Variance Component Estimation and Multitrait Genetic Evaluation for Type Traits of Dairy Goats

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ABSTRACT

Covariance components for final score and 13 linear type traits of dairy goats were estimated by multitrait REML using canonical transformation with an animal model. Data were 10,932 type appraisals from 1988 through 1994 from herds with ≥40 appraisals. Heritabilities were estimated as 0.27 for final score, 0.52 for stature, 0.29 for strength, 0.24 for dairyness, 0.38 for teat diameter, 0.21 for rear legs, 0.32 for rump angle, 0.27 for rump width, 0.25 for fore udder attachment, 0.25 for rear udder height, 0.19 for rear udder arch, 0.25 for udder depth, 0.33 for suspensory ligament, and 0.36 for teat placement. Genetic correlations of linear type traits and final score were positive except for dairyness (–0.15) and teat diameter (–0.10); the largest correlations with final score were 0.66 for fore udder attachment, 0.44 for rear udder arch, 0.36 for rump width, and 0.30 for strength. The largest positive correlation among linear traits was 0.63 for stature and rump width; the largest negative correlation was –0.51 for strength and dairyness. Multitrait evaluations were calculated with data from all herds. Correlations between PTA calculated with animal and sire models ranged from 0.44 to 0.70 for bucks that had a PTA with a reliability of ≥30%.
(**Key words**: animal model, variance component estimation, dairy goat, type traits)

Abbreviation key: **ADGA** = American Dairy Goat Association.

INTRODUCTION

Variance and covariance components of final score and linear type traits have been reported for dairy cattle (5, 8, 11, 13, 14). With a sire model, heritability estimates for final score ranged from 0.14 to 0.30 for Holsteins (6, 12, 13) and from 0.11 to 0.44 for Ayrshires, Brown Swiss, Guernseys, Jerseys, and Milking Shorthorns (10, 11). Genetic evaluations from an animal model were implemented for Holsteins during 1991 for final score and during 1992 for 14 linear type traits (7). Using an animal model, Misztal et al. (8, 9) reported generally higher heritabilities for Holsteins than did VanRaden et al. (14) using a sire model; animal model heritability for final score was estimated to be 0.29 (8).

The American Dairy Goat Association (**ADGA**) has collected data for US Alpines, Experimentals, LaManchas, Nubians, Oberhaslis, Saanens, and Toggenburgs since 1977 for final score (2). Since 1988, data have been collected for 13 primary linear type traits (ADGA, 1995, personal communication), which include stature, strength, dairyness, rump angle, rump width, rear legs–side view, fore udder attachment, rear udder height, rear udder arch, medial suspensory ligament, udder depth, teat placement–rear view, and teat diameter (1). Linear traits are scored from 1 to 50; descriptions for scores of 15 and 35 are in Table 1. Most traits are similar to corresponding traits for dairy cattle; however, rear udder arch considers attachment shape as well as rear udder width (1). A numerical score (50 to 99) is assigned for final score by the appraiser based on general appearance (35%), dairy character (20%), body capacity (10%), and mammary system (35%) for does (1). Crossbred goats are identified as Experimentals by ADGA and are treated as a distinct breed.

In 1986, USDA began to compute genetic evaluations for final score of dairy goats with a sire model (16); calculation of evaluations for the linear type traits began in 1989 (USDA, 1989, unpublished research). Because no heritabilities had been estimated from data for dairy goats, heritability for final score was estimated; for linear type traits, heritabilities for dairy cattle from breeds other than Holstein were used (USDA, 1989, unpublished research). The evaluations are calculated annually and provided to ADGA (17).

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TABLE 1. Descriptions of linear type traits scored from 1 to 50 for dairy goats (1).

Trait	Score = 15	Score = 35
Stature	Short	Tall
Strength	Narrow and frail	Wide and strong
Dairyness	Thick and coarse; round bone	Sharp and angular; clean, flat bone
Teat diameter	Narrow	Wide
Rear legs	Nearly straight (posty) in hock	Slightly angled (sickled) in hock
Rump angle	Considerable slope from hips to pins	Nearly level from hips to pins
Rump width	Narrow through pelvic area	Wide through pelvic area
Fore udder attachment	Loose	Strong
Rear udder height	Low	High
Rear udder arch	Narrow and pointed	Wide and curving
Udder depth	Floor below point of hock	Floor well above hock
Suspensory ligament	Flat udder floor; lacks clear halving; little or no cleft	Deep cleft
Teat placement	Outside of udder half	Halfway way out

The ADGA supports genetic improvement of dairy goats by distributing the annual genetic evaluations for both yield and type traits to US breeders of dairy goats. Two economic indexes with weights of 2:1 and 1:2 for yield and type are distributed also (15). A Sire Development Program (15) has been established by ADGA to identify young bucks with parents of high genetic merit based on these indexes and to promote use of those young bucks. Approximately 4.5% of the dairy goats registered by ADGA during 1995 resulted from AI (J. Wilson, 1996, personal communication).

