Gressler et al. (178)						0.48										AM	DFREML	NE	BRA
Groeneveld et al. (179)	0.52	0.07	-0.57		0.39	0.23	0.13	-0.44		0.18						AM	AGREML	AF	SAF
Haile-Mariam and Kassa-Mersha (180)		0.24	0.08	-0.55		0.16	0.29	0.06	-0.57	0.14	0.21						AM	DFREML	BO
										AAB									
Hamann et al. (181)						0.47										PHS	---	AN	USA
Heyns (182)	0.18					0.05										PHS	---	AF	SAF
Hill et al. (183)						0.32	0.29	-0.31	0.08	0.32						---	---	HE	USA
Iloeje (184)	0.28					0.31					0.30					PHS	HM2	GD	NGR
Iloeje (184)	0.26					0.21					0.29					PHS	HM2	SD	NGR
Itulya et al. (185)	0.53					0.05										PHS	---	HE	USA
Itulya et al. (185)	0.52					0.18										PHS	---	HE	USA
Iwaisaki et al. (186)	0.52	0.08	-0.46	0.09	0.42	0.36	0.13	-0.43	0.12	0.29						AM	GIBBS	GE	USA
Iwaisaki et al. (186)	0.51	0.06	-0.37	0.09	0.44	0.28	0.11	-0.33	0.14	0.25						RRAM	GIBBS	GE	USA
Jenkins et al. (187)	0.42					0.15										PHS	---	CX	USA
Johnson et al. (188)	0.42	0.22	-0.12		0.48	0.63	0.16	-0.36		0.54	0.57	0.15	-0.32		0.50	SDMGS	EMREML	AN	USA
Johnson et al. (188)	0.58	0.22	-0.13		0.62	0.66	0.43	-0.08		0.81	0.58	0.39	-0.05		0.74	SDMGS	EMREML	HE	USA
Johnson et al. (189)	0.75					0.48										AM	DFREML	BA	USA
Kalm et al. (190)	0.53					0.34										PHS	---	CH	SWE
Kalm et al. (190)	0.48					0.52										PHS	---	CH	SWE
Kalm et al. (190)	0.56					0.37										PHS	---	HE	SWE
Kalm et al. (190)	0.64					0.11										PHS	---	HE	SWE
Kaps et al. (191)						0.53	0.18	-0.51	0.10	0.38						AM	DFREML	AN	USA
Kaps et al. (191)						0.53	0.17	-0.51	0.11	0.39						AM	DFREML	AN	USA
Kaps et al. (191)						0.59	0.17	-0.53	0.11	0.42						AM	DFREML	AN	USA
Keeton et al. (192)						0.25	0.19	-0.44		0.20						SMGS	EMREML	LI	USA

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Kemp et al. (193)	0.19															PHS	HM3	SI	CAN
Kennedy and Henderson (194)						0.33					0.32					PHS	HM2	HE	CAN
Kennedy and Henderson (194)						0.19					0.20					PHS	HM2	HE	CAN
Kennedy and Henderson (194)						0.44					0.42					PHS	HM2	AN	CAN
Kennedy and Henderson (194)						0.20					0.28					PHS	HM2	AN	CAN
Khan et al. (195)	0.10	0.04	-0.14	0.05	0.11											AM	EMREML	SA	PAK
Khan and Akhtar (196)	0.98					0.70										MHS	---	JE	PAK
Khan and Akhtar (196)	0.49					0.76										MHS	---	JE	PAK
Khombe et al. (197)						0.28	0.11	-0.27	0.23	0.25						AM	DFREML	MS	ZIM
Knapp and Clark (198)	0.53					0.28										PHS	---	HE	USA
Knapp and Nordskog (199)	0.23					0.12										PHS	---	MB	USA
Knapp and Nordskog (199)	0.34					0.30										OSR	---	MB	USA
Koch (200)	0.55					0.18										PHS	HM2	HE	USA
Koch et al. (201)	0.49					0.15					0.13					PHS	---	HE	USA
Koch et al. (201)	0.57					0.25					0.21					PHS	---	HE	USA
Koch et al. (202)	0.51					0.16					0.13					PHS	---	HE	USA
Koch et al. (202)	0.59					0.19					0.16					PHS	---	HE	USA
Koch et al. (203)	0.43										0.07					PHS	HM3	MBC	USA
Koch et al. (204)	0.46	0.08	0.13	0.02	0.53	0.16	0.17	-0.28	0.26	0.17						AM	DFREML	HE	USA
Koury Filho et al. (205)						0.31	0.09									AM	DFREML	NE	BRA
Kriese et al. (206)	0.45	0.28	-0.47		0.34	0.33	0.25	-0.15		0.39						SMGS	PEA	HE	USA
Kriese et al. (206)	0.28	0.19	-0.58		0.17	0.19	0.14	-0.38		0.17						SMGS	PEA	BA	USA
Laloë et al. (207)	0.35					0.23										PHS	HM3	LI	FRA
Laloë et al. (207)	0.34					0.37										PHS	HM3	LI	FRA
Laloë et al. (207)	0.15					0.06										PHS	HM3	CH	FRA
Laloë et al. (207)	0.35					0.34										PHS	HM3	CH	FRA
Lamb et al. (208)						0.12										SM	REML	HE	USA
Lasley et al. (209)	0.67					0.11										PHS	---	HE	USA
Lee and Pollak (210)	0.21					0.34										SMGS	GIBBS	HW	KOR
Legault and Touchberry (211)	0.38															PHS	---	MB	USA
Legault and Touchberry (211)	0.48															ODR	---	MB	USA
Legault and Touchberry (211)	0.51															FS	---	MB	USA
Lehmann et al. (212)						0.21					0.20					PHS	---	MBC	USA
Liu et al. (213)	0.24										0.05					PHS	HM3	HE	CAN
Liu et al. (213)	0.65										0.16					PHS	HM3	SY	CAN
Liu et al. (214)						0.27	0.20	-0.86		0.07						AM	DFREML	AN, HE	CAN
Lôbo et al. (215)	0.29					0.25										AM	DFREML	NE	BRA
MacNeil (216)	0.49	0.11				0.30	0.19									AM	DFREML	CGC	USA
MacNeil (217)	0.46	0.10	-0.05		0.49	0.48	0.13	-0.06		0.52						AM	GIBBS	CGC	USA
MacNeil et al. (218)	0.37										0.09					PHS	---	MBC	USA
Magnabosco et al. (219)						0.15	0.11	0.08	0.10	0.22						AM	DFREML	NE	BRA
Magnabosco et al. (219)						0.23	0.16	-0.20	0.08	0.25						AM	GIBBS	NE	BRA
Magnabosco et al. (219)						0.26	0.15	-0.23	0.09	0.26						AM	GIBBS	NE	BRA
Magnabosco et al. (219)						0.26	0.15	-0.23	0.09	0.26						AM	GIBBS	NE	BRA
Marcondes et al. (220)						0.19	0.10									AM	DFREML	NE	BRA
Marcondes et al. (220)						0.23	0.08									AM	DFREML	NE	BRA
Marlowe and Vogt (221)											0.38					PHS	---	AN	USA
Marlowe and Vogt (221)											0.31					PHS	---	HE	USA
Marques (222)	0.58					0.39										PHS	---	SI	BRA
Marques (222)	0.72					0.16										PHS	---	SI	BRA
Marques et al. (223)	0.17					0.09					0.09					PHS	---	GU	BRA
Marques et al. (224)	0.25	0.10	0.25	0.03	0.31	0.09	0.09	-0.17	0.04	0.11						AM	DFREML	SI	BRA
Marques et al. (225)	0.22	0.05	-0.10	0.07	0.23	0.13	0.05	-0.17	0.02	0.13						AM	DFREML	SI	BRA
Martins et al. (226)	0.59					0.42					0.35					PHS	---	NE	BRA
Martins Filho et al. (227)						0.27										AM	DFREML	NE	BRA
Mascioli et al. (228)	0.36					0.47										PHS	---	CC	BRA
Mason et al. (229)											0.27					PHS	---	MB	AUS
Mason et al. (229)											0.22					PHS	---	MB	AUS
Massey and Benyshek (230)	0.16					0.09					0.08					PHS	---	LI	USA
Mavrogenis et al. (231)						0.08										SSR	---	HE	USA
Mello et al. (232)	0.21															AM	GIBBS	CC	BRA
Mello et al. (232)	0.22															AM	GIBBS	CC	BRA
Mello et al. (232)	0.24															AM	GIBBS	CC	BRA
Mello et al. (232)	0.23															AM	GIBBS	CC	BRA
Mello et al. (232)	0.22															AM	GIBBS	CC	BRA
Mello et al. (232)	0.32															AM	GIBBS	CC	BRA
Mercadante et al. (233)						0.27	0.13		0.10							AM	DFREML	NE	BRA
Mercadante et al. (233)						0.28	0.11		0.11							AM	DFREML	NE	BRA
Mercadante et al. (233)						0.29	0.13		0.10							AM	DFREML	NE	BRA
Mercadante et al. (233)						0.28	0.16		0.07							AM	DFREML	NE	BRA
Mercadante and Lôbo (234)						0.29	0.13	0.00	0.10	0.35						AM	DFREML	NE	BRA
Meyer (235)	0.21			0.05		0.12	0.04		0.23							AM	DFREML	CH	AUS
Meyer (236)	0.58	0.19	-0.57	0.04	0.39	0.32	0.22	-0.67	0.22	0.15						AM	DFREML	PHE	AUS
Meyer (237)	0.29	0.10		0.06		0.20	0.08		0.15							AM	DFREML	AN	NZ
Meyer (237)	0.38	0.07		0.05		0.23	0.08		0.16							AM	DFREML	AN	AUS
Meyer (238)						0.22	0.24	-0.58	0.17	0.14						AM	DFREML	PHE	AUS
Meyer (238)						0.24	0.06	0.14	0.10	0.30						AM	DFREML	WO	AUS
Meyer (238)						0.16	0.17	-0.23	0.22	0.19						AM	DFREML	PHE	AUS
Meyer (238)						0.17	0.14	-0.02	0.18	0.24						AM	DFREML	HE	AUS
Meyer (238)						0.22	0.12	-0.36	0.15	0.19						AM	DFREML	AN	AUS
Meyer (238)						0.15	0.11	-0.23	0.14	0.16						AM	DFREML	AN	NZ
Meyer (238)						0.22	0.17	-0.30	0.14	0.22						AM	DFREML	LI	AUS
Meyer et al. (239)	0.35	0.08		0.04		0.07	0.10		0.22							AM	AIREML	HE	AUS
Milagres et al. (240)	0.32					0.40										PHS	---	NE	BRA
Minyard and Dinkel (241)						0.33										PHS	---	HE	USA
Minyard and Dinkel (241)						0.32										PHS	---	AN	USA
Miquel and Cartwright (242)	0.15					0.24										PHS	---	HE	USA
Miquel and Cartwright (242)	0.16					0.44										PHS	---	BR	USA
Miquel and Cartwright (242)	0.55					0.25										PHS	---	BH	USA
Miquel and Cartwright (242)	0.50					0.22										PHS	---	HB	USA
Miquel and Cartwright (242)	0.26					0.07										PHS	---	HF1	USA
Miquel and Cartwright (242)	0.20					0.19										PHS	---	BF1	USA
Miranda et al. (243)	0.46															PHS	---	GU	BRA
Morris et al. (244)	0.32	0.11	0.24		0.44	0.14	0.35	-0.16		0.26						AM	AIREML	AN	NZ
Mostert et al. (245)	0.51	0.06	-0.60		0.38	0.21	0.10	-0.49		0.15						AM	DFREML	AF	SAF
Mostert et al. (245)	0.37	0.15	-0.54		0.25	0.33	0.19	-0.81		0.12						AM	DFREML	AN	SAF
Mostert et al. (245)	0.45	0.08	-0.35		0.39	0.25	0.08	-0.67		0.15						AM	DFREML	BR	SAF
Mostert et al. (245)	0.29	0.11	-0.56		0.19	0.22	0.11	-0.52		0.15						AM	DFREML	SG	SAF

