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Genetic Characterization of Criollo Cattle in Bolivia: II. Sire Usage and Genetic Trends for Pre and Postweaning Growth Traits

R.E. Peña*, M.A. Elzo†, and F. Rojas*

*Centro de Investigación Agrícola Tropical, Santa Cruz de la Sierra, Bolivia, and †Animal Science Department, University of Florida, Gainesville, FL 32611.

Introduction

Criollo cattle breeds are regarded as a unique genetic resource because they are the only Bos taurus breeds adapted to the tropical and subtropical conditions of America. Several studies also indicated the relative advantage of Criollo × Zebu crossbreds over the average of both parents and over the Zebu for reproductive traits and growth performance (Bauer, 1968, 1986; Plasse, 1983). From the United States (Hammond et al, 1996) to Argentina (Corva, 1995), several research institutions in America have demonstrated an increased interest on Criollo breeds for crossbreeding programs. Bolivia has been one of these countries.

The Criollo Saavedreño cattle, maintained at the Saavedra Experiment Station in the subtropical lowlands of Bolivia, are a dual-purpose (milk-beef) Criollo breed considered tick resistant and heat tolerant (Wilkins et al., 1983). This Criollo herd has received a favorable reception by livestock producers of the Santa Cruz State, which has the most dynamic livestock industry in Bolivia. For the past few years, demand for Saavedreño bulls has been greater than the availability, and the number of commercial producers working with Criollo Saavedreño cattle has increased.

Because of the potential economic impact of the Criollo Saavedreño on the livestock industry in the Santa Cruz region, it was important to assess the effectiveness of the breeding program used in this herd since its establishment in 1978. Thus, the objectives were to appraise genetic trends for growth traits and usage of sires and dams between 1978 and 1997 in the Criollo Saavedreño population.

Materials and Methods

Herd Management

The Criollo Saavedreño herd was kept in the Saavedra Experiment Station, Santa Cruz State, Bolivia, located at 17º14' S and 63º10' W, at 320 m above sea level. The Station has a mean annual temperature of 23.4 ºC, a mean annual relative humidity of 67.9 %, and a mean annual precipitation of 1347 mm. About two thirds of the annual rainfall was concentrated in the spring and summer months (October to March). This period of the year was defined as the rainy season. The autumn and winter months (April to September) were defined as the dry season and usually limited the quantity and quality of pastures for cattle.

The Criollo Saavedreño herd was kept under an all-grazing regime with free access to mineralized salts. The Gramineae species more commonly used were that of the Brachiaria Genus (e.g., Brachiaria humidicola, Brachiaria decumbens, Brachiaria mutica), and Jaragua (Hyparrhenia rufa), Panico (Panicum maximum var. Dwarf), and Stargrass (Cynodon plectostachyus). About 20 % to 30 % of the pastures were formed by one Gramineae associated with one legume. Legume species more commonly used were Chamba (Leucaena leucocephala), Glicina (Glycine wightii), Desmodio (Desmodium intortum), and Grazing Peanut (Arachis pintoi). Pastures were not fertilized.

Dams in the Criollo Saavedreño herd calved year around, and were milked twice each day. Calvings were evenly distributed between the rainy and dry seasons. Calves were kept separated from their dams from 3 d postpartum, and maintained on immature pastures of Panico and Stargrass. Calves were allowed to suckle for 30 to 60 min twice each day after incomplete hand-milking. An average consumption of 700 kg of milk per calf to weaning was estimated (Wilkins et al., 1983). Calves were weaned, on the average, at 250 d of age. At weaning, bulls were screened for defects such as skin depigmentation, and testicular abnormalities. No culling was practiced on heifers. Bulls and heifers were kept together (on rotational grazing of Brachiaria grasses without supplementation) until they were 15 months old, or their weight was between 230 and 240 kg. Subsequently, male and female calves were grouped by sex to avoid uncontrolled matings. Bulls not selected as sires were castrated at 18 months of age. Bulls used as sires were selected based on their gain from weaning to 550 d, and the milk yield of their dams. Heifers were culled if they failed to get pregnant at 3 years of age.

The base population of the Criollo Saavedreño herd was formed by 85 Bolivian Criollo cows, purchased from producers of eastern Bolivia, and 35 Latin-American Criollo sires (9 Bolivian, 7 Brazilian, 12 Costa Rican, 4 Cuban, and 3 Nicaraguan).

Artificial insemination was practiced. Cows were visually checked for heat twice each day. The average number of AI services per pregnant cow was 1.8. In addition to semen of the thirty five Latin-American Criollo sires, semen of 24 sires born in the herd (Pedigree sires) was also used, starting in 1986. To create connectedness across years, sires were used for 2.5 years on the average. A minimum of 3 sires, and a maximum of 11 sires (8 sires per year on the average) were used each year. Eighty five base dams and 451 dams born in the herd had, on the average, three calvings each. The number of calves considered in this study was 1649, born in the herd between 1979 and 1997.

Traits, Model and Computing Strategy

Traits. Traits considered for analysis were birth weight (BWT), gain from birth to weaning (GBW), and gain from weaning to 550 d (GWH). Weaning weights were adjusted to 250 d, because calves had been weaned at an average age of 250 d. Weights of calves at 1.5 yr of age were adjusted to 550 d. All weight adjustments were calculated using Beef Improvement

Federation formulas (BIF, 1996). Gains were calculated as differences between adjusted weights.

Model. The model used to analyze direct and maternal effects for BWT, GBW and GWH was a Multiple Trait Animal Model. Fixed effects for each trait were contemporary group, and age of dam at calving × sex of calf subclass. Random effects were direct additive genetic, maternal additive genetic, and residual. The model accounted for additive relationships among all animals in the population. The covariance matrix among random genetic effects was A*Vg where A = additive relationship matrix, * = direct product, and Vg is a multiple-trait additive genetic covariance matrix among direct and maternal genetic effects. Residual effects among animals were assumed to be uncorrelated. Thus, the residual covariance matrix was equal to I*Ve, where I = identity matrix, and Ve = multiple trait residual covariance matrix (Henderson and Quaas, 1976; Quaas and Pollak, 1980).

Expected breeding values (BV) for direct (D) and maternal (M) effects of BWT, GBW, and GWH were computed for all animals in the relationship matrix with the Multiple Trait Derivative-Free Restricted Maximum Likelihood package (MTDFREML; Boldman et al., 1995). Restricted Maximum Likelihood Estimates of direct and maternal (co)variance components used in MTDFREML for all traits GWH were computed (see Chapter 2) using the Derivative Free Restricted Maximum Likelihood (DFREML) package of K. Meyer (Meyer, 1997).

Genetic trends by origin of sires. From the total of 59 sires used in the Saavedreño herd from 1979 to 1997, 35 were defined as base sires, and 24 sires born in the herd as pedigree sires. Semen from the 35 base sires came from Criollo populations in Bolivia (9 sires), Brazil (7), Costa Rica (12), Cuba (4), and Nicaragua (3). Because of the low number of Cuban and Nicaraguan sires, and their small number of progeny and years used, they were not considered for this analysis. Thus, only pedigree sires and base sires from Bolivia, Brazil, and Costa Rica were considered. For each group of sires, yearly weighted means were computed, where the weights were the number of progeny per bull each year. The maternal effects of GWH computed for the Criollo Saavedreño showed a small heritability estimate and large standard error (.05 ± .05, Chapter 2) and was not considered for the analyses of genetic trends.

Genetic trends by age of parents. For this analysis, sires were divided into young bulls and older bulls, and dams were separated into heifers and older dams. Mean BV of young bulls in a given year was the average BV of all bulls born in the herd that entered the stud that year. Older bulls were the remaining sires. Likewise, mean BV of heifers in a given year was the average BV of all heifers calving that year. Older dams were dams with two or more calvings. Trends in the yearly means of young bulls and heifers will help understand changes in the replacement strategies used between 1979 and 1997 in the Saavedreño herd.

Total genetic trends. For the analysis of total genetic trends for growth traits, animals were grouped into 1) sires used between 1979 and 1997, 2) dams that calved between 1979 and 1997, and 3) calves born in the herd from 1979 to 1997. For each group, unweighted yearly means of BV were calculated for all traits (BWTD, GBWD, GWHD, BWTM, and GBWM). In addition, yearly weighted means were computed for sires. Weights were the number of progeny per bull each year. Because the number of calves born in 1979, 1980, and 1981 was small, these years were pooled together, and one mean for each trait was calculated for these three years; and was referred to as year 1981.

Results and Discussion

Genetic Trends by Origin of Sires

Pedigree sires and base sires from Bolivia, Brazil and Costa Rica were compared on the basis of their weighted yearly means of BV for BWTD, GBWD, GWHD, BWTM, and GBWM (Tables 3.1 and 3.2). Bulls from Costa Rica sired 179 calves and were used for nine years (1979 to 1987). Bolivian and Brazilian base sires were used for fourteen years. Nine Bolivian bulls sired 236 calves and seven Brazilian bulls sired 358 calves until 1997. Twenty four pedigree sires produced 660 progeny from 1986 to 1997.

Birth weight direct. Weighted means of BV for BWTD (Figure 1) of Costa Rican sires had a negative trend between 1981 (.38 kg) and 1985 (-2.18 kg), and positive increases in 1986 (1.01 kg) and 1987 (1.30 kg). The higher values obtained in 1986 and 1987 were due to the use

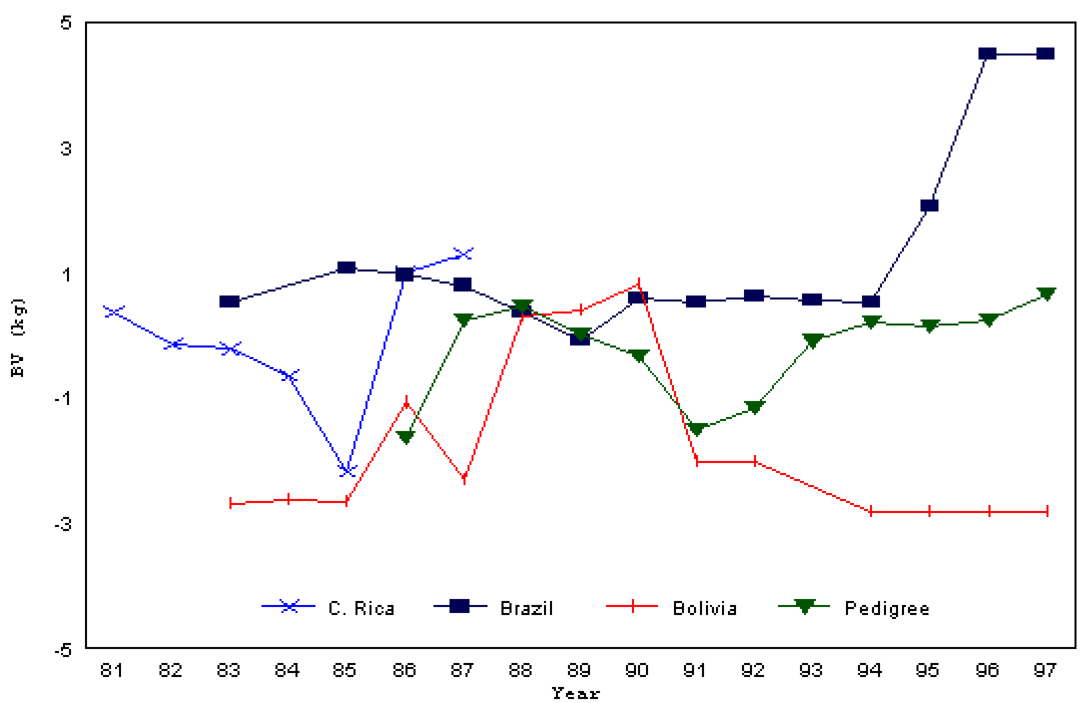

Figure 1. Weighted yearly means of BV for BWTD of sires by origin.

of three sires not used before, all of which had positive BV for BWTD. In general, however, Costa Rican sires were responsible for maintaining small means of BV for BWTD of calves during the initial years of the Criollo Saavedreño herd. Brazilian bulls, on the other hand, presented the highest weighted means of BV for BWTD for 11 of the 14 years they were used. Their weighted means of BV showed a positive trend from 1990 to 1997. Bolivian sires presented negative (and smaller than -1.00 kg) weighted means of BV for BWTD for 11 of the 14 years they were used in the herd. Their largest weighted mean of BV was .83 kg (1990), and was due to the use of the only two Bolivian sires with positive BV for BWTD. Between 1991 and 1997, weighted means of BV of Bolivian sires showed a negative trend for BWTD. Bolivian sires can be credited with the maintenance of small BV for BWTD in the Criollo Saavedreño herd during the last 14 years by counterbalancing the larger mean BV of Brazilian and pedigree sires.