The objectives of this study were 1) to estimate genetic parameters for dairy goats with a multitrait animal model for use in genetic evaluation of dairy goats and 2) to compare genetic evaluations from the multitrait animal model with those from the previous sire model.

MATERIALS AND METHODS

Type information (18,861 records from all breeds except Experimental) for final score and 13 linear traits from 1988 through 1994 were obtained from the ADGA type program and adjusted for the age of the doe at kidding (USDA, 1989, unpublished research). Appraisers make no adjustment for stage of lactation, and stage of lactation was not included in the analysis because kidding date was included in <5% of records received before 1992 and in only 33% of records since then. Because kidding is seasonal for goats, the bias from not accounting for stage of lactation is expected to be less than for dairy cattle. Numbers of does and means and standard deviations for final score and linear type traits are presented by breed in Table 2. Data for Experimentals were excluded so that the data analyzed would be the same as those used for the sire model evaluations of type traits released to the dairy goat industry by ADGA during spring 1995.

For estimation of variance components, data were restricted further to herds with ≥40 type appraisals to reduce computational requirements. Those 154 herds had 10,932 type records for 7752 does (2752 Alpines, 846 LaManchas, 2067 Nubians, 64 Oberhaslis, 758 Saanens, and 1265 Toggenburgs).

Pedigrees were extracted from ADGA pedigree information that had been supplied for yield evaluations and included animals born during 1978 or later. Pedigrees were collected for all does scored for type and for their ancestors by processing the pedigree file in order of descending birth date and using a hash table (18) to indicate which animals had type scores or progeny so that their pedigrees could be selected.

A linear mixed model was used:

$$\mathbf{y} = \mathbf{Hh} + \mathbf{Pp} + \mathbf{Zu} + \mathbf{e}$$

where $\mathbf{y}$ is 10,932 × 14 matrix of type records; $\mathbf{h}$ is 642 × 14 matrix of fixed effects for herd appraisal date; $\mathbf{u}$ is 23,278 × 14 matrix of breeding values that equals $\mathbf{a} + \mathbf{Qg}$ where $\mathbf{a}$ is 23,278 × 14 matrix of random additive genetic effects, $\mathbf{g}$ is 22 × 14 matrix of fixed effects for unknown-parent groups based on breed and four animal birth-year groups for the five breeds with greatest populations (Alpine, LaMancha, Nubian, Saanen, and Toggenburg) and one group each for Experimentals and Oberhaslis, and $\mathbf{Q}$ is incidence matrix relating animals to unknown-parent groups; $\mathbf{p}$ is 7752 × 14 matrix of random permanent environmental effects; $\mathbf{e}$ is 10,932 × 14 matrix of random residual effects; and $\mathbf{H}$, $\mathbf{P}$, and $\mathbf{Z}$ are incidence matrices relating $\mathbf{h}$, $\mathbf{p}$, and $\mathbf{u}$ to $\mathbf{y}$, respectively. Effects of animal, permanent environment, and residual had variances $\mathbf{G} \otimes \mathbf{A}$, $\mathbf{P} \otimes \mathbf{I}$, and $\mathbf{R} \otimes \mathbf{I}$, respectively, where $\mathbf{G}$, $\mathbf{P}$, and $\mathbf{R}$ are covariance matrices among the 14 traits for the effects of animal, permanent environment, and residuals, respectively; $\mathbf{A}$ is the matrix of

TABLE 2. Final score and scores for 13 linear type traits of 18,861 dairy does scored for type from 1988 to 1994.[1]