	Birth weight					Weaning weight					Average daily gain								
Author	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Mostert et al. (245)	0.31	0.15	-0.48		0.23	0.21	0.18	-0.68		0.10						AM	DFREML	SD	SAF
Mpiri et al. (246)	0.33															PHS	---	BO	TAN
Mpiri et al. (246)	0.18															PHS	---	BO	TAN
Mrode and Thompson (247)						0.19			0.08							AM	REML	SI	UK
Mucari and Oliveira (248)						0.14	0.01	-0.16	0.10	0.14						AM	DFREML	GU	BRA
Nadarajah et al. (249)						0.63										PHS	---	AN	USA
Nadarajah et al. (249)						0.51										PHS	---	HE	USA
Nájera Ayala et al. (250)	0.19					0.14										PHS	---	NE	BRA
Neely et al. (251)						0.15										PHS	---	HE	USA
Nelsen et al. (252)	0.50					0.25					0.27					PHS	---	HE	USA
Nelsen et al. (252)	0.39					0.34					0.35					SSR	---	HE	USA
Nelsen and Kress (253)	0.40					0.35					0.38					PHS	---	AN	USA
Nelsen and Kress (253)	0.54					0.43					0.41					PHS	---	HE	USA
Nephawe et al. (254)						0.22										AM	REML	BN	SAF
Nephawe et al. (254)						0.27										AM	REML	BN	SAF
Neser et al. (255)						0.14	0.14	-0.33	0.15	0.14						AM	DFREML	BN	SAF
Nobre et al. (256)	0.46					0.51										PHS	---	NE	BRA
Nobre et al. (257)	0.35															PHS	---	NE	BRA
Nobre et al. (258)	0.33	0.21														AM	EMREML	NE	BRA
Nobre et al. (258)	0.21	0.06														AM	EMREML	NE	BRA
Nobre et al. (258)	0.10	0.11														RRAM	EMREML	NE	BRA
Nobre et al. (258)	0.14	0.08														RRAM	EMREML	NE	BRA
Pabst et al. (259)						0.39										PHS	---	AN	UK
Pabst et al. (259)						0.47										PHS	---	DE	UK
Pabst et al. (259)	0.23					0.38										PHS	---	HE	UK
Pabst et al. (259)						0.29										PHS	---	SU	UK
Pahnish et al. (260)						0.28										PHS	---	HE	USA
Pahnish et al. (260)						0.57										PHS	---	HE	USA
Pahnish et al. (261)	0.20					0.10					0.05					PHS	---	HE	USA
Pani et al. (262)	0.21					0.12					0.14					PHS	---	HE	USA
Pani et al. (262)	0.37					0.11					0.04					PHS	---	HE	USA
Pereira et al. (263)	0.36	0.07	-0.07	0.03	0.38	0.22	0.05	0.13	0.11	0.27						AM	DFREML	NE	BRA
Peters et al. (264)	0.15					0.40										PHS	HM3	MBC	NGR
Philipsson (265)	0.18	0.12														---	---	SLB	SWE
Philipsson (265)	0.19	0.04														---	---	SLB	SWE
Phocas and Laloë (266)	0.33	0.11	-0.41	0.03	0.27	0.13	0.09	-0.41	0.08	0.11						SDMGS	AIREML	CH	FRA
Phocas and Laloë (266)	0.38	0.11	-0.59	0.02	0.25	0.29	0.12	-0.22	0.05	0.29						SDMGS	AIREML	LI	FRA
Phocas and Laloë (266)	0.37	0.10	-0.49	0.04	0.28	0.32	0.13	-0.22	0.02	0.32						SDMGS	AIREML	BL	FRA
Phocas and Laloë (266)	0.28	0.08	-0.39	0.02	0.23	0.20	0.07	-0.09	0.09	0.22						SDMGS	AIREML	MA	FRA
Pimenta Filho (267)						0.35	0.39	-0.68		0.17						AM	DFREML	GU	BRA
Pitchford et al. (268)	0.31															AM	AIREML	MC	AUS
Plasse et al. (269)	0.23	0.07	0.22	0.04	0.30	0.08	0.14	0.07	0.14	0.16						AM	DFREML	BR	VEN
Plasse et al. (269)	0.33	0.06	-0.02	0.08	0.36	0.08	0.13	0.11	0.13	0.16						AM	DFREML	BR	VEN
Plasse et al. (270)	0.33	0.08	-0.37	0.03	0.28	0.07	0.14	-0.13	0.16	0.12						AM	DFREML	BR	VEN
Pons et al. (271)						0.26										PHS	---	HE	BRA
Quaas et al. (272)	0.16	0.06	-0.44		0.13	0.12	0.08	-0.04		0.15						SMGS	EMREML	SI	USA
Quintanilla et al. (273)						0.21	0.11	-0.19	0.05	0.22						AM	GIBBS	BP	SPA
Redman and Brinks (274)	0.52					0.63										---	---	SI	CAN
Redman and Brinks (274)	0.54					0.48										---	---	SI	CAN
Renand (275)	0.31					0.21										PHS	HM3	CX	FRA
Renand (275)	0.32					0.18										PHS	HM3	CX	FRA
Reynolds et al. (276)	0.21					0.24					0.20					SSR	---	HE	USA
Ribeiro et al. (277)						0.31	0.06	-0.32	0.19	0.27						AM	DFREML	NE	BRA
Ribeiro et al. (277)						0.17	0.07	0.36	0.09	0.26						AM	DFREML	NE	BRA
Ribeiro et al. (277)						0.33	0.02	-0.21	0.19	0.31						AM	DFREML	NE	BRA
Ribeiro et al. (277)						0.33	0.03	0.19	0.14	0.37						AM	DFREML	NE	BRA
Ribeiro et al. (277)						0.21	0.08	0.13	0.09	0.28						AM	DFREML	NE	BRA
Ribeiro et al. (277)						0.31	0.04	0.18	0.14	0.36						AM	DFREML	NE	BRA
Rico and Planas (278)	0.10					0.20					0.08					PHS	---	CH	CUB
Robinson (279)						0.34	0.16			0.42						AM	---	BX	AUS
Robinson (280)	0.35	0.08		0.05		0.20	0.09		0.14							AM	DFREML	AN	AUS
Robinson and O´Rourke (281)	0.45	0.10				0.31	0.19									AM	DFREML	MC	AUS
Robinson and O´Rourke (281)						0.35	0.04									AM	DFREML	BR	AUS
Robinson and O´Rourke (281)						0.52	0.07									AM	DFREML	BR	AUS
Rodríguez-Almeida et al. (282)						0.14	0.13		0.23							SD	DFREML	HE	USA
Rodríguez-Almeida et al. (282)						0.20	0.14		0.04							SD	DFREML	AN	USA
Rollins and Wagnon (283)						0.09										PHS	---	HE	USA
Rollins and Wagnon (283)						0.54										PHS	---	HE	USA
Román (284)	0.40	0.09			0.20	0.28	0.19			0.38						AM	AIREML	MC	MEX
Rönningen et al. (285)	0.26															PHS	---	BO	KEN
Rönningen et al. (285)	0.57															ODR	---	BO	KEN
Rosa et al. (286)	0.26					0.28										PHS	---	NE	BRA
Rosales-Alday et al. (287)	0.40	0.12	-0.63	0.04	0.25	0.33	0.19	-0.39	0.10	0.28						AM	DFREML	SI	MEX
Roso and Fries (288)						0.34										PHS	REML	PHE	BRA
Rust et al. (289)	0.30	0.14	-0.45		0.23	0.26	0.17	-0.61		0.15						AM	AGREML	SI	SAF
Sakaguti et al. (290)	0.37					0.47										AM	AIREML	TA	BRA
Sampaio et al. (291)	0.69					0.38										PHS	---	GI	BRA
Sarmento et al. (292)											0.12	0.29	-0.77		0.05	AM	DFREML	NE	BRA
Schaeffer and Wilton (293)						0.18										SM	MML	HE	CAN
Schaeffer and Wilton (293)						0.24										SM	MML	HE	CAN
Schaeffer and Wilton (293)						0.31										SM	MML	SI	CAN
Schaeffer and Wilton (293)						0.40										SM	MML	SI	CAN
Schaeffer and Wilton (293)						0.30										SM	MML	AN	CAN
Schaeffer and Wilton (293)						0.40										SM	MML	AN	CAN
Schaeffer and Wilton (293)						0.23										SM	MML	CH	CAN
Schaeffer and Wilton (293)						0.30										SM	MML	CH	CAN
Schaeffer and Wilton (293)						0.26										SM	MML	SH	CAN
Schaeffer and Wilton (293)						0.33										SM	MML	SH	CAN
Schaeffer and Wilton (293)						0.14										SM	MML	MA	CAN
Schaeffer and Wilton (293)						0.17										SM	MML	MA	CAN
Schaeffer and Wilton (293)						0.12										SM	MML	LI	CAN
Schaeffer and Wilton (293)						0.15										SM	MML	LI	CAN
Schaeffer and Wilton (293)						0.09										SM	MML	BL	CAN
Schaeffer and Wilton (293)						0.09										SM	MML	BL	CAN
Schaeffer and Wilton (293)						0.12										SM	MML	CN	CAN
Schaeffer and Wilton (293)						0.18										SM	MML	CN	CAN
Schaeffer and Wilton (293)						0.15										SM	MML	GE	CAN
Schaeffer and Wilton (293)						0.20										SM	MML	GE	CAN