Pedigree sires had positive weighted means of BV for BWTD for seven of the 12 years they were used, ranging from .02 kg to .66 kg. Their negative weighted means of BV ranged from -1.63 kg to -.09 kg. Although no definite trend was observed for the weighted means of BV of pedigree sires between 1986 and 1991, a positive trend was clear from 1992 to 1997. During this period, the weighted means of BV of the pedigree sires were intermediate between those of the Brazilian and the Bolivian sires. Brazilian sires had a positive trend of BV for BWTD between 1990 and 1997. On the other hand, Bolivian sires showed a negative trend for this trait between 1991 and 1997. The fact that most pedigree sires in the stud from 1992 to 1997 descended from Brazilian and Bolivian sires may explain the intermediate values for BWTD of pedigree sires.

Gain from birth to weaning direct. Costa Rican sires (Table 1, Figure 2) showed small changes in their weighted means of BV for GBWD from 1981 (1.27 kg) to 1984 (-1.11 kg).

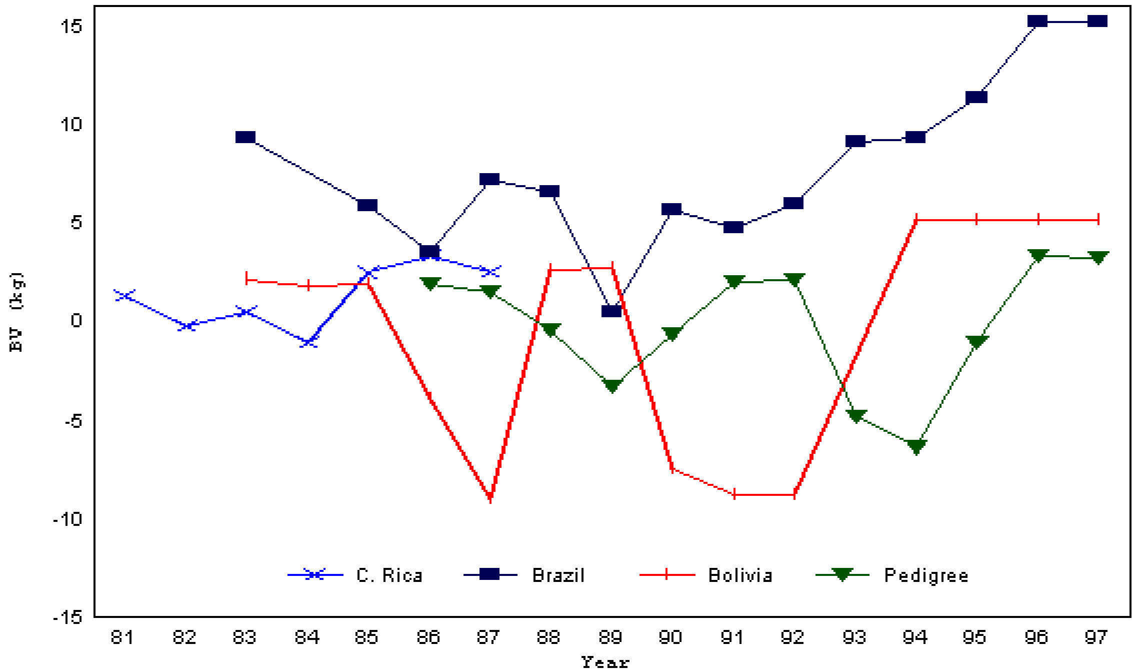

Figure 2. Weighted yearly means of BV for GBWD of sires by origin.

Values increased, though, to stabilize between 1985 (2.44 kg) and 1987 (2.51 kg). Of all sire groups, the Costa Rican was the one with the smallest fluctuations in weighted means of BV for GBWD. The group of Brazilian sires showed a negative trend for GBWD between 1983 (9.34 kg) and 1989 (.40 kg), and a positive trend for this trait from 1990 (5.68 kg) to 1997 (15.23 kg). However, this sire group had the largest weighted means of BV for GBWD for 13 of the 14 years they were used. Although Brazilian sires showed a wider range of weighted means of BV (.40 to 15.23) than Bolivian sires (-9.02 to 5.09), the weighted means of BV of the later group showed more variation from year to year. The reason may be that while one to four (2.5, on the average) Brazilian sires were used each year, only one or two (1.5, on the average) Bolivian sires were used. Thus, individual differences among Bolivian sires greatly affected their weighted means of

BV causing large fluctuations from year to year.

The group of pedigree sires, as the group of Bolivian sires, did not show definite trends for GBWD. Weighted means of BV fluctuated between positive and negative values without a clear trend, although the means of the last two years (1996 and 1997) were the largest ever for this group. The reason for this apparent lack of direction of pedigree sires may be that they descend from sire groups with differing trends for the same trait, e.g., from Brazilian sires with predominantly large (.40 kg to 15.23 kg) weighted means of BV for GBWD and from Costa Rican (-1.11 kg to 3.32 kg) and Bolivian (-9.02 kg to 5.09) sires with small or negative weighted values for the same trait.

Gain from weaning to 550 d direct. The sire group from Costa Rica (Table 1, Figure 3) was the group with the narrowest range of weighted means of BV for GWHD (-3.10 kg to 6.12 kg). Their weighted means of BV showed a positive trend from 1981 to 1983, dropped to -3.10 kg in 1984, and stayed stable from 1985 to 1987. The drop of weighted means of BV observed for this group in 1984 was due to the use of the one sire with the lowest negative (-4.69 kg) BV for GWHD.

Table 1. Weighted yearly means of BV (kg) for GBWD and GWHD by origin of sires and by years they were used

Year	Origin of Sire							
	Costa Rica		Brazil		Bolivia		Pedigree sires	
	GBWD[a]	GWHD	GBWD	GWHD	GBWD	GWHD	GBWD	GWHD
81	1.27	2.91	-	-	-	-	-	-
82	-.31	4.49	-	-	-	-	-	-
83	.49	6.12	9.34	1.39	2.13	-6.72	-	-
84	-1.11	-3.10	-	-	1.76	-6.61	-	-
85	2.44	4.02	5.81	4.15	1.91	-6.65	-	-

86	3.32	3.92	3.50	1.88	-3.90	-7.85	1.85	7.32
87	2.51	3.89	7.18	2.50	-9.02	-5.95	1.46	3.30
88	-	-	6.60	2.32	2.57	-1.03	-.43	-2.28
89	-	-	.40	5.09	2.68	-.71	-3.31	-1.61
90	-	-	5.68	2.69	-7.53	2.31	-.64	1.23
91	-	-	4.76	3.39	-8.79	-1.31	2.00	1.53
92	-	-	5.93	2.32	-8.79	-1.31	2.07	4.21
93	-	-	9.15	1.21	-	-	-4.85	.266
94	-	-	9.34	1.39	5.09	8.20	-6.44	-.43
95	-	-	11.31	4.71	5.09	8.92	-1.12	7.84
96	-	-	15.23	10.83	5.09	8.92	3.29	10.93
97	-	-	15.23	10.83	5.09	8.92	3.20	8.02

[a]GBWD = gain from birth to weaning direct; GWHD = gain from weaning to 550 d.

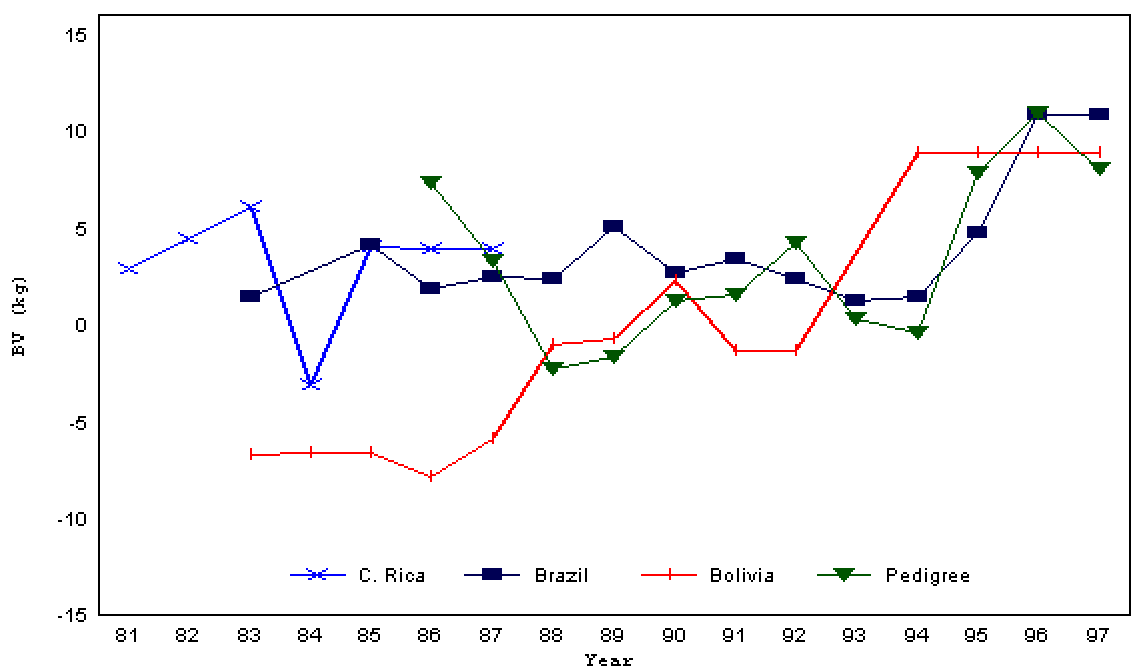

Figure 3. Weighted yearly means of BV (kg) for GWHD of sires by origin.

Weighted means of BV for GWHD of Brazilian sires showed a smaller range of variation (1.21 kg to 10.83 kg) than their weighted means for GBWD. The yearly weighted means of BV for GWHD of the Brazilian sire group had only small changes between 1983 (1.39 kg) and 1995 (4.71 kg); however, it increased in 1996 and 1997 (10.83 kg). This smaller variation of weighted means of BV may be explained by the fact that Brazilian sires tended to have smaller BV for GWHD than for GBWD. For example, the Brazilian sire with the highest BV for growth had a 15.23 kg BV for GBWD and a 10.83 kg BV for GWHD.