Trait	Alpine (n = 5570)		LaMancha (n = 2282)		Nubian (n = 5597)		Oberhasli (n = 535)		Saanen (n = 2249)		Toggenburg (n = 2628)	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Final score	82.0	4.4	82.1	3.9	80.9	4.7	79.3	5.0	81.6	4.6	82.5	4.0
Stature	24.0	6.4	20.8	6.4	26.2	6.2	19.2	6.2	29.6	7.0	20.5	6.4
Strength	26.5	3.9	27.2	4.3	26.7	4.2	26.3	4.1	27.7	4.4	26.8	3.8
Dairyness	33.5	4.2	32.2	4.8	31.5	5.1	34.3	4.3	32.9	4.5	33.6	3.9
Teat diameter	24.0	6.6	22.5	6.6	20.8	6.1	24.6	7.3	23.4	6.5	22.1	6.3
Rear legs	26.0	3.8	26.2	3.5	26.9	3.4	27.8	3.4	26.5	3.9	26.9	3.4
Rump angle	29.1	5.3	28.6	5.0	27.2	4.9	27.4	5.1	28.9	5.5	28.6	4.9
Rump width	26.5	4.1	24.9	4.0	26.9	4.5	25.0	4.1	29.2	4.8	26.6	4.0
Fore udder attachment	29.0	5.2	30.0	4.7	29.3	5.3	25.1	6.1	29.4	5.1	30.0	5.0
Rear udder height	36.8	5.4	35.4	5.6	32.3	6.4	34.3	6.6	33.4	6.2	35.9	5.4
Rear udder arch	22.7	6.4	21.5	6.2	18.8	6.1	16.9	5.4	21.4	6.2	24.3	6.2
Udder depth	29.7	5.9	29.7	5.4	31.5	6.5	29.1	6.0	29.3	6.1	29.8	5.3
Suspensory ligament	26.1	5.0	25.8	5.1	24.3	5.2	28.7	5.0	27.3	5.7	26.2	4.9
Teat placement	16.8	7.4	17.7	7.3	12.7	6.4	17.1	7.3	17.3	7.7	15.0	7.4

[1]Scores adjusted for age of doe at kidding.

additive genetic relationships among animals; **I** is an identity matrix; and ⊗ denotes Kronecker product.

Because many dairy goat herds had more than one breed, all breeds were analyzed together, and breed differences were accounted for through unknown-parent groups as is done for evaluation of yield traits (19). This approach assumed that the variance components were appropriate for all breeds included and that there was no heterosis. The proportion of crossbred data was <2%; therefore, not accounting for heterosis should not have had a large effect on solutions.

Estimates of **G**, **P**, and **R** were obtained by multitrait REML using canonical transformation and approximate diagonalization (4, 9). The approximation was required because the model contained two random effects in addition to the residual effect. The convergence criterion was the sum of squared differences of solutions from previous and current rounds divided by the sum of squared solutions.

Using the estimated (co)variance matrices, the multitrait animal model reported by Misztal et al. (7) was used to calculate evaluations and their reliabilities using data from all herds. This analysis included 24,474 appraisals from 1988 or later for 18,750 does, 35,469 parents without records, and 22 unknown-parent groups; appraisals for 111 does were excluded because those does had no contemporaries. A base was imposed by setting the mean evaluations of does born during 1990 to 0 for each trait. Correlations of animal and sire model evaluations were calculated for the 2573 bucks with reliability ≥30% from the animal model for all breeds, except Experimentals, for which no sire model evaluations had been calculated. Sire model evaluations for final score included data from before 1988. These correlations provided an indication of the effect of changing from the sire to animal model system and reflected changes in data included for final score as well as in evaluation methodology.

Genetic trends were estimated from mean EBV of does by birth year. For does born from 1978 to 1993, a quadratic function of birth year was fit to those means. When the quadratic term was not significant ($P < 0.05$), a linear equation was fit. Trend was defined as the difference in EBV for 1992 and 1993. For traits fit with a quadratic function, the trend changed every year.

RESULTS AND DISCUSSION

The REML procedure required 80 rounds to reach the convergence criteria of 1.4×10^{-6} for residual, 2.1×10^{-5} for permanent environmental, and 6.0×10^{-6} for animal effects. The success of the simultaneous diagonalization of **G** and **P**, as measured by the relative off-diagonals, was 4.3×10^{-2} and 7.8×10^{-2}, respectively.

Estimates of heritabilities, repeatabilities, and variances of effects of genetics, permanent environment, and residuals are presented in Table 3. Heritabilities ranged from 0.19 for rear udder arch to 0.52 for stature. The major differences from heritabilities for dairy cattle that were assumed for the sire model were for teat diameter, teat placement, and suspensory ligament. In general, the heritability estimates for dairy goats were higher than those for dairy cattle estimated with a sire model (3, 5, 6, 10, 11, 12, 13, 14) and similar or lower than those for dairy cattle estimated with an animal model (8, 9). For both dairy cattle and dairy goats, stature was the trait that had the highest heritability (3, 5, 6, 8, 9, 10, 11, 12, 13, 14).