Author	Birth weight					Weaning weight					Average daily gain								
	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	h^2_d	h^2_m	r_{dm}	c^2	h^2_t	Model[a]	Method[b]	Breed group[c]	Country[d]
Schaeffer and Wilton (293)						0.13										SM	MML	BS	CAN
Schaeffer and Wilton (293)						0.16										SM	MML	BS	CAN
Schaeffer and Wilton (293)						0.17										SM	MML	TT	CAN
Schaeffer and Wilton (293)						0.23										SM	MML	TT	CAN
Schaeffer and Wilton (293)						0.14										SM	MML	PI	CAN
Schaeffer and Wilton (293)						0.15										SM	MML	PI	CAN
Scherre et al. (294)	0.38					0.37										PHS	---	NE	BRA
Scherre et al. (294)	0.48					0.30										PHS	---	NE	BRA
Schoeman and Jordaan (295)						0.57	0.13	-0.37	0.09	0.45						AM	AGREML	BV	SAF
Sharma et al. (296)	0.35					0.14					0.09					PHS	MIVQUE	HE	CAN
Sharma et al. (296)	0.47					0.25					0.28					PHS	MIVQUE	MBS	CAN
Shelby et al. (297)	0.72					0.23										PHS	HM1	HE	USA
Shelby et al. (298)	0.54					0.24					0.48					PHS	HM2	HE	USA
Shepard et al. (299)						0.19	0.24	-0.56		0.13						SMGS	EMREML	AN	USA
Silva et al. (300)	0.76															PHS	---	NE	BRA
Silveira et al. (301)						0.17	0.08	0.27	0.13	0.26						AM	DFREML	NE	BRA
Smith et al. (302)	0.68					0.59										PHS	---	MBC	USA
Smith et al. (303)	0.27					0.14										PHS	---	MB	USA
Splan et al. (304)						0.16										SM	DFREML	MBC	USA
Splan et al. (305)						0.14	0.19	-0.18		0.19						AM	DFREML	CX	USA
Swalve (306)	0.33	0.07	-0.04		0.36	0.34	0.18	-0.39	0.08	0.29						AM	DFREML	SI	AUS
Swiger (307)	0.22					0.25										PHS	HM2	HE	USA
Swiger et al. (308)						0.58										PHS	HM2	MBC	USA
Talib et al. (309)						0.33										PHS	HM3	BI	IDN
Tanida et al. (310)	0.23					0.11										DDR	---	HE	USA
Tanida et al. (310)	0.23					0.61										PHS	---	HE	USA
Tawah et al. (311)	0.39	0.06	-0.86		0.22	0.27	0.20	-0.68		0.13						AM	DFREML	GD	CAM
Tawah et al. (311)	0.65	0.22	-0.93		0.23	0.29	0.27	-0.39		0.26						AM	DFREML	WA	CAM
Tawonezvi (312)	0.44					0.38					0.37					PHS	---	MS	ZIM
Tawonezvi et al. (313)	0.32					0.38										PHS	---	NK	ZIM
Tess et al. (314)	0.83					0.35					0.25					PHS	---	HE	USA
Thrift et al. (315)	0.19					0.27										PHS	---	HE, AN	USA
Thrift et al. (315)	0.34					0.39										PHS	---	HE, AN	USA
Thrift et al. (315)	0.39					0.16										PHS	---	HE, AN	USA
Thrift et al. (315)	0.43					0.39										PHS	---	HE, AN	USA
Tongthainan and Sirisom (316)	0.26					0.28										SM	REML	MBC	THA
Torres et al. (317)	0.15					0.26					0.28					PHS	---	GI	BRA
Tosh et al. (318)	0.51	0.09	0.17	0.02	0.61	0.33	0.13	-0.11	0.20	0.36						AM	DFREML	MC	CAN
Trail et al. (319)	0.21					0.08										PHS	---	MBC	UGA
van der Westhuizen and Rust (320)						0.28	0.28	-0.39		0.26						AM	AGREML	AF	SAF
van Graan et al. (321)	0.23	0.11	-0.08		0.27											AM	AGREML	BN	SAF
Van Vleck et al. (322)						0.34	0.16	0.04	0.18	0.43						AM	DFREML	MB	USA
Van Vleck et al. (322)						0.31	0.15	0.02	0.20	0.39						AM	DFREML	MB	USA
Van Vleck et al. (322)						0.27	0.12	-0.03	0.17	0.32						AM	DFREML	MB	USA
Van Vleck et al. (322)						0.44	0.06	0.06	0.16	0.48						AM	DFREML	CO	USA
Van Vleck et al. (322)						0.46	0.06	0.07	0.14	0.51						AM	DFREML	CO	USA
Van Vleck et al. (322)						0.36	0.05	0.11	0.14	0.41						AM	DFREML	CO	USA
Van Vleck and Cundiff (323)	0.44					0.25										SD	DFREML	MBC	USA
Van Vleck and Cundiff (323)	0.47					0.19										SD	DFREML	MBC	USA
Vargas et al. (324)						0.29	0.18	-0.03		0.37						AM	DFREML	BR	USA
Varona et al. (325)	0.26	0.05	-0.33		0.23											AM	GIBBS	GE	USA
Vesely and Robison (326)	0.67					0.50										PHS	---	HE	USA
Vesely and Robison (326)	0.46					0.31										ODR	---	HE	USA
Vesely and Robison (326)	0.29					0.31										MHS	---	HE	USA
Veseth et al. (327)	0.18					0.17					0.20					PHS	HM3	HE	USA
Vogt and Marlowe (328)											0.07					ODR	---	AN	USA
Vogt and Marlowe (328)											0.06					ODR	---	AN	USA
Vogt and Marlowe (328)											0.07					ODR	---	HE	USA
Vogt and Marlowe (328)											0.14					ODR	---	HE	USA
Wagnon and Rollins (329)						0.42										PHS	---	---	USA
Wagnon and Rollins (329)						0.57										PHS	---	---	USA
Wakhungu et al. (330)	0.40															SD	ML	SA	KEN
Waldron et al. (331)	0.24	0.11	0.37	0.03	0.39	0.15	0.14	-0.35	0.21	0.14						AM	EMREML	HE	NZ
Waldron et al. (331)	0.33	0.04	0.28	0.06	0.40	0.14	0.11	0.06	0.15	0.21						AM	EMREML	AN	NZ
Waldron et al. (331)	0.32	0.06	0.13	0.07	0.37	0.13	0.15	0.00	0.09	0.20						AM	EMREML	AN	NZ
Willis and Wilson (332)	0.67															PHS	---	SG	CUB
Wilson et al. (333)						0.38										PHS	---	HE	USA
Wilson et al. (334)						0.55										PHS	---	CX	USA
Wilson et al. (335)	0.26					0.22										PHS	---	AN	USA
Wilson et al. (335)	0.15					0.25										PHS	---	HE	USA
Wilson et al. (336)						0.35										PHS	---	CX	USA
Wilson et al. (337)	0.41					0.13										SD	AQF	HE	USA
Wilson et al. (337)	0.19					0.16										SD	AQF	AN	USA
Winder et al. (338)	0.46					0.39	0.10									PHS,SMGS	---	RA	USA
Woodward et al. (339)	0.28					0.18										SM	EMREML	SI	USA
Wright et al. (340)						0.12	0.09	0.16		0.19						SMGS	EMREML	SI	USA
Zarazua et al. (341)	0.18															PHS	---	IN	MEX
Unweighted mean of estimates	0.37	0.15	-0.24	0.06	0.36	0.27	0.17	-0.23	0.14	0.25	0.26	0.20	-0.40	0.15	0.24				
Minimum estimate	0.03	0.01	-1.05	0.00	-0.02	-0.01	0.00	-1.00	0.02	0.01	-0.02	0.01	-0.98	0.03	0.00				
Maximum estimate	1.00	1.02	0.99	0.75	0.72	0.95	0.76	1.00	0.67	0.81	0.77	0.70	0.55	0.30	0.74				
Number of estimates	372	193	159	77	166	504	280	233	171	243	123	50	45	23	50				

[a]AM= animal model, DDR= daughter on dam regression analysis, FS= full-sib correlation, MHS= maternal half-sib correlation, ODR= mean offspring on dam regression analysis, OMR= offspring on midparent regression analysis, OSR= mean offspring on sire regression analysis, PHS= paternal half-sib correlation, RRAM= random regression animal model SD= sire-dam model, SDMGS= combination of sire-dam and sire-maternal grand sire model, SM= sire model, SMGS= sire-maternal grand sire model, SSR= son on sire regression analysis.

