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ESTIMATE OF GENETIC CHANGE IN MILK YIELD IN A GYR HERD IN BRAZIL

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ABSTRACT

An evaluation was made of genetic change in 305 day milk yield, lactation length and daily milk yield in Gyr cattle selected for milk production. The data were obtained from the records of a herd raised in the municipality of Cajuru, State of São Paulo. A total of 3,987 lactations corresponding to the period from 1962 to 1987 were analyzed. Several statistical models were utilized to estimate repeatability, and phenotypic, genotypic and environmental changes. Month and year of calving, bull, cow within-bull, cow's age at calving, and lactation length effects were significant. Repeatability estimates calculated by intraclass correlation for milk yield, lactation length and daily milk yield were 0.46, 0.34 and 0.43, respectively. The method used to estimate genetic change was based on repeated observations of the same animal in different years. The estimative of genetic change for milk yield during the period was 18.5 kg/year. With adjustments for length, the estimated change was 12.9 kg/year. The estimated genetic changes were 0.05 day/year and 0.015 kg/day per year for lactation length and daily milk yield, respectively.

INTRODUCTION

In Brazil, a country of tropical climate, the number of Zebu European halfbred cattle exploited for milk yield has increased considerably. Among Zebu breeds, the Gyr has been most extensively used for milk production. Even though the total number has

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remained constant or has declined slightly, over the last few years the number of Gyr animals raised for milk production has increased significantly. The breed is used both as a "pure" breed in some regions of the country and in crosses with European breeds.

The best way to evaluate milk yield in dairy breeds is by recording milk production. In Brazil, this service has been provided under the coordination of the Brazilian Breeders Association since 1944 (BBA, personal communication). The relevance of recording is undeniable. BBA has tested approximately 352 herds, 23,818 cows, 3845 bulls and 10,570 lactations. The participation of Gyr in lactations under the control of BBA is on the order of 9.2%. Twenty herds were tested in June 1989, totalling 2300 cows under milk yield recording.

Genetic change for milk yield in Holsteins, Jerseys and other breeds raised in temperate climates has been reported to be 30 to 110 kg milk per year (Van Vleck and Henderson, 1961; Cassel *et al.*, 1986).

Estimates of genetic change in the tropics, and especially for cattle of Indian origin, have been considerably variable, ranging from 7 to 40 kg milk/year (Lôbo, 1980; Lôbo *et al.*, 1982; Ramos, 1984; Ramos *et al.*, 1985; Ledic and Lôbo, 1987; Magnabosco *et al.*, 1990). Surveys carried out in Latin America have yielded results close to those obtained for Zebus by Indian investigators. The reasons for the low magnitudes of estimates of change are mainly related to the lack of selection programs, the general use of natural service and use of untested sires in most of the cases in which artificial insemination (AI) is employed.

The objective of the present study was to estimate genetic change in milk yield in Gyr cattle in Brazil.

MATERIAL AND METHODS

Data were obtained from the records of a Gyr herd in São Paulo state selected for milk yield. Records were obtained from the files of the National Center for Research on Dairy Cattle (CNPGL), belonging to the Brazilian Agriculture Research Corporation (EMBRAPA) which are the basis for the progeny testing of dairy Gyr cattle coordinated by this institution.

A total of 3987 lactations by 1272 cows daughters of 78 bulls for the period from 1962 to 1987 were analyzed. The climate of the region where the animals were raised (Northeastern region of the State of São Paulo) is variable, with annual oscillations in rainfall, temperature and relative air humidity and is defined as subtropical according to the Koeppen Classification. Management of the herd is semi-extensive, with animals left in the pasture most of the day, except when the cows are in the stable for mechanical milking (twice a day). Before each milking, calves were present to stimulate milk flow.

After each milking, the calves were confined in separate corrals and their dams in other corrals.

The data were analyzed using the SAEG (Genetic and Statistical Analysis System, 1988) program developed by the State University of Viçosa, state of Minas Gerais (1988) and with the LSMLMW (Least Squares amd Maximum Likelihood Computer Program) of Harvey (1985).