The group of Bolivian sires had the widest range of weighted means of BV for GWHD (-7.85 to 8.92), and clear positive trends for this trait. Its weighted mean BV increased from -6.72 kg in 1983 to 8.92 kg in 1997. The high mean BV of this group from 1994 to 1997 was due to the use of one sire only, which had the highest BV of all Bolivian sires for GBWD, GWHD, and GBWM. This sire also had a negative (-2.82 kg) BV for BWTD, and a low (.85 kg) BV for BWTM. This sire alone caused the positive trends observed for the Bolivian sire group for GBWD, GWHD, and GBWM from 1994 to 1997.

The weighted means of BV for GWHD of pedigree sires dropped from 1986 (7.32 kg) to 1988 (-2.28 kg), increased between 1989 (-1.61 kg) and 1992 (4.22 kg), decreased again in 1993 (.26 kg) and 1994 (-.43 kg), only to augment between 1995 (7.84 kg) and 1997 (8.02 kg). The lowest mean BV (-2.28 kg in 1988) was caused by one of the two young bulls that entered the stud that year, which had a negative (-6.30 kg) BV for GWHD. In general, pedigree sires lacked a defined trend for this trait from 1983 to 1994. Two factors may have influenced these results. Firstly, the fact that pedigree sires descended from Brazilian, Bolivian, and Costa Rican sires, which had variable means of BV for this trait. Secondly, the selection of pedigree sires was based not only on phenotypic gains from weaning to 550 d, but also on the milk yield of their dams. It is not clear from the information available about the Criollo Saavedreño (Rojas, 1998, personal communication) if any of both traits was given more weight through time, or if the importance of each trait shifted from time to time.

Birth weight maternal. Weighted means of BV for BWTM showed less variation than weighted means of BV for BWTD for all sire groups (Table 2, Figure 4). Weighted means of BV for BWTM of Costa Rican sires showed a positive trend from 1981 (.32 kg) to 1983 (1.73 kg), dropped in 1984 (-.37 kg), and stabilize between 1985 (1.00 kg) and 1987 (1.00 kg). The low weighted mean observed for this group in 1984 was caused by the bull with the lowest negative

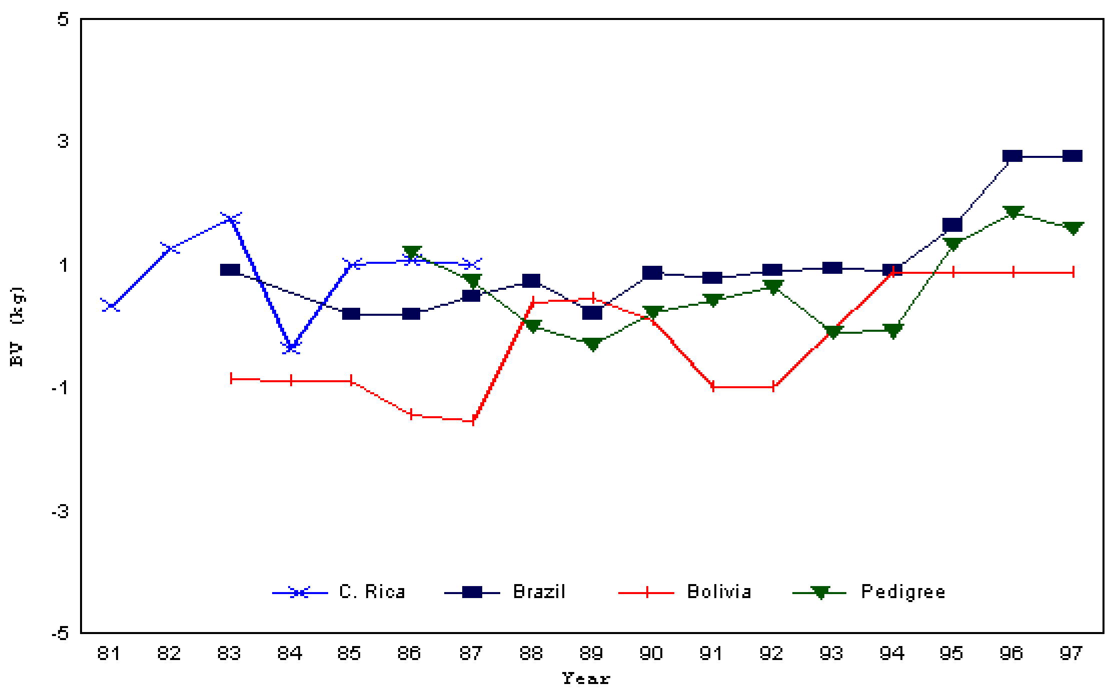

Figure 4. Weighted yearly means of BV (kg) for BWTM of sires by origin.

(-.78 kg) BV for BWTM. This was the same bull which also caused the drop of weighted means of BV for GWHD in 1984. Brazilian sires had the highest weighted means of BV for BWTM across sire groups in nine of the 12 years they were used. Weighted means of BV for this trait of the Brazilian sire group showed small variation between 1983 and 1994 (the range was 1.09 kg), and tended to increase between 1995 (1.62 kg) and 1997 (2.73 kg). The high weighted means of BV in 1996 and 1997 of the Brazilian sire group resulted from the use of one bull, which sired 36 calves from 1996 to 1997. Bolivian sires had the lowest weighted means of BV for BWTM across sire groups in seven of the 14 years they were used. Their weighted means of BV ranged between -1.56 kg (1987) and .85 kg (1994 to 1997). Pedigree sires seemed to have a positive trend for BWTM between 1989 (-.32 kg) and 1997 (1.56 kg). In general, Brazilian, Bolivian and pedigree sires increased their weighted means of BV for this trait between 1994 and 1997.

Gain from birth to weaning maternal. Weighted means of BV for GBWM (Table 2,

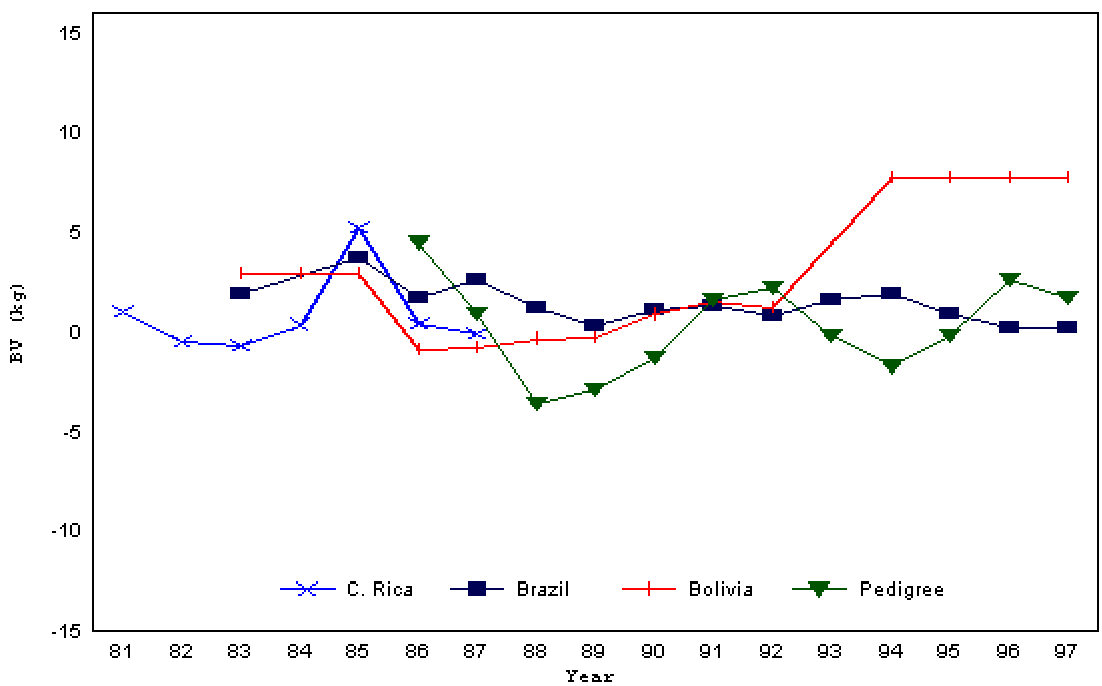

Figure 5. Weighted yearly means of BV for GBWM of sires by origin.

Figure 5) of Costa Rican sires had only small changes between 1981 (.99 kg) and 1987 (-.10 kg), except for the value obtained in 1985 (5.24 kg). This value was caused by one sire with a high BV for GBWM (6.22 kg), which sired most of the calves born in 1985. Brazilian sires appeared

Table 2. Weighted yearly means of BV (kg) for BWTM and GBWM by origin of sires and by years they were used

Year	Origin of Sire							
	Costa Rica		Brazil		Bolivia		Pedigree sires	
	BWTM[a]	GBWM	BWTM	GBWM	BWTM	GBWM	BWTM	GBWM
81	.32	.99	-	-	-	-	-	-
82	1.23	-.49	-	-	-	-	-	-
83	1.73	-.75	.89	1.92	-.87	2.9	-	-
84	-.37	.32	-	-	-.90	2.91	-	-
85	1.00	5.24	.17	3.72	-.89	2.89	-	-
86	1.05	.39	-.17	1.69	-1.44	-.90	1.17	4.45
87	1.00	-.10	.47	2.57	-1.56	-.81	.71	.86
88	-	-	.71	1.16	.38	-.38	-.02	-3.64
89	-	-	.19	.23	.44	-.34	-.32	-2.94
90	-	-	.84	1.08	.09	.84	.22	-1.33
91	-	-	.75	1.29	-.99	1.47	.39	1.57
92	-	-	.89	.81	-.99	1.47	.61	2.20
93	-	-	.92	1.59	-	-	-.13	-.24
94	-	-	.89	1.92	.85	7.72	-.10	-1.77
95	-	-	1.62	.87	.85	7.72	1.32	-.24
96	-	-	2.73	.20	.85	7.62	1.82	2.63
97	-	-	2.73	.20	.85	7.72	1.56	1.72

[a]BWTM = birth weight maternal; GBWM= gain from birth to weaning maternal.

to have a negative trend for GBWM. Their weighted means of BV ranged from 3.72 kg (1985) to .20 kg (1997). Bolivian sires showed a positive trend for GBWM between 1986 (-.90 kg) and 1997 (7.72 kg). Pedigree sires fluctuated the most, but seemed to have a positive trend for GBWM between 1988 (-3.64 kg) and 1997 (1.72 kg).

In conclusion, trends by origin of sires were different for some growth traits analyzed here. The Brazilian sire group stood out against the other sire groups not only for GBWD, but also for BWTD and BWTM. However, potentially negative effects of increased birth weight apparently did not show up in the Saavedreño herd. The Bolivian sire group seemed to be the most appealing for BWTD. Seven of the nine Bolivian base sires used during the 14-year period of analysis had negative BV for BWTD. This group was important for counterbalancing the effects of other sire groups (e.g., Brazilian sires) with larger BV for BWTD. Pedigree sires had a clear positive trend for GWHD. Their highest weighted means of BV resulted from the use of five to six bulls, as opposed to the highest weighted means of Brazilian and Bolivian sires which were determined by one sire only. Although pedigree sires did not stand out for the other growth traits discussed here, their BV showed that they have the genetic capacity, if carefully selected, to speed up genetic progress for growth traits in the Criollo Saavedreño population.