[b]AGREML= analytical-gradients REML, AIREML= average-information REML, AQF= approximate quadratic forms, DFREML= derivative-free REML, EMREML= expectation-maximization REML, GIBBS= Gibbs sampling, HM1= Henderson's Method 1, HM2= Henderson's Method 2, HM3= Henderson's Method 3, MHM4= modified Henderson's Method 4, MIVQUE= minimum variance quadratic unbiased estimation, ML= maximum likelihood, MML= modified maximum likelihood, PEA= Pseudo-expectation approach, REML= restricted maximum likelihood, THA= tilde-hat approach.

[c]AF= Afrikaner, AL= Alentejana, AN= Angus, AV= Asturiana de los Valles, AX= Composite (50% Africander, 25% Shorthorn, 25% Hereford), AXBX= Composite (25% Africander + 25% Shorthorn + 25% Hereford + 25% Brahman), BA= Brangus, BB= Belgian Blue, BF1= Backcross to Brahman sires, BH= F1 Brahman x Hereford, BI= Bali, BL= Blonde d'Aquitaine, BM= Beefmaster, BN= Bonsmara, BO= Boran, BP= Bruna dels Pirineus, BR= Brahman, BS= Brown Swiss, BV= Bovelder, BX= Brahman cross, CC= Canchim, CGC= Composite (50% Red Angus, 25% Charolais, 25% Tarentaise), CH= Charolais, CN= Chianina, CO= Composites: MARC I, MARC II, and MARC III, CSL= Composite (44% British, 25% Charolais, 25% Simmental, 6% Limousin), CT= Costeño Con Cuernos, CX= Crossbreds, DE= Devon, DM= double muscled breed groups, DS= dairy synthetic (60% dairy breeds [Holstein, Brown Swiss, Simmental] and 40% beef breeds), GD= Gudali, GE= Gelbvieh, GI= Gir, GO= Gobra, GU= Guzera, GX= percentage Gelbvieh, HB= F1 Hereford x Brahman, HE= Hereford, HF1= Backcross to Hereford sires, HO= Holstein, HS= Hereford-Shorthorn cross, HW= Hanwoo, IN= Indu-Brazil, JB= Japanese Black, JBR= Japanese Brown, JE= Jersey, LI= Limousin, MA= Maine Anjou, MB= mixed breeds, MBC= mixed breeds and crosses, MBS= multibreed synthetic beef cattle, MC= mixed crosses, MF1= mixed F1 crosses, MIII= MARC III, MS= Mashona, ND= N'Dama, NE= Nelore, NG= Nguni, NK= Nkone, PHE= Polled Hereford, PI= Pinzgauer, RA= Red Angus, RO= Romosinuano, RP= Red Poll, SA= Sahiwal, SB= Simmental-Brahman cross, SD= South Devon, SE= Senepol, SG= Santa Gertrudis, SH= Sorthorn, SI= Simmental, SLB= Swedish Friesian, SM= Sanmartinero, SU= Sussex, SX= Percentage Simmental, SY= Beef Synthetic, SY1= Beef Synthetic # 1, TA= Tabapua, TC= Tropicarne, TT= Tarentaise, WA= Wakwa, WB= Welsh Black, WO= Wokalups, ZE= Zebu.

[d]AAB= Addis Ababa, ARG= Argentina, AUS= Australia, BEL= Belgium, BRA= Brazil, CAM= Cameroon, CAN= Canada, COL= Colombia, CUB= Cuba, ETH= Ethiopia, FRA= France, GER= Germany, GHA= Ghana, IDN= Indonesia, IRL= Ireland, ITA= Italy, JPN= Japan, KEN= Kenya, KOR= Korea, MEX= Mexico, NGR= Nigeria, NZ= New Zealand, PAK= Pakistan, POR= Portugal, SAF= South Africa, SEN= Senegal, SPA= Spain, SWE= Sweden, SWL= Switzerland, TAN= Tanzania, THA= Thailand, TUR= Turkey, UGA= Uganda, UK= United Kingdom, URU= Uruguay, USA= United States, VEN= Venezuela, ZIM= Zimbabwe.

al destete y ganancia diaria de peso. El número, la media no ponderada y el rango (valor mínimo y máximo) de los estimadores de cada parámetro genético para cada característica de crecimiento también se muestran en el Cuadro 1, al final del mismo. Se presenta un total de 2,689 estimadores individuales, provenientes de 89 grupos raciales localizados en 38 países.

Los autores que se repiten dos o más veces en el cuadro, reportaron estimadores de parámetros genéticos para diferentes categorías de un mismo factor. Por ejemplo, estimadores para una misma característica se reportaron para diferentes razas, sexos, estaciones experimentales, métodos de estimación, regiones geográficas o países. La abreviatura AM usada dentro la columna que proporciona información sobre los modelos estadísticos utilizados se refiere a variantes del modelo animal (e.g., modelo animal con efecto genético materno, modelo animal con efecto del ambiente materno permanente, modelo animal multivariado). En esta revisión, todas las variantes del modelo animal reportadas en la literatura se consideraron como una misma variante y todas ellas son citadas como “modelo animal”.

La mayoría de los estudios genéticos (125) para características de crecimiento predestete de bovinos ha sido realizada en los Estados Unidos, seguida por 73 estudios genéticos realizados en Brasil, 29 en Canadá y 25 en Australia, mientras que REML (siglas en inglés de Máxima Verosimilitud Restringida) libre de derivadas ha sido el método de estimación más aplicado (en 107 estudios), seguido por REML basado en un algoritmo de información promedio (en 28 estudios) y REML basado en un algoritmo de esperanza-maximización (en 18 estudios). Del número total de estudios revisados (337), sólo en 10 se utilizó muestreo Gibbs para estimar parámetros genéticos.

Peso al nacimiento

Estimadores de heredabilidad directa. La media de los estimadores de heredabilidad directa para peso al nacimiento (0.37; n=372) indica que los efectos directos para peso al nacimiento son moderadamente

trait were reported for different breeds, sexes, experimental stations, methods of estimation, geographical regions or different countries. The AM abbreviation used within the column that provides information about models refers to variants of the animal model (e.g., animal model with maternal genetic effect, animal model with permanent environmental dam effect, multivariate animal model). All variants of the animal model reported in the literature were considered as one same variant and all of them are cited as “animal model” in this review.

Most genetic studies (125) of preweaning growth traits of cattle have been carried out in the United States, followed by 73 genetic studies performed in Brazil, 29 in Canada, and 25 in Australia, while Derivative-Free REML (Restricted Maximum Likelihood) has been the most applied method of estimation (in 107 studies), followed by Average-Information (in 28 studies) and Expectation-Maximization REML (in 18 studies). Of the total number of studies reviewed (337), only in 10 Gibbs sampling was used to estimate genetic parameters.

Birth Weight

Estimates of direct heritability. The mean of the estimates of direct heritability for birth weight (0.37; n= 372) indicates that direct effects for birth weight are moderately heritable and genetic gain might be achieved through single-trait selection. The weighted (0.31) and unweighted (0.35) means of estimates of direct heritability for birth weight reported by others(5) are similar to the unweighted mean of estimates of direct heritability obtained in the present study. The range of the estimates of direct heritability was very wide. The minimum estimate, obtained with a sire-dam model and Average-Information REML, was 0.03 for Simmental, Brahman and Simmental-Brahman crosses raised in Mexico(6). The maximum estimate, obtained with paternal half-sib correlation, was 1.0 for Hereford cattle under United States conditions(7). However, only twelve estimates of direct heritability had a value greater than 0.7.

The estimates of direct heritability for birth weight were highly variable among them. For example, heredables y que es posible lograr avance genético por medio de selección para una sola característica. La media ponderada (0.31) y la no ponderada (0.35) de los estimadores de heredabilidad directa para peso al nacimiento reportadas por otros autores[5] son similares a la media no ponderada de los estimadores de heredabilidad directa reportada en el presente estudio. El rango de los estimadores de heredabilidad directa fue muy amplio. El estimador mínimo, obtenido con un modelo vaca-semental y REML basado en un algoritmo de información promedio, fue 0.03 para Simmental, Brahman y cruzas Simmental-Brahman criados en México[6]. El estimador máximo, obtenido mediante correlación entre medios hermanos paternos, fue 1.0 para ganado Hereford en condiciones estadounidenses[7]. Sin embargo, sólo 12 estimadores de heredabilidad directa tuvieron un valor mayor que 0.7.