The following linear models were used:

$$Y_{ijkl} = \mu + a_i + b_{ij} + F_k + e_{ijkl},$$

where:

Y_{ijkl} = response for each dependent variable
μ = overall mean
a_i = sire effect (random)
b_{ij} = cow within-sire effect (random)
F_k = set of fixed effects
- continuous covariates [cow age (linear (l), quadratic (Q) and cubic (C) effects), and lactation length (L, Q, C]
- discrete variables (month of calving, year of calving).

e_{ijk} = random error for each observation.

Several runs were developed in order to estimate different parameters. In the first step the repeatability of each dependent variable was obtained by Manixum Likelihood procedures developed by Henderson *et al.* (1959), using the computational resources of Harvey (1985), according to the full model described here. At the same time the constant of year effect was regressed on time, which is an estimate of environmental change (b_e). The sire and daughter within sire effects were deleted in the second analysis and the constant for year effect was equally regressed on time, as an expression of phenotype change (b_{g+e}) (Smith, 1962). The differences between both regression coeficients are: $b_q = b_{(g+e)}-b_e$ which is one estimate of genetic change (Lôbo, 1980), during the period of time represented in this sample.

RESULTS AND DISCUSSION

The nonadjusted means and coefficients of variation (CV) for milk yield and lactation length over the studied period for 1972 Gyr cows were 2359 kg (CV = 29%) and 285 days, respectively (Table I).

These yield means are superior to the mean value for the overall Brazilian dairy herd (800 kg) and also to the mean for Gyr in Brazil, which is about 1500 kg (Ledic, 1985), however, it is less than the value of 2800 kg reported by the BBA for animals tested for milk yield. This is probably due to the fact that many BBA breeders select

Table I - Unadjusted overall means and coefficients of variation (CV) for milk yield up to 305 days, lactation length, and daily milk yield (3987 records).

Traits	Mean	Cv (%)
Lactation length (days)	285	14
Milk yield (kg)	2359	29
Daily milk yield (kg)	8.22	14

CV - coefficient of variation.

animals for testing with a consequent increase in apparent mean milk yield, despite the efforts of BBA to make breeders aware that they should not proceed in this manner.

In the herd under study there is no selective testing. The herd mean agrees with that reported by Ramos (1984), of 2500 kg in a study of Gyr selected for milk production in Brazil.

The least squares analyses of variance for milk yield up to 305 days (MY305), lactation length (LL305) and daily milk yield (DY305) are presented in Table II.

Table II - Least squares analyses of variance for milk yield up to 305 days, lactation length and daily milk yield.

Sources of variation	d.f.	Mean squares		
		MY305	DY305 ($X10^{-2}$)	LL305
Sire	77	917,197**	1,191**	1.88
Cow: sire	1.194	490,354**	612**	2,540**
Month of calving	11	1,454,900**	1,730**	925*
Year of calving	25	2,200,703**	2,831**	5,994**
Lactation length				
Linear effect	1	30,783,905**		
Quadratic effect	1	266,552*		
Cubic effect	1	216,408*		
Cow age				
Linear effect	1	127,448*	265*	2,284*
Quadratic effect	1	78,475,483**	91,180**	1,843*
Cubic effect	1	14,891,067**	17,731**	225
Error	2,673	158,176	195	979

d.f. - degrees of freedom; *P < 0.05; **P < 0.01.

There were significant effects of bull and cow within-bull (P < 0.01) for milk yield up to 305 days and for daily milk yield. All effects included in the model were significant (P < 0.05), except for sire effect on lactation length.

Figure 1 shows the constants for year of calving for milk yield during the period 1962 - 1986. These results indicate that pasture conditions (quantity and quality), the variation in climate conditions over the months, and year of calving had a decisive effect on milk yield in these animals. management and sanitary conditions of the herd, which greatly affect milk yield, are also included in the within year effects.