The Costa Rican sires lacked a defined trend for any of the traits analyzed here. Costa Rican sires had the smallest range of weighted means of BV for GBWD, GWHD, and BWTM across sire groups. They also had the second smallest range of weighted means of BV for BWTD and GBWM. Likewise, the fact that Costa Rican sires were used for only nine years made it difficult to determine any defined trends for growth traits of these sires. The apparent lack of direction of Costa Rican sires for the growth traits analyzed here may be explained by the objective of their usage. Semen from Costa Rican sires was used during the initial years of the Criollo Saavedreño herd (1979 to 1987) to increase milk yield (Wilkins et al., 1983). If a genetic analysis of milk yield is performed, the role of the Costa Rican sires in the forging of the Criollo Saavedreño population would most likely become clear.

Comparison of the genetic trends of the Criollo Saavedreño population with other Criollo populations was not possible because such studies were unavailable. Only two Criollo populations seem to have published genetic studies with predicted genetic values. One study deals with the Milking Criollos in Mexico (de Alba and Kennedy, 1994), where genetic trends only for milk related traits were computed. A second study refers to the Criollo Romosinuano from Colombia (Elzo et al., 1998). Growth traits were evaluated for the sires used in a 10-year period with the objective of estimating (co)variance components.

Genetic Trends by Age of Parents

Two groups of replacement animals, young bulls and heifers, were compared with their ancestors, older bulls and dams, respectively. Twenty-four young bulls born in the herd entered the stud between 1986 and 1997. They sired one to 53 calves on their first year, eight calves each on the average. Likewise, 451 heifers born in the herd joined the stud during the 16-year period from 1982 to 1997.

Direct genetic effects of young and older bulls. Weighted yearly means of BV for BWTD of young bulls (Table 3, Figure 6) decreased from 1987 to 1991, and increased between 1992 (-.41 kg) and 1996 (.45 kg). Older bulls followed a similar pattern. In general, older bulls had higher mean BV for BWTD than young bulls in the first half of the 12-year period from 1986 to 1997. The opposite was true for the second half of that period, with young bulls averaging higher

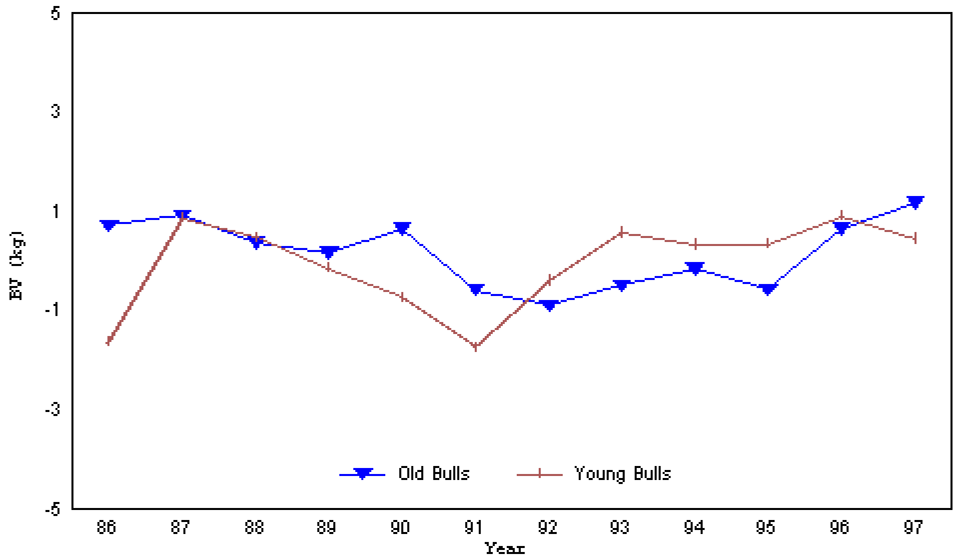

Figure 6. Weighted yearly means of BV for BWTD of older and young bulls

BV than older bulls. Since 1992, the yong bulls chosen to enter the stud had a positive trend for BWTD, which positively influenced the weighted means of BV of older sires since 1993. Increases were small, however, for both young and older bulls. The highest weighted mean for BWTD was .90 kg (1996) for young bulls, and 1.16 kg (1997) for older bulls.

Weighted yearly means of BV for GBWD of young bulls (Table 3, Figure 7) varied from year to year. Their lowest mean BV was observed in 1993 (-13.73 kg). The highest means of BV were observed in 1994 (5.92 kg), 1995 (8.80 kg), and 1996 (7.88 kg). Older bulls had higher weighted means of BV for GBWD during eight of the 12 years considered in this analysis. Although the initial (2.71 kg) and final (7.18 kg) weighted means of older sires suggest positive trends for this trait, values in between were variable and without definite trends. One of the young bulls which caused the drop observed in 1993, continued in the stud the following year and lowered the weighted mean BV of the older sires in 1994, which dropped to an all-time low of -4.98 kg.

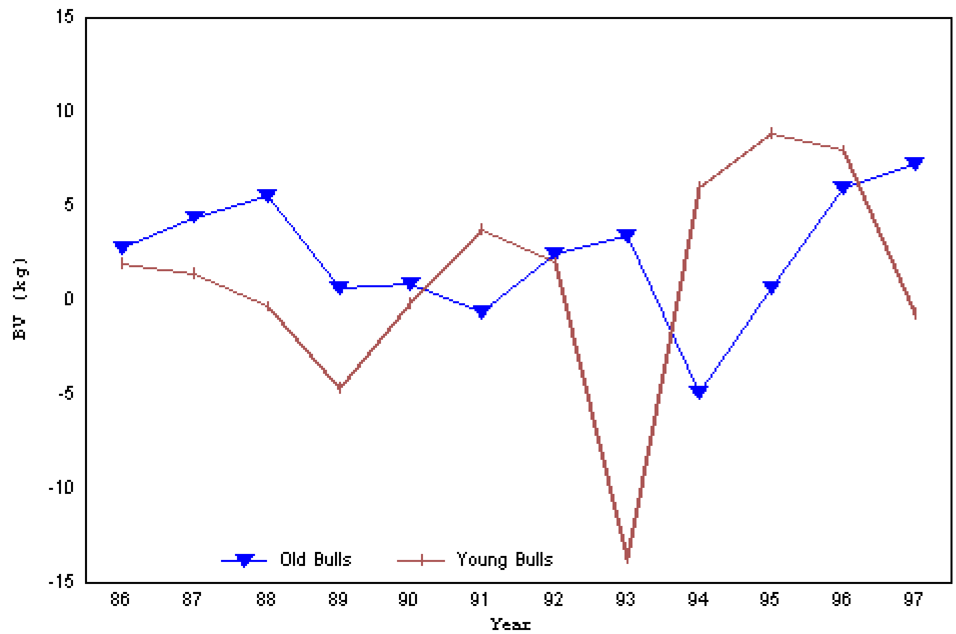

Figure 7. Weighted yearly means of BV for GBWD of older and young bulls.

Weighted means of BV for GWHD of young bulls (Table 3, Figure 8) fluctuated without a clear direction between 1986 and 1992, dropped from 9.83 kg in 1992 to -9.38 kg in 1993, and improved from 1994 to 1996. On the other hand, weighted means of BV of older bulls seemed to remain stable between 1986 and 1992. Weighted means of older bulls augmented in 1993, only to decrease in the following year. Three young bulls entered the stud in 1993, and sired 57 calves. Their weighted mean BV was the lowest for GWHD of young bulls (-9.38 kg). In 1994, one of these bulls sired 43 calves and caused a drop in the weighted mean BV of older bulls, which decreased from 7.31 in 1993 to .62 kg in 1994. However, weighted means of older bulls improved again between 1995 (7.40 kg) and 1997 (9.96 kg) as a direct result of the high BV (11.77 kg to 16.44 kg) for GWHD of the young bulls added to the stud between 1994 and 1996.

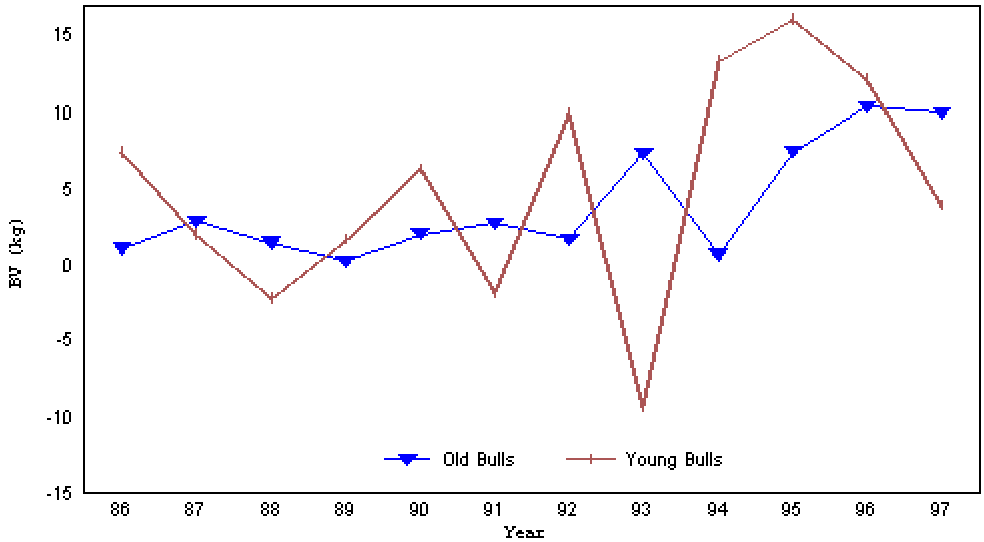

Figure 8. Weighted yearly means of BV for GWHD of older and young bulls.

Maternal effects of young and older bulls. The weighted means of BV for BWTM of young and older bulls (Table 3, Figure 9) showed little variation from 1987 to 1992. In

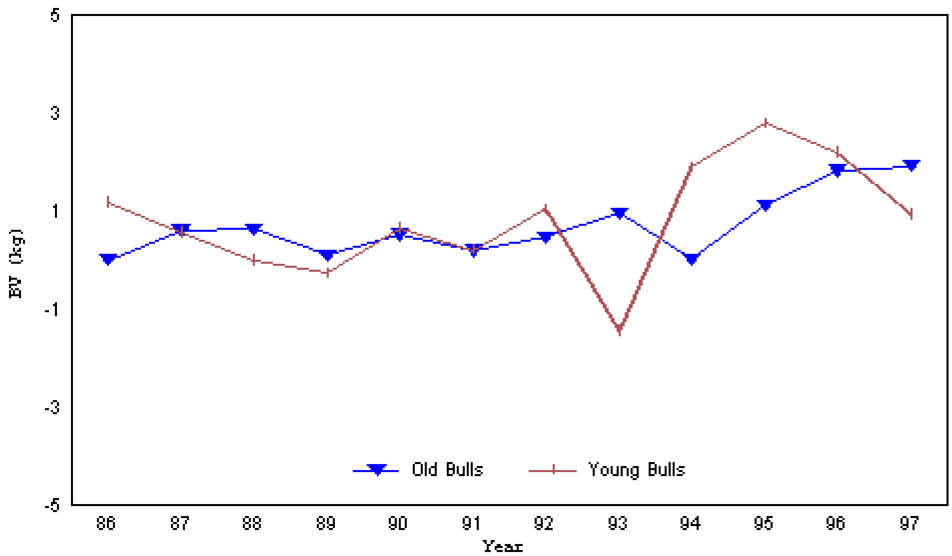

Figure 9. Weighted yearly means of BV for BWTM of older and young bulls.