Los estimadores de heredabilidad directa para peso al nacimiento fueron altamente variables entre ellos. Por ejemplo, Ríos-Utrera *et al*[8], Martínez y Galíndez[9], Carter *et al*[10], Eriksson *et al*[11], Mackinnon *et al*[12] y Knights *et al*[13] reportaron estimadores de heredabilidad directa de 0.22, 0.31, 0.40, 0.50, 0.61 y 0.70, respectivamente. En general, las medias de los estimadores de heredabilidad directa para peso al nacimiento fueron similares para las razas con mayor número de estimadores: Angus (0.34; n=35), Brahman (0.32; n=14), Charoláis (0.38; n=21), Hereford (0.43; n=81), Limousin (0.29; n=6), Nelore (0.34; n=24) y Simmental (0.36; n=17). Para peso al nacimiento, la media de los estimadores de heredabilidad directa obtenidos mediante correlación entre medios hermanos paternos (0.38; n=127) fue similar a las medias de los estimadores correspondientes obtenidos con modelos animal (0.37; n=154) y semental (0.34; n=7). La media de los estimadores de heredabilidad directa obtenidos con modelos semental-abuelo materno fue menor (0.28; n=25).

Estimadores de heredabilidad materna. Los efectos genéticos maternos fueron menos heredables que los efectos genéticos directos para peso al nacimiento. La media y el número de los estimadores de heredabilidad materna fueron 0.14 y 194, respectivamente. La media no ponderada de

Ríos-Utrera *et al*[8], Martínez and Galíndez[9], Carter et al.[10], Eriksson *et al*[11], Mackinnon *et al*[12] and Knights *et al*[13] reported estimates of direct heritability of 0.22, 0.31, 0.40, 0.50, 0.61 and 0.70, respectively. In general, the means of the estimates of direct heritability for birth weight were similar for the breeds with greater number of estimates: Angus (0.34; n=35), Brahman (0.32; n=14), Charolais (0.38; n=21), Hereford (0.43; n=81), Limousin (0.29; n=6), Nelore (0.34; n=24) and Simmental (0.36; n=17). For birth weight, the mean of the estimates of direct heritability obtained with paternal half-sib analyses (0.38; n=127) was similar to the means of corresponding estimates obtained with animal (0.37; n=154) and sire models (0.34; n=10). The mean of the estimates of direct heritability obtained with sire-maternal grand sire models was somewhat smaller (0.28; n=25).

Estimates of maternal heritability. Maternal genetic effects were less heritable than direct genetic effects for birth weight. The mean and the number of the estimates of maternal heritability were 0.14 and 194, respectively. The unweighted mean of estimates of maternal heritability for birth weight reported here is identical to the equivalent weighted mean (0.14) published in a previous review[5]. Like the estimates of direct heritability, the estimates of maternal heritability were in a wide range. The smallest estimate of maternal heritability (0.01), obtained with Derivative-Free REML fitting an animal model, was reported by for Colombian Costeño con Cuernos cattle[14]. The greatest estimate of maternal heritability (1.02) was obtained with paternal half-sib correlation and Hereford cattle reared in the United States[15]. Very few (two) estimates of maternal heritability were above 0.7. Other estimates within this range were: 0.11[16], 0.26[17], 0.33[18], 0.55[19], 0.63[20] and 0.83[21], which show important variability. The means of the estimates of maternal heritability for birth weight by breed were: 0.17 (n=24), 0.10 (n=11), 0.14 (n=14), 0.20 (n=37), 0.08 (n=3), 0.09 (n=11) and 0.11 (n=10) for Angus, Brahman, Charoláis, Hereford, Limousin, Nelore and Simmental, respectively.

Estimates of direct-maternal genetic correlation. The 159 estimates of the genetic correlation between los estimadores de heredabilidad materna para peso al nacimiento aquí reportada es idéntica a la media ponderada correspondiente (0.14) publicada en una revisión previa[5]. Al igual que los estimadores de heredabilidad directa, los estimadores de heredabilidad materna se encontraron dentro de un amplio rango. El menor estimador de heredabilidad materna (0.01), obtenido con REML libre de derivadas ajustando un modelo animal, fue reportado para ganado Costeño con Cuernos colombiano[14]. El mayor estimador de heredabilidad materna (1.02) fue obtenido mediante correlación entre medios hermanos paternos de la raza Hereford en los Estados Unidos[15]. Muy pocos (dos) estimadores de heredabilidad materna fueron mayores que 0.7. Otros estimadores dentro de este rango fueron: 0.11[16], 0.26[17], 0.33[18], 0.55[19], 0.63[20] y 0.83[21], los cuales muestran variación importante. Las medias por raza de los estimadores de heredabilidad materna fueron: 0.17 (n=24), 0.10 (n=11), 0.14 (n=14), 0.20 (n=37), 0.08 (n=3), 0.09 (n=11) y 0.11 (n=10) para Angus, Brahman, Charolais, Hereford, Limousin, Nelore y Simmental, respectivamente.

Estimadores de la correlación genética entre efectos directos y maternos. Los 159 estimadores de la correlación genética entre efectos directos y maternos encontrados en la literatura para peso al nacimiento tuvieron una media de -0.24. Los estimadores estuvieron dentro de un rango que fue de casi -1.00 a casi 1.00. El estimador mínimo (-1.05) fue publicado para ganado Hereford estadounidense[20]. El estimador máximo de 0.99 fue reportado para ganado Sahiwal en Kenia[22]. Aunque con diferentes signos, estos dos estimadores extremos pueden reflejar la ausencia de efectos abuela y(o) semental x hato en los modelos. En contraste, Meyer[3], Snelling *et al*[23] y Plasse *et al*[24] reportaron estimadores de correlación genética cercanos a cero (0.03, 0.04 y 0.06), los cuales indican que tales efectos tuvieron poca asociación genética. Las medias negativas de los estimadores de la correlación genética entre efectos directos y maternos para las razas Angus, Brahman, Charoláis, Hereford, Limousin, Nelore y Simmental fueron variables (-0.16, n=18; -0.09, n=11; -0.43, n=14; -0.25, n=36; -0.38, n=3; -0.06, n=4; y -0.25, n=10, respectivamente).

direct and maternal effects found in the literature for birth weight had a mean of -0.24. The estimates ranged from almost -1.00 to almost 1.00. The minimum estimate (-1.05) was published for American Hereford cattle[20]. The maximum estimate of 0.99 was reported for Sahiwal cattle in Kenya[22]. Although with different signs, these two extreme estimates may reflect the absence of gandmaternal and(or) sire x herd interaction effects in the models. In contrast, Meyer[3], Snelling *et al*[23] and Plasse *et al*[24] reported near zero estimates of direct-maternal genetic correlation (0.03, 0.04 and 0.06), which indicate that such effects had little genetic association. The negative means of the estimates of direct-maternal genetic correlation for Angus, Brahman, Charolais, Hereford, Limousin, Nelore and Simmental breeds were variable (-0.16, n=18; -0.09, n=11; -0.43, n=14; -0.25, n=36; -0.38, n=3; -0.06, n=4; and -0.25, n=10, respectively).

Estimates of maternal permanent environmental effects. Seventy seven (77) estimates of the maternal permanent environmental variance as a proportion of the phenotypic variance were found for birth weight. Such estimates had a mean of 0.06, which indicates that maternal permanent environmental effects have little influence on birth weight compared to direct and maternal genetic effects. In a previous literature review[4] also was concluded that permanent environmental effects had little influence on birth weight, and a weighted mean of 0.03 was reported for such effects as a proportion of the phenotypic variance. A very large estimate (0.75), which was the greatest estimate found for birth weight, was reported for Santa Gertrudis cattle reared in Brazil[25]. In great contrast to this result, other researchers[26-31] reported that the estimate of the proportion of the phenotypic variance due to permanent environmental dam effects was zero for birth weight. Although the smallest and the greatest estimates found in the literature revealed a wide range, the estimates of the maternal permanent environmental variance as a proportion of the phenotypic variance were less variable than the estimates of the three genetic parameters examined above. The means of the estimates of the maternal permanent environmental variance as a proportion

Estimadores de efectos del ambiente materno permanente. Setenta y siete (77) estimadores de la fracción de la varianza fenotípica debida al ambiente materno permanente se encontraron para peso al nacimiento. Estos estimadores tuvieron una media de 0.06, la cual indica que el ambiente materno permanente tiene poca influencia sobre peso al nacimiento, comparado con los efectos genéticos directos y maternos. En una revisión previa de literatura(4) también se concluyó que los efectos del ambiente materno permanente tuvieron poca influencia sobre peso al nacimiento, y se reportó una media ponderada de 0.03 para tales efectos como proporción de la varianza fenotípica. Un estimador muy grande (0.75), el cual fue el mayor estimador encontrado para peso al nacimiento, se reportó para ganado Santa Gertrudis criado en Brasil(25). En gran contraste con este resultado, otros investigadores(26-31) reportaron que el estimador de la fracción de la varianza fenotípica debida a efectos del ambiente materno permanente fue cero para peso al nacimiento. Aunque el mayor y el menor estimador encontrados en la literatura revelaron un amplio rango, los estimadores de la varianza del ambiente materno permanente como proporción de la varianza fenotípica fueron menos variables que los estimadores de los tres parámetros genéticos examinados en los apartados anteriores. Las medias de los estimadores de la varianza del ambiente materno permanente como proporción de la varianza fenotípica para peso al nacimiento fueron similares para Angus (0.05, n=8), Brahman (0.04, n=5), Charoláis (0.06, n=4), Hereford (0.04, n=15), Limousin (0.04, n=2), Nelore (0.03, n=5) y Simmental (0.05, n=5).