TABLE 3. Estimates of heritability, repeatability, and variance of genetic, permanent environmental, and residual effects for final score and 13 linear type traits of dairy goats.

Trait	Heritability: Previous model[1]	Heritability: New model	Repeatability	Variance: Genetic	Variance: Permanent environmental	Variance: Residual
Final score	0.20	0.27	0.51	3.52	3.14	6.37
Stature	0.40	0.52	0.73	17.56	7.14	9.34
Strength	0.24	0.29	0.41	3.25	1.40	6.71
Dairyness	0.16	0.24	0.34	2.64	1.10	7.42
Teat diameter	0.12	0.38	0.68	11.81	9.39	9.81
Rear legs	0.12	0.21	0.30	2.22	0.89	7.39
Rump angle	0.27	0.32	0.47	6.71	3.14	11.10
Rump width	0.24	0.27	0.38	3.95	1.68	9.01
Fore udder attachment	0.18	0.25	0.41	5.07	3.38	11.95
Rear udder height	0.17	0.25	0.38	6.28	3.21	15.57
Rear udder arch	0.17	0.19	0.29	5.16	2.62	18.82
Udder depth	0.27	0.25	0.40	6.92	4.26	16.55
Suspensory ligament	0.16	0.33	0.57	6.75	5.08	8.79
Teat placement	0.18	0.36	0.60	15.57	10.44	17.17

[1]Used for genetic evaluations calculated with a sire model.

Genetic and phenotypic correlations among type traits are shown in Table 4. Because linear type traits are scored between biological extremes, optimal scores can range from the lowest to the highest score observed. Genetic correlations with final score were positive, except for dairyness (–0.15) and teat diameter (–0.10). Positive correlations with final score were highest for fore udder attachment (0.66), rear udder arch (0.44), rump width (0.36), and strength (0.30) and lowest for rear legs (0.01), suspensory ligament (0.04), stature (0.07), and udder depth (0.08). In contrast to higher positive correlations (0.28 to 0.75) of final score and dairyness for dairy cattle (6, 8, 10, 11, 12), the low negative correlation for dairy goats may have resulted from differences between appraisers of dairy cattle and goats in the emphasis placed on general appearance, dairy character, body capacity, and mammary structure when assigning final score. However, high positive correlations (>0.50) with final score of dairy cattle have been reported for all linear type traits except rump angle and rear legs (6, 8, 10, 11, 12), for which intermediate scores are considered to be optimal.

For form traits (stature, strength, and dairyness) of dairy goats, genetic correlations with other linear traits generally were moderate to small (<0.40), except for stature with rump width (0.63) and rear udder arch (0.44) and strength with dairyness (–0.51). Corresponding correlations for dairy cattle (3, 6, 8, 10, 11, 12, 14) generally were larger; the largest correlations were for stature with strength (0.58 to 0.89) and rump width (0.37 to 0.73) and strength with rump width (0.35 to 0.79).

For structure traits (rump angle, rump width, and rear legs) of dairy goats, genetic correlations with other structure traits or mammary traits were small (–0.27 to 0.09); largest correlations were with rear udder height (–0.27 for rump width and –0.26 for rump angle). Corresponding traits for dairy cattle generally were more highly correlated (3, 6, 8, 10, 11, 12, 14).

Among mammary traits of dairy goats, genetic correlations were largest for suspensory ligament with teat placement (0.46), teat diameter (0.40), and udder depth (–0.34); rear udder height with rear udder arch (0.38); and teat diameter with teat placement (0.34). Again, corresponding mammary traits for dairy cattle generally were more highly correlated (3, 6, 8, 10, 11, 12, 14).

Means, standard deviations, minimums, and maximums for animal models across breeds are presented in Table 5 for PTA and in Table 6 for reliability for 6769 bucks with daughters that had type scores. Mean PTA (Table 5) were essentially 0. Stature, teat diameter, and teat placement–the three traits with highest heritabilities–had the widest ranges for PTA. Mean and maximum reliabilities (Table 6) generally increased as heritability increased. A reliability of 0 could occur when daughters of a buck had no herdmates; therefore, no information was contributed to genetic estimates.