1993, the weighted mean BV of young bulls dropped from 1.03 kg (1992) to -1.44 kg (1993). This decline was followed by higher weighted means of BV between 1994 and 1996. Older bulls had a lower weighted mean of BV in 1994 (.01 kg), that was followed by increases between 1995 (1.11 kg) and 1997 (1.91 kg). The smaller mean BV of BWTM observed in young bulls in 1993 was caused by the low BV of the bulls chosen to enter the stud that year. One of these bulls stayed in the stud the following year, and caused the lower mean BV for BWTM of older sires in 1994.

Young bulls had higher weighted means of BV for GBWM than older bulls (Table 3, Figure 10) in seven of the 12-year period of this analysis. However, neither the young nor the

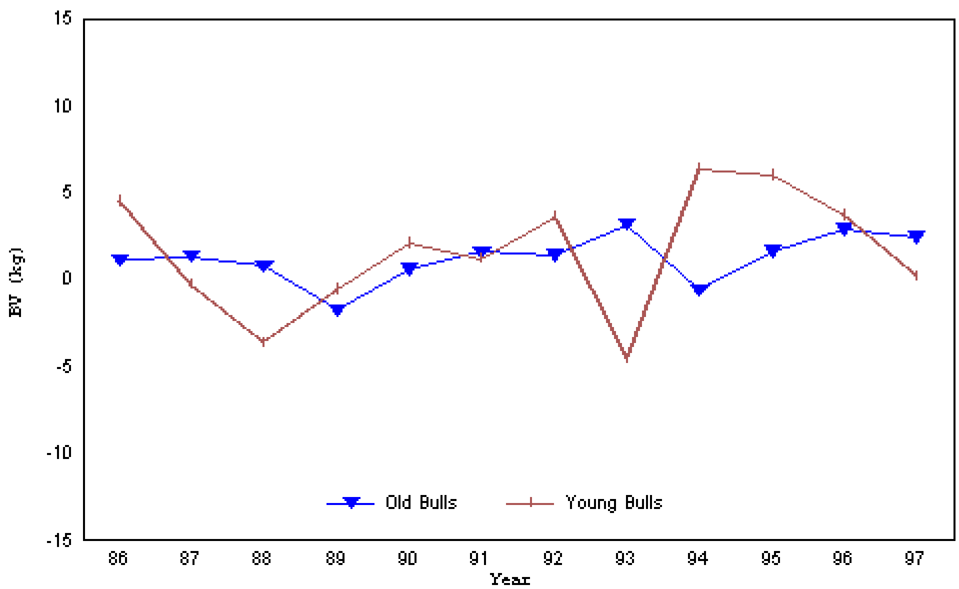

Figure 10. Weighted yearly means of BV for GBWM of older and young bulls

older bulls showed any definite trend of BV through time. In 1993, the mean BV of young bulls decreased from 3.56 kg in 1992 to a minimum of -4.54 kg in 1993. This decrease was as a direct result of the low BV of the three young bulls chosen to enter the stud that year. The only one of the three young bulls that had a negative value for GBWM (-5.21 kg) was the one which sired more progeny (53 calves against 4 from the other two bulls). This bull continued in the stud the following year, causing a drop in the weighted mean of BV of older bulls in 1994.

Table 3. Weighted yearly means of BV (kg) for BWTD, GBWD, GWHD, BWTM and GBWM of young bulls entering the stud and older bulls.

Yr	Young Bulls					Older Bulls				
	BWTD[a]	GBWD	GWHD	BWTM	GBWM	BWTD	GBWD	GWHD	BWTM	GBWM
86	-1.63	1.85	7.32	1.17	4.45	.70	2.71	1.01	-.00	1.09
87	.86	1.33	1.96	.56	-.34	.91	4.36	2.82	.59	1.28
88	.46	-.43	-2.28	-.02	-3.64	.36	5.51	1.41	.62	.75
89	-.14	-4.72	1.58	-.28	-.60	.16	.59	.21	.09	-1.82
90	-.74	-.26	6.25	.64	2.05	.65	.81	2.01	.51	.54
91	-1.76	3.70	-1.93	.20	1.15	-.60	-.66	2.68	.19	1.55
92	-.41	1.92	9.83	1.03	3.56	-.90	2.39	1.65	.45	1.35
93	.57	-13.73	-9.38	-1.44	-4.54	-.50	3.33	7.31	.95	3.11
94	.31	5.92	13.24	1.89	6.33	-.16	-4.98	.62	.01	-.63
95	.33	8.80	16.02	2.78	5.96	-.59	.61	7.40	1.11	1.60
96	.90	7.88	12.09	2.18	3.67	.65	5.90	10.34	1.81	2.84
97	.45	-.78	3.86	.92	.16	1.16	7.18	9.96	1.91	2.41

[a]BWTD = birth weight direct; GBWD = gain from birth to weaning direct; GWHD = gain from weaning to 550 d; BWTM = birth weight maternal GBWM = gain from birth to weaning matemal.

Direct genetic effects of heifers and dams. Yearly means of BV for BWTD of heifers (Table 4, Figure 11) closely fluctuated around the mean BV of dams from year to year and showed no defined trends. The smallest and largest yearly means of BV for BWTD of heifers were -.38 kg (1987) and .79 kg (1989), respectively. The ranges of BV for BWTM of dams were

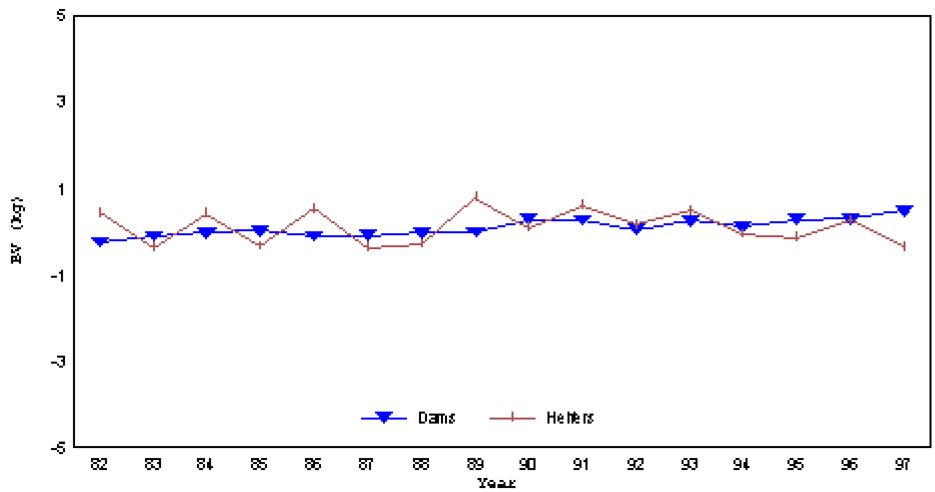

Figure 11. Yearly means of BV for BWTD of dams and heifers.

-.24 kg (1982) and .47 kg (1997), thus, suggesting small but positive trends for this trait in dams. Although the range of BV was narrower for dams than for heifers, dams had higher means of BV in nine of the 16 years (1982 to 1997) of this analysis. The wider range of mean BV observed in heifers was expected because the number of heifers entering the stud each year was smaller than the number of older dams, thus, individual differences had more impact on the mean BV of heifers.

Yearly means of BV for GBWD (Table 4, Figure 12) of heifers tended to increase from 1983 (.06 kg) to 1989 (3.51 kg), and decreased between 1990 (2.00 kg) and 1997 (-3.27 kg). Heifers showed higher yearly means of BV than older dams in 11 of the 16 years (1982 to 1997) considered in this analysis. However, yearly means of BV for older dams had a positive trend during the same period. The lowest weighted means of BV of heifers were observed in 1996 and 1997. The majority of these heifers were born in 1993 and 1994. Bulls used during those years had the lowest weighted means of BV for GBWD, most especially the sires used in 1994. Thus,

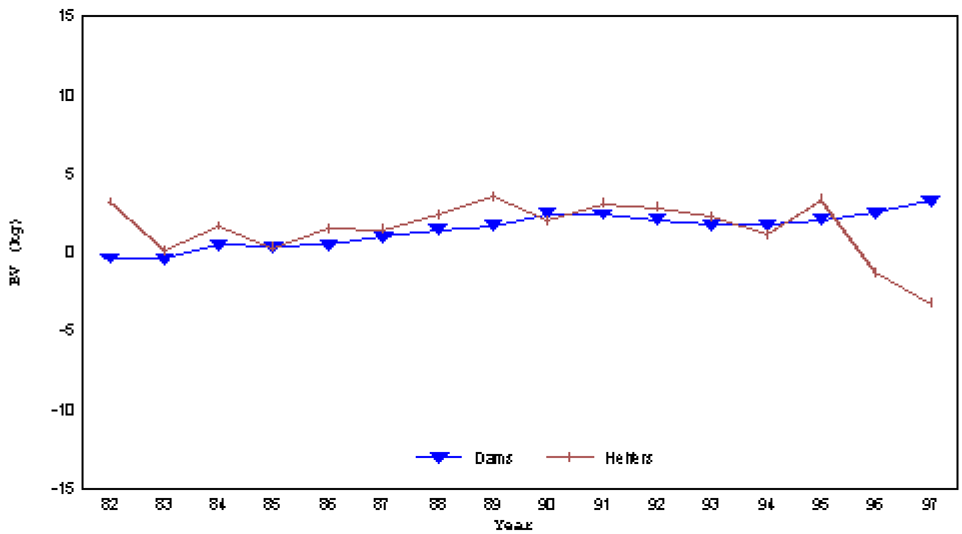

Figure 12. Yearly means of BV for GBWD of dams and heifers.

the low mean BV of heifers entering the stud in 1996 and 1997 probably reflected the low weighted means of BV of their sires for GBWD.