Estimadores de heredabilidad total. Para peso al nacimiento, la media (0.36; n=166) de los estimadores de heredabilidad total fue muy similar a la media de los estimadores de heredabilidad directa. El rango de los estimadores fue de -0.02 a 0.72. El estimador negativo fue reportado para ganado Hereford (n=4,423) criado en los Estados Unidos(20). El estimador positivo fue reportado para ganado puro y cruzado (n=3,936) criado en este mismo país(32). Los estimadores de heredabilidad total para peso al nacimiento manifestaron gran variación, como lo indican los estimadores (0.25, 0.35, 0.40, 0.45, 0.50, 0.62) obtenidos en otros estudios(33-38)...

of the phenotypic variance for birth weight were similar for Angus (0.05, n=8), Brahman (0.04, n=5), Charolais (0.06, n=4), Hereford (0.04, n=15), Limousin (0.04, n=2), Nelore (0.03, n=5) and Simmental (0.05, n=5).

Estimates of total heritability. For birth weight, the mean (0.36; n=166) of the estimates of total heritability was highly comparable to the mean of the estimates of direct heritability. The range of the estimates was between -0.02 and 0.72. The negative estimate was reported for Hereford cattle (n=4,423) reared in the United States(20). The positive estimate was reported for purebred and crossbred cattle (n=3,936) reared in the same country(32). The estimates of total heritability for birth weight manifested large variation as indicate the estimates (0.25, 0.35, 0.40, 0.45, 0.50, 0.62) obtained in other studies(33-38). The means of the estimates of total heritability for Angus, Brahman, Charolais and Nelore resembled each other (0.36, 0.35, 0.34, 0.33, respectively), but the mean of the estimates of total heritability for Hereford was somewhat greater (0.44), whereas the mean for Simmental was somewhat smaller (0.29).

Weaning weight

Estimates of direct heritability. On average, direct effects for weaning weight were less heritable than direct effects for birth weight (0.27 *vs* 0.37). The weighted mean of estimates of direct heritability for weaning weight (0.24) obtained by Koots *et al*(5) is comparable to the corresponding unweighted mean obtained in the present review. Weaning weight was the trait with the most estimates of direct heritability (n=504). The range of the estimates of direct heritability for weaning weight was wide. The smallest estimate (-0.01) was obtained applying the Henderson's Method 2 on purebred and crossbred cattle data from the United States(39). On the contrary, the greatest estimate (0.95) was obtained applying Average-Information REML fitting a sire-maternal grand sire model on Italian Charolais data(40). Only three estimates of direct heritability were larger than 0.7.

Estimates (0.19, 0.25, 0.30, 0.35, 0.40, 0.43, 0.50, 0.55, 0.58, 0.62) for cattle reared in Australia(3), 0.35, 0.40, 0.45, 0.50, 0.62) obtenidos en otros trabajos[33-38]. Las medias de los estimadores de heredabilidad total para Angus, Brahman, Charolais y Nelore fueron muy parecidas (0.36, 0.35, 0.34, 0.33, respectivamente), pero la media de los estimadores de heredabilidad total para Hereford fue mayor (0.44), mientras que la media para Simmental fue menor (0.29).

Peso al destete

Estimadores de heredabilidad directa. En promedio, los efectos directos para peso al destete fueron menos heredables que los efectos directos para peso al nacimiento (0.27 *vs* 0.37). La media ponderada de los estimadores de heredabilidad directa para peso al destete (0.24) obtenida por Koots *et al*[5] es similar a la media no ponderada correspondiente obtenida en la presente revisión. Peso al destete fue la característica con el mayor número de estimadores de heredabilidad directa (n= 504). El rango de los estimadores de heredabilidad directa para peso al destete fue amplio. El menor estimador (-0.01) fue obtenido aplicando el Método 2 de Henderson en datos de ganado estadounidense puro y cruzado[39]. Por el contrario, el mayor estimador (0.95) fue obtenido con REML basado en un algoritmo de información promedio ajustando un modelo semental-abuelo materno en datos de Charoláis italiano[40]. Sólo tres estimadores de heredabilidad directa fueron mayores que 0.7.

Estimadores (0.19, 0.25, 0.30, 0.35, 0.40, 0.43, 0.50, 0.55, 0.58, 0.62) para ganado criado en Australia[3], Francia[40], Uruguay[41], Brasil[42], Canadá[43], Kenia[44], España[45], Portugal[46], Bélgica[47] y los Estados Unidos[48] son buenos indicadores de la gran variabilidad de los 504 estimadores incluidos en este rango. Cuando se promedió por raza, las medias de los estimadores de heredabilidad directa para peso al destete fueron, en general, similares para Angus (0.31; n=67), Brahman (0.26; n=17), Charolais (0.28; n=26), Hereford (0.24; n=113), Limousin (0.23; n=13), Nelore (0.26; n=45) y Simmental (0.26; n=20). Para peso al destete, la media de los estimadores de heredabilidad directa obtenidos mediante correlación entre medios hermanos paternos (0.30; France[40], Uruguay[41], Brazil[42], Canada[43], Kenya[44], Spain[45], Portugal[46], Belgium[47] and the United States[48] are good indicators of the great variability of the 504 estimates included in this range. When averaged by breed, the means of the estimates of direct heritability for weaning weight were, in general, similar for Angus (0.31; n=67), Brahman (0.26; n=17), Charolais (0.28; n=26), Hereford (0.24; n=113), Limousin (0.23; n=13), Nelore (0.26; n=45) and Simmental (0.26; n=20). For weaning weight, the mean of the estimates of direct heritability obtained with paternal half-sib correlation (0.30; n=143) tended to be larger than the means of corresponding estimates obtained with animal (0.25; n=245), sire (0.23; n=38), and sire-maternal grand sire models (0.25; n=29).

Estimates of maternal heritability. Maternal genetic effects for weaning weight were, on average, lowly heritable (0.17), and were, basically, as heritable as maternal genetic effects for birth weight. The unweighted mean of the estimates of maternal heritability for weaning weight of the present review is in close proximity to the corresponding weighted means reported in two previous literature reviews[4,5]. The estimates of maternal heritability for weaning weight ranged from 0.00 to 0.76. The minimum estimate was for Mexican Angus[18]. The maximum estimate, which was the only estimate greater than 0.7, was for Canadian Hereford[49]. Other variable estimates (0.15, 0.21, 0.30, 0.36, 0.40, 0.47) within this range were for Brangus[19], Gobra[50], Asturiana de los Valles[51], Nelore[52], Hereford[53] and Senepol cattle[54]. Generally, the mean of the estimates of maternal heritability for Angus (0.16), Brahman (0.13), Charolais (0.14), Hereford (0.23), Limousin (0.15), Nelore (0.12) and Simmental (0.13) cattle were low and similar to each other. The numbers of estimates of maternal heritability were: 43, 14, 12, 51, 8, 29, and 12, respectively.

Estimates of direct-maternal genetic correlation. The mean of the estimates of the direct-maternal genetic correlation for weaning weight was -0.23, which was calculated for 233 estimates found. The range of the estimates was from negative perfect (-1.00) to positive perfect correlation (1.00). The smallest n=143) tendió a ser mayor que las medias de los estimadores correspondientes obtenidos con modelos animal (0.25; n=245), semental (0.23; n=38) y semental-abuelo materno (0.25; n=29).

Estimadores de heredabilidad materna. Los efectos genéticos maternos para peso al destete fueron, en promedio, poco heredables (0.17) y fueron, básicamente, tan heredables como los efectos genéticos maternos para peso al nacimiento. La media no ponderada de los estimadores de heredabilidad materna para peso al destete de la presente revisión es parecida a las medias ponderadas correspondientes reportadas en dos revisiones bibliográficas anteriores[4,5]. Los estimadores de heredabilidad materna para peso al destete estuvieron dentro de un rango que fue de 0.00 a 0.76. El estimador mínimo fue para Angus mexicano[18]. El estimador máximo, el cual fue el único estimador mayor que 0.7, fue para Hereford Canadiense[49]. Otros estimadores variables (0.15, 0.21, 0.30, 0.36, 0.40, 0.47) dentro de este rango fueron para ganado Brangus[19], Gobra[50], Asturiana de los Valles[51], Nelore[52], Hereford[53] y Senepol[54]. En general, las medias de los estimadores de heredabilidad materna para ganado Angus (0.16), Brahman (0.13), Charolais (0.14), Hereford (0.23), Limousin (0.15), Nelore (0.12) y Simmental (0.13) fueron bajas y similares entre ellas. Los números de estimadores de heredabilidad materna fueron: 43, 14, 12, 51, 8, 29 y 12, respectivamente.