Correlations of PTA calculated with animal and sire models are shown in Table 7 for the 2573 bucks that had animal model reliabilities of ≥30% and a PTA from the sire model. The correlations were considerably lower than the corresponding correlations of >0.9 that have been reported by Misztal et al. (7) for Holstein dairy cattle, probably because of the use of different heritabilities for the two models, the separate evaluation by breed with the sire model, the

TABLE 4. Genetic (above diagonal) and phenotypic (below diagonal) correlations for final score and 13 linear type traits of dairy goats.

	Final score	Stature	Strength	Dairyness	Teat diameter	Rear legs	Rump angle	Rump width	Fore udder attachment	Rear udder height	Rear udder arch	Udder depth	Suspensory ligament	Teat placement
Final score		0.07	0.30	–0.15	–0.10	0.01	0.17	0.36	0.66	0.20	0.44	0.08	0.04	0.15
Stature	0.05		0.14	0.22	0.07	–0.05	0.03	0.63	–0.06	–0.23	–0.01	0.11	0.05	0.06
Strength	0.24	0.11		–0.51	–0.02	–0.20	0.25	0.35	0.15	–0.27	0.07	–0.17	0.02	0.04
Dairyness	–0.10	0.10	–0.41		0.10	0.09	–0.02	–0.10	–0.16	0.04	–0.06	–0.05	0.09	0.02
Teat diameter	–0.06	0.06	–0.02	0.07		–0.04	0.00	0.03	–0.20	–0.01	–0.03	–0.23	0.40	0.34
Rear legs	–0.01	–0.04	–0.14	0.06	–0.02		–0.10	0.00	–0.11	0.03	0.01	0.09	–0.02	–0.06
Rump angle	0.16	0.05	0.21	–0.05	0.01	–0.04		0.11	–0.02	–0.26	–0.07	0.06	0.01	0.04
Rump width	0.24	0.34	0.23	–0.15	0.01	0.01	0.01		0.09	–0.27	0.09	–0.03	0.09	0.05
Fore udder attachment	0.55	–0.04	0.14	–0.10	–0.13	–0.02	0.08	0.07		0.24	0.31	0.16	–0.05	0.04
Rear udder height	0.20	–0.13	–0.14	0.07	0.01	–0.01	–0.14	–0.12	0.22		0.38	0.26	0.05	0.07
Rear udder arch	0.33	–0.01	0.05	0.03	0.00	–0.05	–0.04	0.03	0.26	0.30		0.02	0.05	0.14
Udder depth	0.08	0.04	–0.02	–0.14	–0.23	0.06	0.06	–0.01	0.15	0.10	–0.01		–0.34	–0.08
Suspensory ligament	–0.04	0.05	–0.01	0.06	0.34	–0.02	0.00	0.03	–0.11	–0.03	–0.02	–0.26		0.46
Teat placement	0.10	0.04	0.05	–0.02	0.31	–0.03	0.04	0.03	0.03	0.03	0.05	–0.03	0.36	

TABLE 5. Means, standard deviations, minimums, and maximums for animal model PTA for final score and 13 linear type traits of 6769 dairy bucks with scored daughters.

Trait	$\overline{X}$	SD	Minimum	Maximum
Final score	–0.05	0.60	–2.42	1.67
Stature	–0.04	1.82	–5.69	8.84
Strength	–0.03	0.54	–2.07	3.12
Dairyness	–0.08	0.63	–2.86	2.04
Teat diameter	–0.06	1.19	–4.53	4.58
Rear legs	0.06	0.50	–2.83	1.98
Rump angle	–0.20	0.88	–3.80	4.93
Rump width	0.05	0.78	–2.87	3.56
Fore udder attachment	–0.03	0.74	–3.98	2.37
Rear udder height	–0.07	1.04	–4.09	3.36
Rear udder arch	–0.11	1.23	–3.50	3.03
Udder depth	0.02	0.87	–3.24	3.58
Suspensory ligament	–0.02	0.93	–3.90	3.35
Teat placement	–0.10	1.49	–4.63	5.42

small numbers of bucks that had repeatability of ≥30% for each breed, and the influence of correlated traits on the evaluations with the animal model. Because correlations were calculated within breed, different bases by breed for the sire model did not affect correlations. For all breeds, correlation for final score was among the lowest correlations (0.46 to 0.56) of animal and sire model PTA, perhaps because genetic evaluation of final score using a sire model included scores prior to 1988. The highest correlation of animal and sire model PTA was 0.70 for Saanen stature; lowest correlation was 0.44 for Oberhasli rump width. Traits with higher heritabilities generally had a higher correlation of animal and sire model PTA. The analysis across breeds used for animal model evaluations enabled better estimation of the

TABLE 6. Means, standard deviations, minimums, and maximums for animal model reliability for final score and 13 linear type traits of 6769 dairy bucks with scored daughters.