Yearly means of BV for GWHD showed a slightly negative trend for heifers, and a

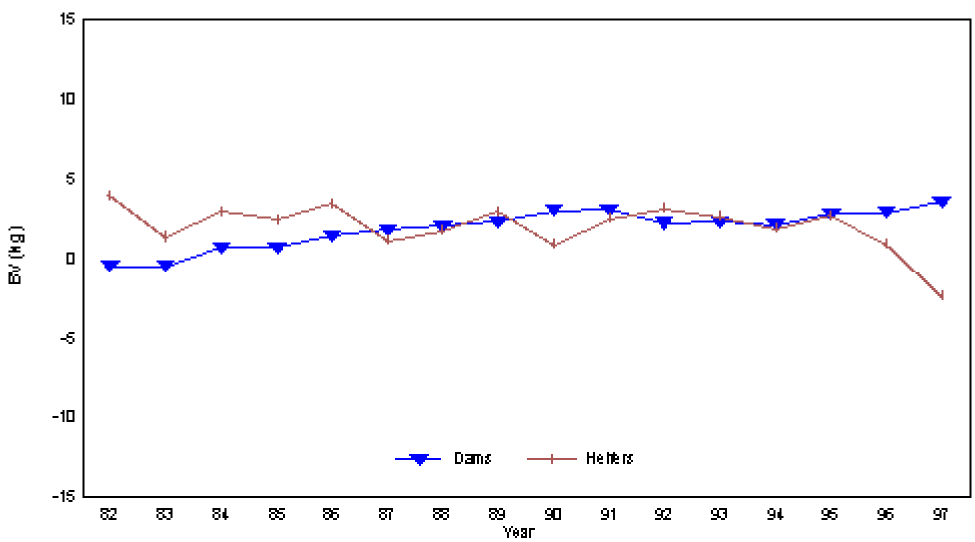

Figure 13. Yearly means of BV for GWHD of dams and heifers.

slightly positive trend for older dams (Table 4, Figure 13). Means of BV of heifers ranged between -2.36 kg (1997) and 3.94 kg (1982). Means of BV of dams increased from -.54 kg in 1982 to 3.57 kg in 1997. Heifers showed higher mean BV than dams in the 1982 to 1986 period, and similar values to those of dams between 1987 and 1995. In 1996 and 1997, mean BV of heifers decreased from 2.68 kg in 1995 to .89 kg in 1996, and -2.36 kg in 1997. Most heifers entering the stud in 1996 and 1997 were sired by the bulls used in 1993 and 1994. Those bulls had negative weighted means of BV for GWHD, and negatively affected the mean BV of heifers in the 1996 to 1997 period.

Maternal effects of heifers and dams. Mean BV for BWTM of heifers (Table 4, Figure 14) fluctuated between a maximum of .84 kg (1986) and a minimum of -.38 kg (1997), thus,

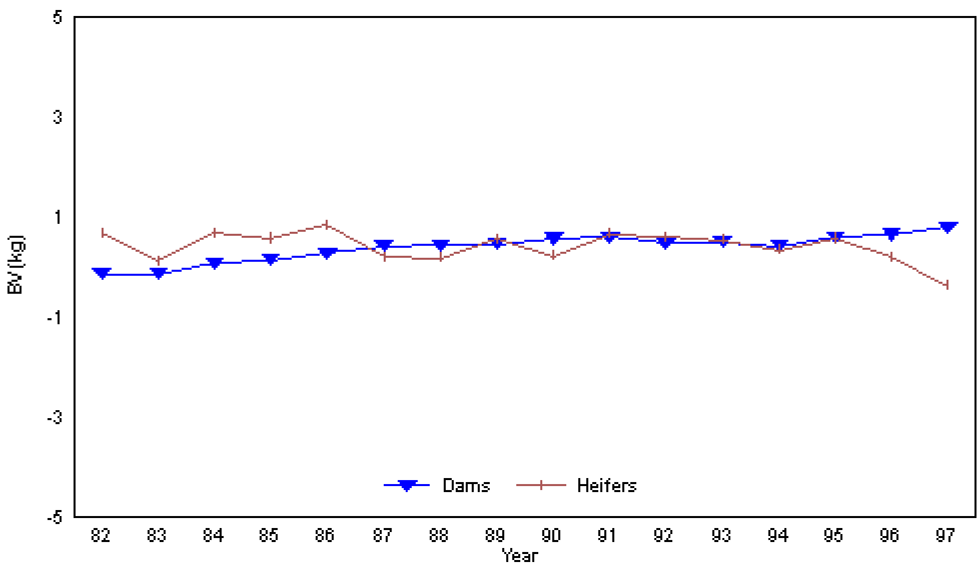

Figure 14. Yearly means of BV for BWTM of dams and heifers.

suggesting a slightly negative trend. Older dams, on the other hand, manifested positive trends for BWTM, with means of BV increasing from -.14 kg in 1982 to .79 kg in 1997. The patterns of mean BV for BWTM of heifers and older dams closely followed the patterns for GBWD and GWHD discussed previously for them. Because of the large genetic correlations (see Chapter 2) estimated between BWTM and GBWD (.71 ± .23), and between BWTM and GWHD (.75 ± .27), this similarity among the patterns of the three traits was expected.

Heifers showed higher mean BV for GBWM than older dams in nine of 16 years of the period of analysis, predominantly in the first half of that period (Table 4, Figure 15).

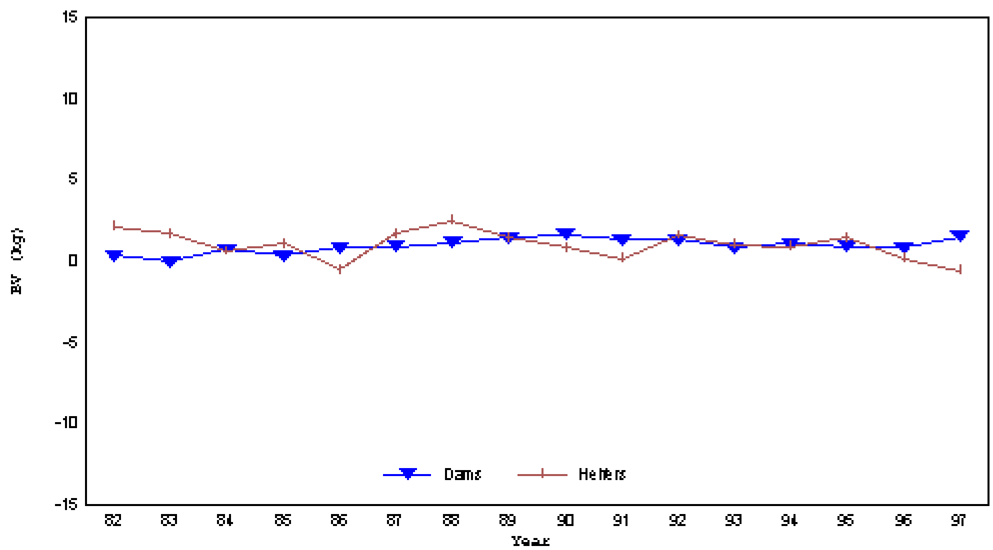

Figure 15. Yearly means of BV for GBWM of dams and heifers.

However, no defined trend was apparent for heifers. Mean BV of heifers ranged between -.60 kg (1997) and 2.45 kg (1988). Older dams seemed to have a positive trend for GBWM. Mean BV of heifers and dams were similar between 1992 and 1995. Means differed, however in 1996 and 1997 with heifers achieving their lowest mean in 1997 (-.60 kg). Most heifers that entered the stud those years were born in 1993 and 1994. Thus, the drop may be a consequence of the sires used in 1993 and 1994, which had negative weighted means of BV for GBWM.

Table 4. Weighted yearly means of BV (kg) for BWTD, GBWD, GWHD, BWTM and GBWM of heifers entering the stud and older dams

Yr	Heifers					Older Dams				
	BWTD[a]	GBWDD	GWHD	BWTM	GBWM	BWTD	GBWD	GWHD	BWTM	GBWM
82	.43	3.17	3.94	.68	2.13	-.24	-.39	-.54	-.14	.33
83	-.37	.06	1.34	.11	1.65	-.10	-.41	-.51	-.14	-.04
84	.41	1.65	2.93	.67	.59	-.03	.49	.68	.07	.71
85	-.34	.27	2.46	.56	1.03	.01	.30	.65	.13	.31
86	.53	1.49	3.43	.84	-.58	-.11	.44	1.44	.28	.79
87	-.38	1.43	1.09	.19	1.65	-.09	.96	1.80	.41	.89
88	-.29	2.38	1.74	.17	2.45	-.03	1.44	2.06	.44	1.13
89	.79	3.51	2.93	.55	1.43	-.02	1.68	2.29	.45	1.41
90	.10	2.00	.85	.21	.81	.29	2.46	3.03	.56	1.61
91	.60	3.06	2.51	.66	.11	.26	2.39	3.04	.60	1.27
92	.15	2.81	3.14	.59	1.58	.05	2.07	2.22	.47	1.28
93	.48	2.22	2.64	.53	.96	.24	1.74	2.31	.49	.80
94	-.06	1.09	1.89	.33	.89	.12	1.73	2.14	.41	1.05
95	-.14	3.33	2.68	.57	1.39	.27	2.05	2.79	.59	.86
96	.27	-1.34	.89	.20	.15	.30	2.50	2.85	.65	.83
97	-.36	-3.27	-2.36	-.38	-.60	.47	3.25	3.57	.79	1.49

[a]BWTD = birth weight direct; GBWD = gain from birth to weaning direct; GWHD = gain from weaning to 550 d direct; BWTM = birth weight maternal GBWM = gain from birth to weaning maternal

Total Genetic Trends

Direct genetic effects of sires. Weighted and unweighted means of BV were computed for sires used each year. Fifty nine sires were used in the Saavedreño herd between 1979 and 1981. Unweighted means provide an average of all bulls available in a given year in the stud.

Weighted means (Table 5) reflect how chosen sires were used. Weighted yearly means shared a similar pattern of fluctuations for BWTD, GBWD and GWHD with the unweighted yearly means for this group of animals.

The weighted yearly means of BV for BWTD of sires used from 1979 to 1997 (Table 5, Figure 16) showed only small changes throughout this period, and remained within a -1.00 kg to 1.00 kg range. The smallest value obtained was -.89 kg in 1991, and the largest was .91 kg in 1987. The small variation of weighted means of BWTD over time was due to the counterbalancing effects of sire groups with high (Brazilian sires) and low (Bolivian and pedigree sires) weighted means for BWTD.

Weighted yearly means of BV for GBWD (Table 5, Figure 16) increased from 1983 (2.05 kg) to 1988 (5.31 kg). This increase may reflect the influence of Brazilian Criollo sires, which had the largest weighted means of BV for this trait when compared to other groups of sires. From 1989 to 1994, the weighted means of BV showed a negative direction, attaining the smallest value of -4.88 kg in 1994. While the decline of weighted means of BV observed in 1989 was due to the use of sires with low BV for GBWD, the drop observed in 1993 (-3.82 kg) and 1994 (-4.88 kg) was due to the low BV for GBWD of the young bulls added to the stud in 1993, one of which continued to be used in 1994. Larger weighted and unweighted means for GBWD during the 1995 (1.19 kg) to 1997 (4.14 kg) period, were due to the combined use of the Bolivian and Brazilian base sires with the highest BV for GBWD, together with pedigree sires which had the highest weighted means of BV for GBWD.