Estimadores de la correlación genética entre efectos directos y maternos. La media de los estimadores de la correlación genética entre efectos directos y maternos para peso al destete fue -0.23, la cual fue calculada para 233 estimadores encontrados en la literatura. El rango de los estimadores fue de una correlación perfecta negativa (-1.00) a correlación perfecta positiva (1.00). El menor estimador fue obtenido para ganado Hereford canadiense aplicando REML libre de derivadas y ajustando un modelo animal[49]. El mayor estimador también fue obtenido aplicando REML libre de derivadas ajustando un modelo animal, pero para ganado Tabapua brasileño[55]. Algunos ejemplos de estimadores intermedios (-0.72, -0.61, 0.05, 0.38, 0.89) de la estimate was obtained applying Derivative-Free REML fitting an animal model for Canadian Hereford cattle[49]. The greatest estimate also was obtained applying Derivative-Free REML fitting an animal model but for Brazilian Tabapua cattle[55]. Some examples of intermediate estimates of direct-maternal genetic correlation for weaning weight are those (-0.72, -0.61, 0.05, 0.38, 0.89) obtained by Ríos-Utrera *et al*[8], Rasali *et al*[56], Nephawe *et al*[57], Núñez-Domínguez *et al*[58] and Ishida and Mukai[59]. For weaning weight, the means of the estimates of direct-maternal genetic correlation for Angus (-0.27), Brahman (-0.13), Charolais (-0.47), Hereford (-0.37), Limousin (-0.27), Nelore (-0.06) and Simmental (-0.18) were more variable, in contrast to the mean of the estimates of direct and maternal heritability. The numbers of estimates by breed were: 35, 11, 11, 49, 8, 20, and 12, respectively.

Estimates of maternal permanent environmental effects. The mean of the estimates (n=171) of the maternal permanent environmental variance as a proportion of the phenotypic variance for weaning weight was greater than the corresponding mean for birth weight (0.14 *vs* 0.06). Crews and Kemp[60], for several crosses in Canada, reported an estimate of the proportion of the phenotypic variance due to maternal permanent environmental effects for weaning weight of 0.02, which was the smallest estimate found. In contrast, an estimate of 0.67, which was the greatest estimate found, was obtained for Santa Gertrudis cattle in Brazil[25]. Estimates of 0.10[61], 0.15[50], 0.20[62], 0.26[23] and 0.35[63] also were found, indicating variation among them. Angus (0.10), Brahman (0.12), Charolais (0.13), Limousin (0.11), Nelore (0.12) and Simmental (0.09) had similar means of the estimates of the maternal permanent environmental variance as a proportion of the phenotypic variance for weaning weight. However, the corresponding mean of the estimates for Hereford (0.18) was two fold greater than the corresponding mean of the estimates for Simmental. Meyer[3], who concluded that weaning weight in Herefords was primarily determined by permanent environmental effects due to the dam, reported an estimate (0.23) similar to the unweighted mean obtained here for Hereford.

correlación genética entre efectos directos y maternos para peso al destete son los obtenidos por Ríos-Utrera *et al*[8], Rasali *et al*[56], Nephawe *et al*[57], Núñez-Domínguez *et al*[58] e Ishida y Mukai[59]. Para peso al destete, las medias de los estimadores de la correlación genética entre efectos directos y maternos para Angus (-0.27), Brahman (-0.13), Charolais (-0.47), Hereford (-0.37), Limousin (-0.27), Nelore (-0.06) y Simmental (-0.18) fueron más variables, en contraste con las medias de los estimadores de heredabilidad directa y materna. Los números de estimadores por raza fueron: 35, 11, 11, 49, 8, 20 y 12, respectivamente.

Estimadores de efectos del ambiente materno permanente. La media de los estimadores (n=171) de la varianza del ambiente materno permanente como proporción de la varianza fenotípica para peso al destete fue mayor que la media correspondiente para peso al nacimiento (0.14 vs 0.06). Crews y Kemp[60], para diversas cruzas en Canadá, reportaron un estimador de la fracción de la varianza fenotípica debida a efectos del ambiente materno permanente para peso al destete de 0.02, el cual fue el menor estimador encontrado. En contraste, para ganado Santa Gertrudis en Brasil[25], se obtuvo un estimador de 0.67, el cual fue el mayor estimador encontrado. Estimadores con valores de 0.10[61], 0.15[50], 0.20[62], 0.26[23] y 0.35[63] también fueron encontrados, indicando variación entre ellos. Angus (0.10), Brahman (0.12), Charolais (0.13), Limousin (0.11), Nelore (0.12) y Simmental (0.09) tuvieron similares medias de los estimadores de la varianza del ambiente materno permanente como proporción de la varianza fenotípica para peso al destete. Sin embargo, la media correspondiente para Hereford (0.18) fue dos veces mayor que la media correspondiente para Simmental. Meyer[3], y se concluyó que el peso al destete en Hereford estuvo principalmente determinado por efectos del ambiente permanente debido a la madre, reportando un estimador (0.23) similar a la media no ponderada obtenida para Hereford en este estudio.

Estimadores de heredabilidad total. La media de los 243 estimadores de heredabilidad total para peso al destete fue 0.25. Los estimadores mínimo (0.01) y máximo (0.81) de heredabilidad total revelaron

Estimates of total heritability. The mean of the 243 estimates of total heritability for weaning weight was 0.25. The minimum (0.01) and the maximum (0.81) estimates of total heritability revealed a wide range. The minimum estimate was reported for double muscled cattle in Canada[49]. The maximum estimate was reported for Hereford cattle in the United States[38]. Only two estimates of total heritability exceeded 0.7. Other estimates of total heritability for weaning weight inside this range were: 0.20[30], 0.30[64], 0.40[65], 0.50[66] and 0.64[56]. In general, the means of the estimates of total heritability were similar for Angus, Brahman, Charolais, Hereford, Limousin, Nelore and Simmental. Such means were: 0.28 (n=35), 0.22 (n=11), 0.18 (n=11), 0.22 (n=49), 0.25 (n=8), 0.26 (n=20) and 0.21 (n=12), respectively.

Average daily gain

Estimates of direct heritability. The mean of the estimates of direct heritability for average daily gain was practically equal to the mean of the estimates of direct heritability for weaning weight (0.26 *vs* 0.27). Koots *et al*[5] obtained a similar weighted mean of estimates of direct heritability for average daily gain (0.29). The number of estimates of direct heritability found for average daily gain was 123. Estimates of direct heritability for average daily gain ranged from a negative (-0.02) to a positive estimate (0.77). The negative estimate was published for a variety of breeds and crosses in the United States[39]; the positive estimate was published for Nelore cattle in Brazil[67]. The maximum estimate found was the only estimate greater than 0.7. Burrow[68], Miller and Wilton[69], DeNise *et al*[70], Shibata and Kumazaki[71], Salgado and Franke[72] and Magaña *et al*[73] reported variable estimates, which were: 0.14, 0.22, 0.32, 0.42, 0.55 and 0.60, respectively.

Estimates of maternal heritability. Fifty estimates of maternal heritability for average daily gain were found in the literature. Those estimates had a mean of 0.20. The estimates of maternal heritability for average daily gain analyzed by Koots *et al*[5] had a weighted mean (0.24) similar to the unweighted mean obtained in the present analysis. The estimates un amplio rango. El estimador mínimo fue reportado para ganado con doble músculo en Canadá[49]. El estimador máximo fue reportado para ganado Hereford en los Estados Unidos[38]. Sólo dos estimadores de heredabilidad total excedieron 0.7. Otros estimadores de heredabilidad total para peso al destete dentro de este rango fueron: 0.20[30], 0.30[64], 0.40[65], 0.50[66] y 0.64[56]. En general, las medias de los estimadores de heredabilidad total fueron similares para Angus, Brahman, Charoláis, Hereford, Limousin, Nelore y Simmental. Las medias fueron: 0.28 (n=35), 0.22 (n=11), 0.18 (n=11), 0.22 (n=49), 0.25 (n=8), 0.26 (n=20) y 0.21 (n=12), respectivamente.

Ganancia diaria de peso

Estimadores de heredabilidad directa. La media de los estimadores de heredabilidad directa para ganancia diaria de peso fue prácticamente igual a la media de los estimadores de heredabilidad directa para peso al destete (0.26 vs 0.27). Koots *et al*[5] obtuvieron una media ponderada similar (0.29) de estimadores de heredabilidad directa para ganancia diaria de peso. El número de estimadores de heredabilidad directa encontrados para ganancia diaria de peso fue 123. Los estimadores de heredabilidad directa para ganancia diaria de peso se encontraron dentro de un rango que fue de un estimador negativo (-0.02) a un estimador positivo (0.77). El estimador negativo fue publicado para varias razas y cruzas en los Estados Unidos[39]; el estimador positivo fue publicado para ganado Nelore en Brasil[67]. El máximo estimador encontrado fue el único estimador mayor que 0.7. Burrow[68], Miller y Wilton[69], DeNise *et al*[70], Shibata y Kumazaki[71], Salgado y Franke[72] y Magaña *et al*[73] reportaron estimadores variables, los cuales fueron: 0.14, 0.22, 0.32, 0.42, 0.55 y 0.60, respectivamente.

Estimadores de heredabilidad materna. Cincuenta estimadores de heredabilidad materna para ganancia diaria de peso fueron encontrados en la literatura. Estos estimadores tuvieron una media de 0.20. Los estimadores de heredabilidad materna para ganancia diaria de peso analizados por Koots *et al*[5] tuvieron una media ponderada (0.24) similar a la media no

of heritability for maternal effects ranged widely. For Spanish Asturiana de los Valles cattle, a near zero estimate (0.01) was reported[45], which suggest that maternal genetic effects have little or nil influence on average daily gain. In contrast, for Canadian Hereford, a relatively great estimate (0.70) was reported[49], which indicates that the maternal genetic component have large effects on average daily gain. As occurred with estimates of direct heritability, estimates of maternal heritability for average daily gain varied largely. For example, Sapp *et al*[74], Roso *et al*[75], Stålhammar and Philipsson[76], Deese and Koger[77] and Pang *et al*[49] reported estimates of 0.14, 0.20, 0.31, 0.46 and 0.53, respectively.