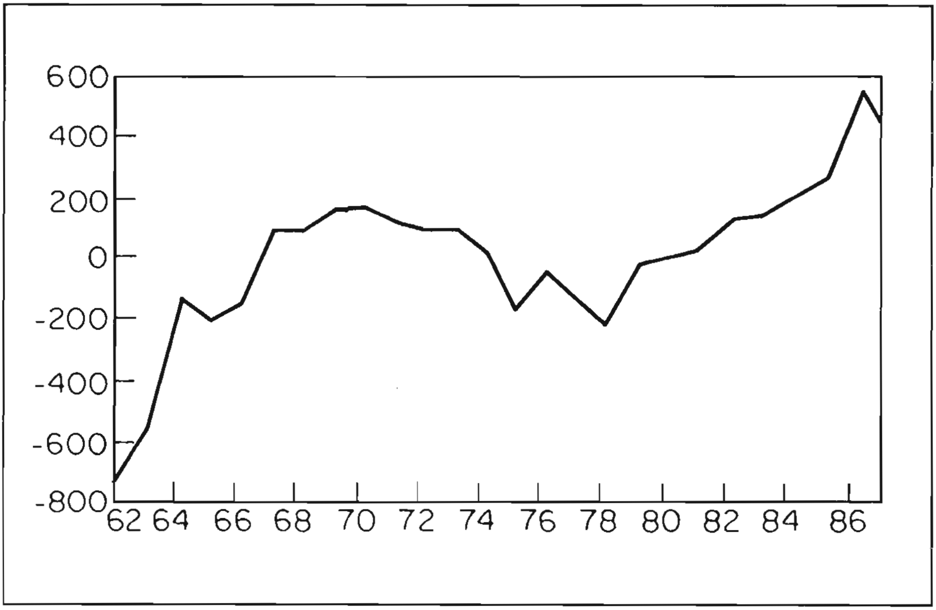

Figure 1 - Least squares constants for milk yield up to 305 days for each year of calving.

The significant effect of cow age at calving (CAC) was demonstrated when effects of CAC were partitioned into linear, quadratic and cubic regression effects. Quadratic and cubic effects were found to be significant (P < 0.01) for milk yield up to 305 days and for daily milk yield. Figure 2 shows the curve for yield determined by the regression equation obtained by the polynomial regression. The significant quadratic effect (P < 0.01) of age of the cow on milk yield reveals that milk yield increases with age up to maturity, i.e., when the animal is seven to eight years old.

The repeatability estimates for milk yield up to 305 days, lactation length and daily milk yield were obtained by intraclass correlation; these estimates were used to

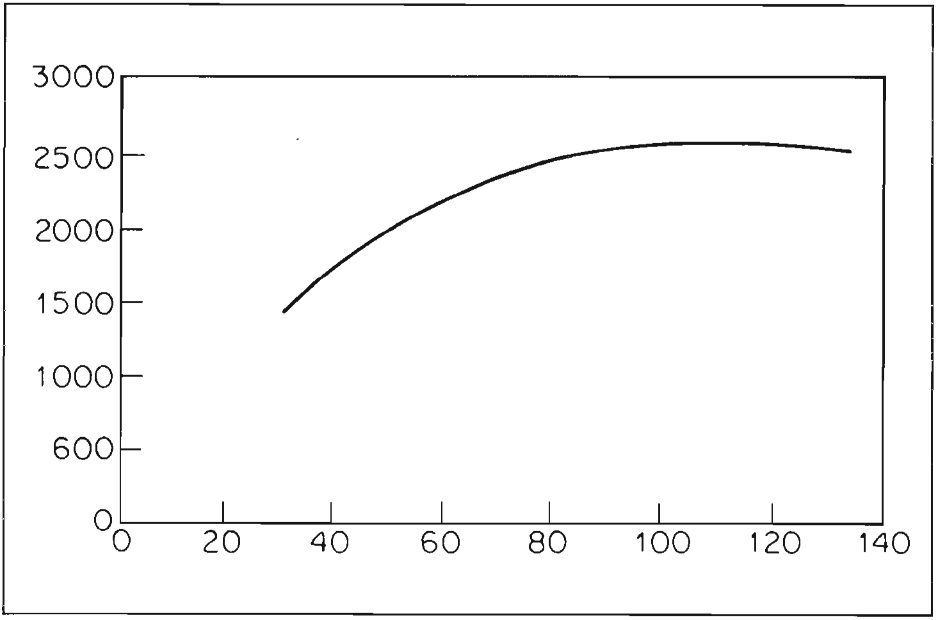

Figure 2 - Effect of cow age on milk yield up to 305 days.

calculate environmental change by maximum likelihood procedures (Henderson *et al.*, 1959). These estimates of repeatability are presented in Table III.