Trait	$\overline{X}$	SD	Minimum	Maximum
	(%)			
Final score	27.5	14.0	0	92
Stature	39.1	15.5	0	95
Strength	29.4	14.1	0	93
Dairyness	27.1	13.6	0	92
Teat diameter	33.2	14.7	0	94
Rear legs	25.4	13.1	0	91
Rump angle	31.3	14.3	1	93
Rump width	31.2	14.2	0	93
Fore udder attachment	26.7	13.9	0	92
Rear udder height	28.3	13.8	0	92
Rear udder arch	24.2	13.0	0	90
Udder depth	28.7	13.4	1	92
Suspensory ligament	31.4	14.3	0	93
Teat placement	32.7	14.5	1	94

TABLE 7. Correlations of PTA calculated with animal and sire models by breed for 2573 dairy bucks with an animal model reliability of ≥30% and a sire model PTA.

Trait	Alpine (n = 852)	LaMancha (n = 297)	Nubian (n = 715)	Oberhasli (n = 67)	Saanen (n = 280)	Toggenburg (n = 362)
Final score	0.56	0.46	0.50	0.54	0.56	0.48
Stature	0.68	0.67	0.63	0.59	0.70	0.68
Strength	0.62	0.62	0.64	0.63	0.67	0.65
Dairyness	0.54	0.56	0.59	0.57	0.53	0.56
Teat diameter	0.64	0.62	0.66	0.64	0.59	0.62
Rear legs	0.53	0.53	0.62	0.57	0.61	0.58
Rump angle	0.60	0.67	0.65	0.50	0.69	0.65
Rump width	0.58	0.56	0.50	0.44	0.53	0.54
Fore udder attachment	0.57	0.47	0.58	0.46	0.62	0.58
Rear udder height	0.56	0.59	0.65	0.59	0.60	0.60
Rear udder arch	0.55	0.48	0.55	0.55	0.59	0.62
Udder depth	0.57	0.60	0.64	0.62	0.58	0.64
Suspensory ligament	0.64	0.60	0.60	0.70	0.62	0.57
Teat placement	0.62	0.68	0.67	0.68	0.68	0.60

effects of herd appraisal date because does of all breeds contributed to estimation of the same effect for herds that had mixed breeds.

Table 8 contains genetic trends and root mean squared errors for the equation fit to the birth year means of evaluations. The trends are the superiority for EBV of does born during 1993 over those born during 1992. For the seven traits that were best fitted by a quadratic equation, the trend would be different for other years. The largest trend was for rump angle (0.336). The largest negative trend was for rump width (–0.128). Almost no trend was detected for final score (0.009). For some traits, the birth year means were quite variable. The worst equation fit was for stature. Although stature had the highest heritability, little emphasis was likely placed on selection of stature; therefore, individual parents could have had a noticeable effect on the population. The quadratic term improved the fit, particularly for traits that changed little during early years and had a steeper slope during recent years.

CONCLUSIONS

The (co)variances that were estimated for final score and linear type traits of dairy goats were implemented for multitrait animal model evaluations calculated during fall 1995. For some traits, heritabilities were quite different from those that had been used with the sire model (Table 3). Differences between dairy goats and cattle for heritabilities and genetic correlations probably reflect genetic differ-

TABLE 8. Genetic trend in 1993 for final score and 13 linear type traits from a linear (L) or quadratic (Q) fit of average EBV by birth year for 38,205 does born from 1978 to 1993.

Trait	Trend	Equation	Root MS error from fitting equation
Final score	0.009	L	1.4
Stature	–0.018	L	6.4
Strength	0.096	Q	3.0
Dairyness	0.063	Q	2.8
Teat diameter	0.012	L	3.9
Rear legs	–0.099	Q	1.5
Rump angle	0.336	Q	3.1
Rump width	–0.128	Q	3.1
Fore udder attachment	0.029	L	3.2
Rear udder height	0.025	L	3.6
Rear udder arch	0.040	L	4.0
Udder depth	0.031	Q	2.3
Suspensory ligament	0.024	L	2.3
Teat placement	0.092	Q	3.1

ences between species and differences in type appraisal programs. Adoption of the new heritabilities for dairy goats should allow more accurate ranking of animals with different amounts of information.

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