Estimates of direct-maternal genetic correlation. The mean of the estimates of the genetic correlation between direct and maternal effects for average daily gain was -0.40. This mean estimate was about two fold smaller than the means of the estimates of the direct-maternal genetic correlation for birth and weaning weight. The 45 estimates found were within a wide range. This range included positive and negative estimates, although most of the estimates were negative. Of the total number of estimates only three were positive. To some extent, this last finding could be the reason of the smaller mean estimate of such correlation obtained for average daily gain, compared to corresponding mean estimates for birth and weaning weight. The minimum estimate (-0.98), obtained with an animal model and Derivative-Free REML, was reported for double muscled cattle in Canada[49]. The maximum estimate (0.55), obtained with an animal model and Average-Information REML, was reported for Japanese Black cattle raised in Japan[59]. Some negative estimates reported were: -0.79[78], -0.63[79], -0.51[80], -0.35[74], -0.25[81] and -0.05[82]. The three positive estimates were reported by Ishida and Mukai[59], Stålhammar and Philipsson[76] and Deese and Koger[77].

Estimates of maternal permanent environmental effects. The estimates of the maternal permanent environmental variance as a proportion of the phenotypic variance for average daily gain had a mean of 0.15 (n=23). The range of the estimates ponderada obtenida en el presente análisis. Los estimadores de heredabilidad para efectos maternos se distribuyeron dentro de un rango muy amplio. Para ganado español Asturiana de los Valles fue reportado[45] un estimador cercano a cero (0.01), el cual sugiere que los efectos genéticos maternos tienen poca o nula influencia sobre la ganancia diaria de peso. En contraste, para Hereford canadiense, se publicó[49] un estimador relativamente grande (0.70), el cual indica que el componente genético materno tiene grandes efectos sobre la ganancia diaria de peso. Como ocurrió con los estimadores de heredabilidad directa, los estimadores de heredabilidad materna para ganancia diaria de peso variaron grandemente. Por ejemplo, Sapp *et al*[74], Roso *et al*[75], Stålhammar y Philipsson[76], Deese y Koger[77] y Pang *et al*[49] mencionan estimadores de 0.14, 0.20, 0.31, 0.46 y 0.53, respectivamente.

Estimadores de la correlación genética entre efectos directos y maternos. La media de los estimadores de la correlación genética entre efectos directos y maternos fue -0.40 para ganancia diaria de peso. Este estimador promedio fue casi dos veces más pequeño que el estimador promedio de la correlación genética entre efectos directos y maternos para peso al nacimiento y peso al destete. Los 45 estimadores encontrados estuvieron dentro de un amplio rango, el cual incluyó estimadores positivos y negativos; del número total de estimadores sólo tres fueron positivos. En cierto grado, este último hallazgo puede ser la causa de haber obtenido un menor estimador promedio de dicha correlación para ganancia diaria de peso, comparado con el estimador promedio correspondiente para peso al nacimiento y peso al destete. El estimador mínimo (-0.98), obtenido con un modelo animal y REML libre de derivadas, se reportó para ganado con doble músculo en Canadá[49]. El estimador máximo (0.55), obtenido con un modelo animal y REML basado en un algoritmo de información promedio, se emncionó para ganado Japonés Negro criado en Japón[59]. Algunos estimadores negativos en la literatura fueron: -0.79[78], -0.63[79], -0.51[80], -0.35[74], -0.25[81] y -0.05[82]. Los tres estimadores positivos correspondieron a Ishida y Mukai[59], Stålhammar y Philipsson[76], y Deese y Koger[77].

of the maternal permanent environmental variance as a proportion of the phenotypic variance for average daily gain was not as large as the corresponding range for birth and weaning weight. Both, the minimum (0.03) and the maximum estimate (0.33), for Limousin and Hereford cattle raised in Sweden, were obtained by Stålhammar and Philipsson[76]. Other estimates within this range were obtained by Gunski *et al*[83], Shi *et al*[81], Corbet *et al*[31] and Prayaga and Henshall[84], who reported estimates of 0.06, 0.09, 0.17 and 0.22, respectively.

Estimates of total heritability. The mean of the estimates of total heritability for average daily gain (0.24) was extremely similar to the mean of the estimates of total heritability for weaning weight (0.25), but somewhat smaller than the mean of the estimates of total heritability for birth weight (0.36). Fifty estimates of total heritability were found for average daily gain. Such estimates ranged from 0.00 for Canadian crossbred cattle[60] to 0.74 for American Hereford[38,85]. Estimates of total heritability reported in previos studies [72,86,87,88] were variable (0.08, 0.19, 0.36, 0.41).

CONCLUSIONS AND IMPLICATIONS

The analysis of estimates of genetic parameters, published in the scientific literature from 1946 through 2006, showed that the genotype of the calf was more important than the genotype of the dam to determine preweaning growth traits, as indicated by the moderate means of estimates of direct heritability and the low means of estimates of maternal heritability. Maternal permanent environmental effects had a larger influence on weaning weight and average daily gain than on birth weight. However, the means of the estimates of total heritability suggest that total genetic progress to single-trait selection would be possible for birth weight, weaning weight and average daily gain. Estimates within each of the five genetic parameters varied greatly for each of the three preweaning growth traits. Such variation may reflect differences in breed groups, data source (field or experimental), methods of estimation, effects included in the model, number of records, measurement errors, sex, *Estimadores de efectos del ambiente materno permanente*. Los estimadores de la varianza del ambiente materno permanente como proporción de la varianza fenotípica para ganancia diaria de peso tuvieron una media de 0.15 (n=23). El rango de los estimadores de la varianza del ambiente materno permanente como proporción de la varianza fenotípica para ganancia diaria de peso no fue tan grande como el rango correspondiente para peso al nacimiento y peso al destete. Ambos, el estimador mínimo (0.03) y el estimador máximo (0.33), para ganado Limousin y Hereford criado en Suecia, se obtuvieron por Stålhammar y Philipsson(76). Otros estimadores dentro de este rango se obtuvieron por Gunski *et al*(83), Shi *et al*(81), Corbet *et al*(31) y Prayaga y Henshall(84), quienes mencionaron estimadores de 0.06, 0.09, 0.17 y 0.22, respectivamente.

Estimadores de heredabilidad total. La media de los estimadores de heredabilidad total para ganancia diaria de peso (0.24) fue muy similar a la media de los estimadores de heredabilidad total para peso al destete (0.25), pero fue algo menor que la media de los estimadores de heredabilidad total para peso al nacimiento (0.36). Cincuenta estimadores de heredabilidad total se encontraron para ganancia diaria de peso. Tales estimadores fueron de 0.00 para ganado cruzado canadiense(60) a 0.74 para Hereford estadounidense(38,85). Los estimadores de heredabilidad total reportados en estudios previos(72,86,87,88) fueron variables (0.08, 0.19, 0.36, 0.41).

CONCLUSIONES E IMPLICACIONES

Los análisis de los estimadores de parámetros genéticos, publicados en la literatura científica de 1946 a 2006, revelaron que el genotipo del becerro fue más importante que el genotipo de la vaca para determinar características de crecimiento predestete, como lo indican las medias moderadas de los estimadores de heredabilidad directa y las medias bajas de los estimadores de heredabilidad materna. Los efectos del ambiente materno permanente tuvieron mayor influencia sobre peso al destete y ganancia diaria de peso que sobre peso al nacimiento. Sin embargo, las medias de los estimadores de heredabilidad total sugieren que progreso genético, como respuesta a la selección para una sola característica, es posible para peso al nacimiento, peso al destete y ganancia diaria de peso. Los estimadores dentro de cada uno de los cinco parámetros genéticos variaron grandemente para cada una de las tres características de crecimiento predestete. Esta variación puede reflejar diferencias en raza, fuente de la información (experimento o campo), método de estimación, efectos incluidos en el modelo, número de registros, errores de medición, sexo, ambiente y manejo. Estimadores de heredabilidad directa, heredabilidad materna y heredabilidad total mayores que 0.7 fueron poco frecuentes en la literatura. Las medias de los estimadores de heredabilidad directa y heredabilidad materna para peso al destete fueron similares para Angus, Brahman, Charoláis, Hereford, Limousin, Nelore y Simmental, a pesar del hecho de que las razas *B. indicus* (Nelore y Brahman) son generalmente criadas en ambientes hostiles con manejo deficiente. Sin embargo, las medias de los estimadores de la correlación genética entre efectos directos y maternos para peso al destete fueron

environment and management. Estimates of direct heritability, maternal heritability, and total heritability greater than 0.7, were rare. The means of the estimates of direct heritability and of maternal heritability for weaning weight were similar for Angus, Brahman, Charolais, Hereford, Limousin, Nelore and Simmental, despite the fact that *B. indicus* breeds (Nelore and Brahman) are generally raised under harsh environments with poor management. However, the means of the estimates of direct-maternal genetic correlation for weaning weight were different among the most genetically studied breeds mentioned above. For weaning weight, the mean of the estimates of direct heritability obtained with paternal half-sib analyses tended to be larger than the means of corresponding estimates obtained with animal, sire, and sire-maternal grand sire models, suggesting that paternal half-sib analyses may result in biased estimates of heritability.

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diferentes entre las razas genéticamente más estudiadas aquí mencionadas. Para peso al destete, la media de los estimadores de heredabilidad directa obtenidos mediante correlación entre medios hermanos paternos tendió a ser mayor que las medias de los estimadores correspondientes obtenidos con modelos animal, semental y semental-abuelo materno, sugiriendo que el método de la correlación entre medios hermanos paternos puede proporcionar estimadores sesgados de heredabilidad.

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