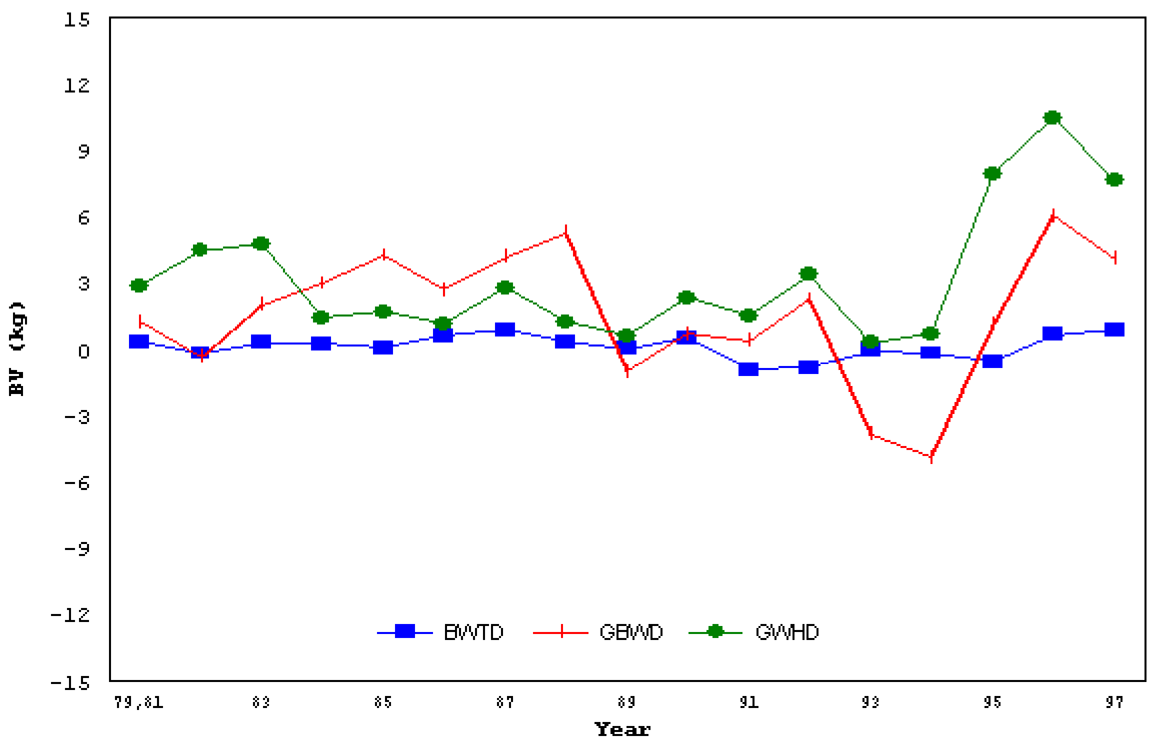

Figure 16. Weighted yearly means of BV for BWTD, GBWD and GWHD of sires used each year.

The weighted yearly means of BV for GWHD of sires (Table 5, Figure 16) increased between 1981 and 1983, decreased in 1984, remained fairly stable from 1984 to 1994, and increased from 1995 to 1997. The small variations of weighted means of BV from 1984 (1.44 kg) to 1994 (.73 kg) were mostly due to the use of sire groups with small weighted means of BV for this trait (e.g., Bolivian sires). The larger values of weighted yearly means of BV for GWHD from 1995 (7.96 kg) to 1997 (7.36 kg) shared a similar pattern with the large values computed for GBWD during the same period of time. This pattern resulted from the use of the Bolivian and Brazilian base sires with the highest BV for GWHD, combined with pedigree sires which averaged their highest weighted means of BV for this trait from 1995 to 1997.

The patterns of variation observed for weighted yearly means of GBWD and GWHD for sires used by year indicate that the small size of the herd made it possible for one, or few sires, to greatly affect yearly averages of BV. In addition, because the Criollo Saavedreño is considered a dual-purpose (milk-beef) breed, sires may have been chosen using several criteria (e.g., weight gain and milk yield). Also, one of the objectives reported for the Saavedreño herd was to produce bulls for crossbreeding programs with dairy breeds (Wilkins et al., 1983). Although only growth traits were considered in this study, it is likely that management decisions taken to favor milk yield may have affected the use of sires.

Direct genetic effects of dams. Yearly means of BV for BWTD, GBWD and GWHD of dams calving from 1979 to 1997 (Table 5) were smaller than the values computed for sires. The values for dams ranged from -1.19 kg (GBWD, 1981) to 2.94 kg (GWHD, 1991), while the values computed for sires varied from -4.88 kg (GBWD, 1994) to 10.49 kg (GWHD, 1996). This difference in range of mean BV was due to the much larger number of cows (536) than bulls (59). Although the Criollo Saavedreño population had cows with BV for GWHD larger than the BV of any bull, these values became unnoticeable when means were calculated. Because the number of sires was much smaller, individual sire BV were more apparent and more likely to affect the mean.

Yearly means of BV for BWTD of dams calving from 1979 to 1997 (Table 5, Figure 17) showed little change and seemed to maintain values close to zero during this period. The smallest value obtained was -.14 kg in 1987, and the largest was .41 kg in 1991. This small increase in the yearly means of the dams BV for BWTD was matched by a period of increases of yearly means of BV for GBWD and GWHD for dams calving those years. The smaller yearly means observed for BWTD from 1992 (.07 kg) to 1994 (.06 kg) also matched more observable decreases in the yearly means for GBWD and GWHD. This similarity among the trends of BWTD, GBWD and GWHD was to be expected because of the positive additive genetic correlations among growth traits for this herd (see Chapter 2).

Yearly means of BV for GBWD of dams calving from 1981 to 1991 (Table 5, Figure 17) increased slowly but consistently from -1.19 kg (1981) to 2.52 kg (1991). The observed fluctuations between 1981 and 1984 may be explained, at least in part, by variability in the mean BV for GBWD of purchased base dams. For example, in 1983, the yearly mean for GBWD of dams calving that year (-.51 kg) was smaller than the value of 1982 (.46 kg) because of the base dams added to the herd, which averaged -1.03 kg BV for this trait.

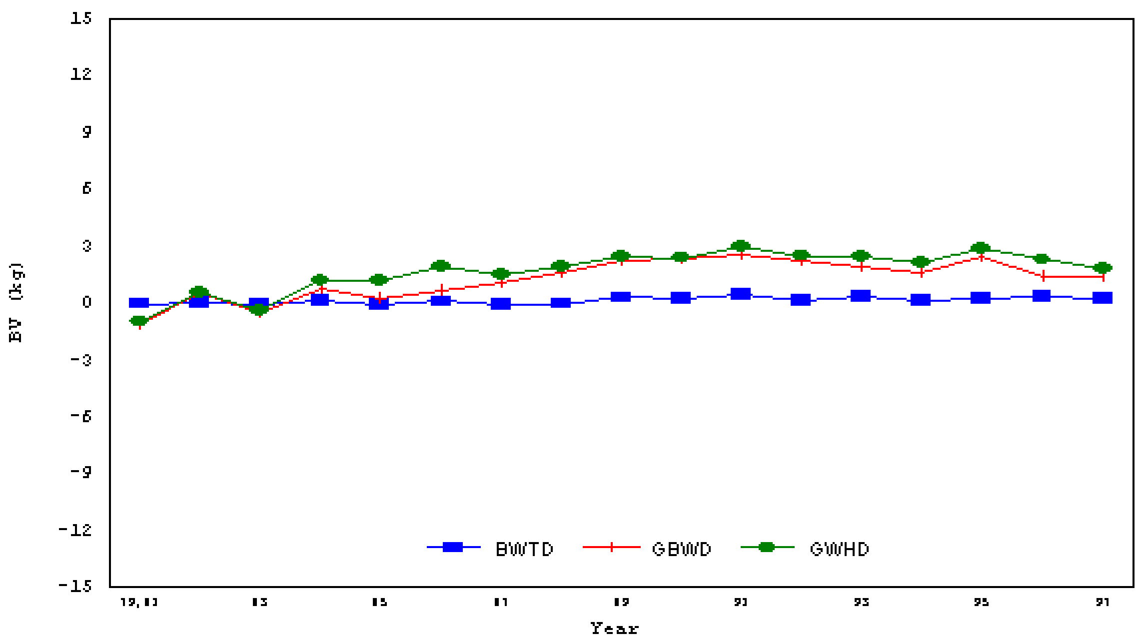

Figure 17. Yearly means of BV for BWTD, GBWD and GWHD of dams used each year.

The more continuous increase of yearly means of BV for GBWD observed since 1985 coincided with the year in which dams born in the herd became the majority of calving dams. The six-year period from 1992 to 1997 showed a slight decline of yearly means of BV for

Table 5. Yearly means of BV (kg) of direct effects for BWT, GBW and GWH by sires and dams used each year

Year	Sires			Dams		
	BWTD[a]	GBWD	GWHD	BWTD	GBWD	GWHD
1981	.38	1.27	2.91	-.09	-1.19	-1.04
1982	-.15	-.31	4.49	-.02	.46	.48
1983	.33	2.05	4.79	-.12	-.51	-.45
1984	.28	3.01	1.44	.07	.70	1.17
1985	.08	4.28	1.70	-.11	.18	1.14
1986	.65	2.69	1.16	.03	.64	1.84
1987	.91	4.21	2.78	-.14	1.04	1.47
1988	.37	5.31	1.28	-.08	1.57	1.88
1989	.07	-.98	.62	.25	2.23	2.39
1990	.53	.72	2.37	.22	2.26	2.34
1991	-.89	.43	1.53	.41	2.52	2.94
1992	-.80	2.29	3.42	.07	2.24	2.44
1993	-.04	-3.82	.33	.33	1.92	2.43
1994	-.15	-4.88	.73	.06	1.51	2.06
1995	-.53	1.14	7.96	.18	2.40	2.78
1996	.67	6.08	10.49	.29	1.34	2.25
1997	.89	4.14	7.63	.22	1.30	1.78

[a]BWTD = birth weight direct; GBWD = gain from birth to weaning direct; GWHD = gain from weaning to 550 d direct.

GBWD for dams calving those years, although the yearly mean in 1997 (1.30 kg) was still higher than the value observed in 1985 (.18 kg).

Yearly means of BV for GWHD of dams calving from 1979 to 1997 (Table 5, Figure 17) closely followed the pattern of GBWD for this group of animals. From 1981 to 1985, BV values fluctuated as in GBWD, probably influenced by base dams joining the herd each of those years. The period from 1985 to 1991 showed substantial increase on yearly means of BV for dams calving those years, presenting a trend that closely followed that observed for GBWD. The positive trend observed for GWHD was likely due to the increased ability of heifers born in the herd to gain weight after weaning as a result of heavier base bulls. Between 1992 and 1997 there was a small decrease in yearly means of BV for GWHD of dams calving those years. The period of 1992 to 1997 saw the largest number of heifers entering the stud. These heifers were born between 1989 and 1994. Bulls used during that period had low weighted means of BV for GBWD and GWHD. Thus, these heifers probably reflected the low weighted means of BV of their sires, and negatively influenced the yearly weighted means of dams from 1992 to 1997.

Maternal effects of sires. Weighted mean BV for BWTM of sires used from 1981 to 1997 (Table 6, Figure 18) followed the pattern of the unweighted mean BV for this trait. The weighted mean BV had small changes until 1994,and increased between 1995 (1.22 kg) and 1997 (1.53 kg).This increase of weighted means for BWTM of sires is related to the use of bulls with higher BV for this trait. Three of the only five bulls with BV for BWTM larger than 2.0 kg were used between 1995 and 1997. Although these bulls were probably chosen to increase BV for GBWD and GWHD, the large genetic correlations (see Chapter 2) between BWTM and GBWD (.71 ± .23), and between BWTM and GWHD (.75 ± .27) explain the correlated response obtained in the weighted means of BV for BWTM in these Saavedreño cattle.