Table III - Repeatability coefficient estimates (t) for milk yield up to 305 days (MY 305), lactation lenght (LL 305) and daily milk yield (DY 305).

Trait	Repeatability coefficients		
	K^1	t	SE
MY 305	3,2	0,46	0,02
LL 305	3,2	0,34	0,02
DY 305	3,2	0,43	0,02

K^1 - Number of lactation per cow.

SE - Standard error of t.

Estimates of annual phenotypic ($\hat{p}$), genetic ($\hat{g}$) and environmental ($\hat{e}$) changes obtained are presented in Table IV. Genetic change ($\hat{g}$) was estimated by the difference between linear regression on year of calving, obtained from least squares analysis of variance b(g+e) and from maximum likelihood analysis of variance b(e). On latter analysis the values of 0.46, 0.34 and 0.43 were used for the repeatability estimates on MY305, LL305 and DY305, respectively. The estimate of genetic change in milk yield was 18.5 kg per year. When records were adjusted for lactation length in the model, the estimate of annual change was 12.9 kg due to the reduction in additive genetic variation for milk yield.

Table IV - Estimates of Annual phenotypic ($\hat{p}$), genetic ($\hat{g}$) and environmental ($\hat{e}$) changes for milk yield, lactation length and daily milk yield, estimated including or excluding lactation length in the model.

Trait	All lactations		
	$\hat{p}$	$\hat{g}$	$\hat{e}$
Not adjusted for lactation length			
Milk yield (kg)	17.16	18.50	-1.34
Lactation length (days)	0.27	0.05	-0.31
Daily milk yield (kg)	-0.52	0.015	0.005
Adjusted for lactation length			
Milk yield	14.31	12.94	1.37

On the basis of method used initially by Rendel and Robertson (1950) which considers all lactations, and the estimate of genetic change obtained by the difference between the regression coefficients [$b_{(g+e)}$ - $b_{(e)}$] (which take into consideration the effects of selection and incomplete repeatability of the trait), the conclusion is that there was a positive genetic change for milk yield in the herd studied.

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RESUMO

O objetivo do presente estudo foi avaliar as mudanças genéticas da produção de leite em 305 dias de lactação, período de lactação e produção de leite diário do gado Gir selecionado para produção de leite. os dados foram obtidos de registros de um rebanho mantido no município de Cajuru, estado de São Paulo. Vários modelos estatísticos foram utilizados para estimar repetibilidade e mudanças genéticas, fenotípicas e ambientais. Mês e ano do parto, touro, vaca dentro de touro, idade da vaca à parição e período de lactação afetaram significativamente as características estudadas. Foi analisado um total de 3.987 lactações correspondendo ao período de 1962 a 1987. Estimativas de repetibilidade calculadas pela correlação intraclasse para produção de leite, período de lactação e produção de leite diária foram 0,46; 0,34 e 0,43, respectivamente. O método usado para estimar a mudança genética foi baseado em observações repetidas do mesmo animal em diferentes anos. As estimativas da mudança genética para a produção de leite no período estudado foi de 18,5 kg/ano. Quando o efeito de duração da lactação foi incluído no modelo estatístico o valor foi de 12,9 kg/ano, ocorrendo uma acentuada redução na magnitude de mudança genética devido a correlação genética entre as duas características e conseqüentemente redução na variabilidade genética da produção de leite. Para as características período de lactação e produção de leite diário as mudanças genéticas foram 0,05 dia/ano e de 0,015 kg/ano, respectivamente.

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