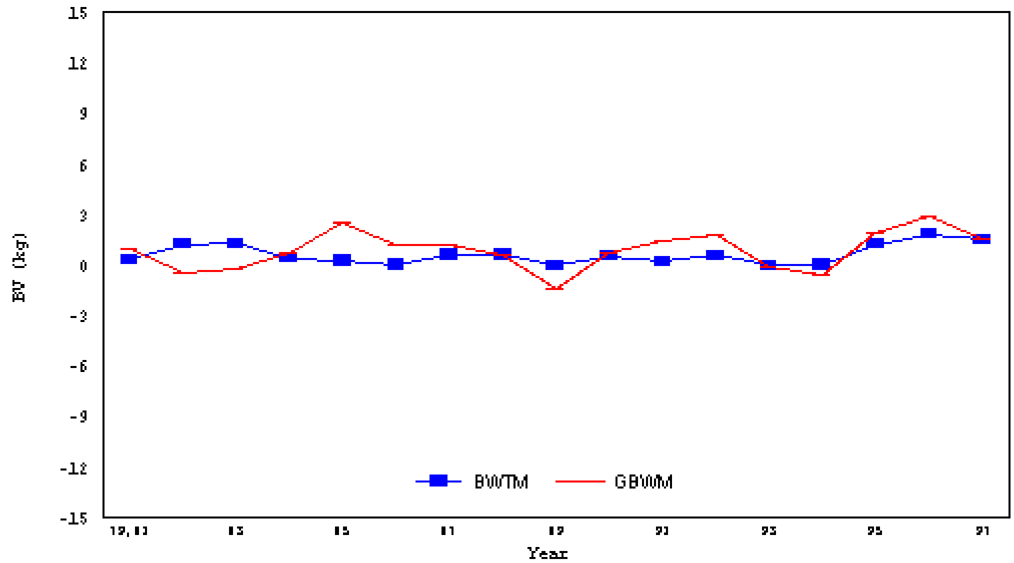

Figure 18. Weighted yearly means of BV for BWTM and GBWM of sires used each year.

Variations in the weighted means of BV for GBWM (Table 6, Figure 18) can be divided into five stages. From 1982 (-.49 kg) to 1985 (2.50 kg) there was an increase in the yearly means of BV for this trait. Between 1986 (1.17 kg) and 1989 (-1.46 kg), mean BV declined to their lowest point. This period was followed by improved means of BV from 1990 (.67 kg) to 1992 (1.83 kg). Mean BV decreased in 1993 (-.11 kg) and in 1994 (-.57 kg) only to increase again and achieve their maximum value in 1996 (2.91). Although the observed trends for the weighted BV of GBWM followed a pattern similar to that of the unweighted means most of the time, there were two periods during which both patterns, weighted and unweighted, differed. The first period was between 1983 and 1985, the second from 1993 to 1995. This was due to differential sire usage. For example, the unweighted yearly means of BV of sires available in 1983, 1984 and 1985 were .63 kg, -.35 kg, and 1.59 kg, respectively. The weighted yearly means of BV of the sires used were -.28 kg (1983), .78 kg (1984), and 2.50 kg (1985). The differences observed between weighted and unweighted means indicate that, in 1983, sires with lower BV for GBWM (Costa Rican sires) had more progeny than sires with higher BV (Bolivian sires). The opposite was true in 1984 and 1985.

Maternal effects of dams. Yearly means of BV for BWTM increased fairly steadily throughout the years of this study (Table 6, Figure 19). These small increases were more evident from 1981 (-.17 kg) to 1991 (.61 kg). Between 1992 and 1997 there was no clear pattern, although the values obtained the last two years (1996 to 1997) were smaller than the 1991 value. The pattern observed for BWTM of dams fairly followed the patterns of GBWD and GWHD. Because of the large genetic correlations estimated (see Chapter 2) between BWTM and GBWD

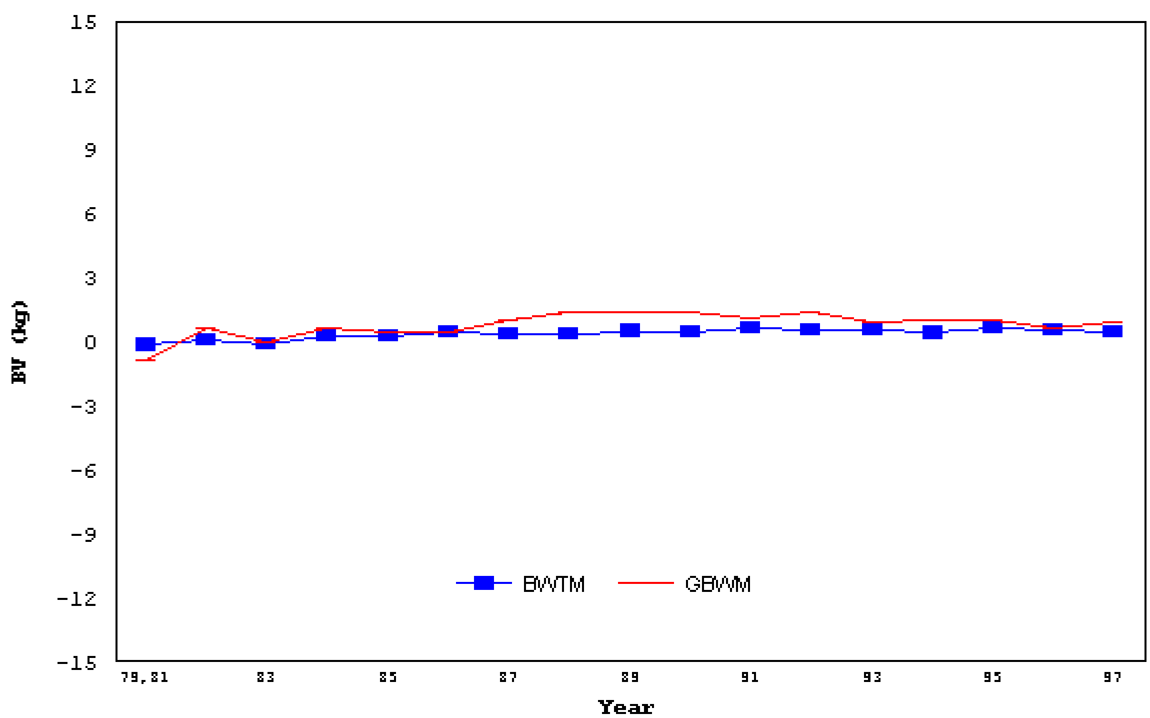

Figure 19. Yearly means of BV for BWTM and GBWM of dams used each year.

(.71 ± .23), and between BWTM and GWHD (.75 ± .27), these similarity among the patterns of the three traits was to be expected.

Yearly means of BV for GBWM of dams (Table 6, Figure 19) ranged from -.87 kg (1981) to 1.39 kg (1989). Changes in the yearly means of BV can be divided into three phases. From 1981 to 1988 there was a noticeable increase in this trait. Yearly mean BV augmented from -.87 kg (1981) to 1.35 kg (1988). During the following three-year period (1988 to 1990) the yearly mean BV of GBWM remained stable. However, from 1990 to 1997, yearly means decreased from 1.35 kg (1990) to .87 kg (1997). Variations in the yearly means of BV for GBWM had a resemblance with the pattern of variations of the yearly means for GWHD in dams. This resemblance between GBWM and GWHD was not observed in the group of sires probably because sires represented a much smaller non-random sample of animals from the Saavedreño population.

The Criollo Saavedreño population is small (1782 animals). Thus, it is not appropriate to compare it with large cattle populations such as Hereford (Bertrand et al., 1998b) and Simmental (Elzo et al., 1987) because of the much larger intensity of selection feasible in large populations. However, because comparable studies with Criollo populations were unavailable, genetic trends in two of the smaller USA breeds, Gelbvieh and Shorthorn, will be compared with the genetic trends obtained here for all calves born in the Criollo Saavedreño population. Trends by groups of calves by year were chosen for this comparison because they represent total genetic trends in the Criollo population.

The Gelbvieh (Bertrand et al., 1998a) and the Shorthorn (American Shorthorn Association, 1995) breeds showed clear positive trends for weaning and yearling weights. In the

Gelbvieh breed, weaning weight had a total increase of 7.0 lb EPD (equivalent to 6.36 kg BV) in the 19-year period from 1978 to 1996. The Shorthorn breed had a total increase of 11.0 lb EPD (equivalent to 10.0 kg BV) for weaning weight between 1983 and 1994. The Criollo Saavedreño calves had a total increase of 3.42 kg BV for GBWD between 1979 and 1996.

Table 6. Yearly means of BV (kg) of matemal effects for BWT and GBW by sires and dams used each year

Year	Sires		Dams	
	BWTM[a]	GBWM	BWTM	GBWM
1981-81	.32	.99	-.17	-.87
1982	1.23	-.49	.06	.56
1983	1.26	-.28	-.13	-.03
1984	.41	.78	.21	.63
1985	.24	2.50	.26	.46
1986	.03	1.17	.40	.40
1987	.58	1.20	.32	1.00
1988	.60	.60	.36	1.35
1989	-.02	-1.46	.46	1.39
1990	.52	.67	.45	1.35
1991	.19	1.45	.61	1.04
1992	.58	1.83	.50	1.36
1993	-.05	-.11	.51	.86
1994	.03	-.57	.38	1.00
1995	1.22	1.88	.59	.99
1996	1.84	2.91	.51	.62
1997	1.53	1.55	.43	.87

[a]BWTM = birth weight maternal; GBWM= gain from birth to weaning matemal.

A similar situation was observed when postweaning growth was compared. The Gelbvieh breed had a total increase of 15.0 lb EPD (or 13.64 kg BV) for yearling weight. The Shorthorn breed increased its EPD in 17.0 lb (or 15.45 kg BV) for the same trait. The increase of BV of the Saavedreño calves for GWHD, although not strictly comparable to yearling weight, was smaller (4.88 kg BV) than the improvements observed for the Gelbvieh and Shorthorn breeds. The smaller increase of genetic means for growth in the Saavedreño population was probably due to: 1) the substantially smaller selection intensity achievable in the Criollo Saavedreño, 2) the consideration of milk production traits, in addition to growth traits for choosing replacement animals, and 3) to the use of phenotypic values for selection.

The advantages of applying BLUP methodologies are clearly demonstrated with the positive changes in genetic means for growth traits of the Gelbvieh and Shorthorn breeds. This results further emphasize the importance of continued genetic evaluations including other connected herds for the future genetic improvement of the Criollo Saavedreño breed.

Conclusions

Analysis of genetic trends by origin of sires showed that sires of different origins had specific trends for some of the growth traits analyzed here. The Bolivian sire group stood out for low BV for BWTD, the Brazilian sire group for high BV for GBWD, and pedigree sires for high BV for GWHD.

Young bulls manifested variable or slightly positive trends for growth traits mostly between 1994 and 1996. Heifers had higher means of BV than older dams mostly during the first half of the 1982 to 1997 period of analysis. However, heifers had a slight negative trend for most growth traits, mainly between 1995 and 1997. Results suggests that more importance was placed on weight gain in male than in female replacements.

The analysis of total genetic trends brought up some important conclusions. Weighted yearly means of BV of sires used in the herd between 1979 and 1997 suggested positive trends for growth traits mostly between 1995 and 1997. Trends were different in dams. Yearly means of BV for growth traits of dams augmented mostly between 1981 and 1991, and showed slight declines from 1992 to 1997. The declines observed from 1992 to 1997 may be explained by the decline of mean BV of heifers during the same period of time.

The analysis of genetic trends in this population stressed the fact that one, or few sires, can greatly affect the yearly means of BV for any one trait, or even change the direction of genetic trends. Hence, if semen is to be imported from other countries, it would be advisable to import from populations which, as the Criollo Saavedreño, have available BV for the traits to be improved. However, BV computed for a Criollo population in another country may be misleading. Thus, a careful genetic evaluation of the performance of the imported seedstock in the Saavedreño population is highly recommendable.

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