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# Genetic trends in the production of brazilian dairy crossbreds*

*Ary Ferreira de Freitas*[1], *Charles J. Wilcox*[2] *and Claudio Napole Costa*[1]

## ABSTRACT

Data on lactation performance of crossbred dairy cattle on 20 farms in southeastern Brazil were analyzed to estimate genetic, phenotypic and environmental trends. Records resulted from the herd testing program of progeny testing of crossbred dairy sires by Centro Nacional de Pesquisa Gado de Leite (EMBRAPA) for 1977 to 1992. Represented were 2,343 records from 1,402 cows by 80 sires; cows were European x Zebu crossbreds (2/8 to 7/8). European breeds were Holstein (major contributor) plus Jersey and Brown Swiss (minor contributors). Traits studied were milk, fat and protein yields, and fat and protein percentages, each based on total lactation and 305-day performance. Mean total and 305 day performance was: milk yield, 2027 and 1865 kg; fat yield, 67.7 and 62.7 kg; protein yield, 53.5 and 53.4 kg; fat percentage, 3.59 and 3.59%; and protein percentage, 2.84 and 2.84%. All annual trends were curvilinear. Expressed as linear changes per year, changes in yields were negative; changes in percentages were variable, some negative and some positive. Linear negative annual trends for yields averaged 2.3% (phenotypic), 0.5% (genetic) and 1.7% (environmental).

## INTRODUCTION

The Centro Nacional de Pesquisa Gado de Leite-CNPGL-EMBRAPA-Coronel Pacheco-MG-Brazil developed a program of progeny testing with crossbred sires used in commercial and research institute herds located in the southeast region of the country. The program began in 1977. Most of the herds were milk producers characteristic of this region; they had low production levels, utilizing crossbred animals of undetermined genetic composition in many cases. Herds of *Bos taurus* and zebu specialized dairy breeds maintained in a tropical environment with inadequate management cannot be very efficient. Thus, goals were the formation of a dairy crossbred population which was adapted to environmental and management systems prevalent in the region.

Estimates of phenotypic, genetic, and environmental trends for milk production and other production traits have been obtained by many researchers by several procedures. Lobo *et al.* (1982) studied animals of the Pitangueiras breed (5/8 Red Poll x 3/8 Zebu); Polastre *et al.* (1990), evaluated crossbred Holstein x Zebu, and Ledic (1992) Gir. They estimated annual genetic trends for increase in milk yield of 6.8, 8.97, and 2.28 kg, respectively. Lobo *et al.* (1982) also obtained estimates of 0.30 and 0.18 for fat yields, and -0.0003 and 0.0003 for fat percentages, in two sets of data.

The international literature has several estimates of trends for European breeds, principally Holstein and Jersey. Moya *et al.* (1985) obtained estimates of annual genetic changes of 16.32 and 43.09 kg for milk yield , 0.32 and 0.72 kg for fat yield, 1.53 and 0.78 kg for protein yield, 0.002 and -0.021 for fat percentage, 0.013 and -0.014 for protein percentage for Holsteins

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[1] Centro Nacional de Pesquisa Gado de Leite, EMBRAPA, Coronel Pacheco, MG, Brasil - CNPq.
[2] Department of Dairy and Poultry Sciences, University of Florida, Gainesville, FL 32611, USA. Send correspondence to C.J.W.

and Jerseys in subtropical Florida, U.S.A. In temperate U.S.A., Meinert and Pearson (1992), estimated annual genetic trends 118 ± 17 kg for milk and 3.5 ± 0.6 kg for fat yield for Holsteins. Numerous other researchers have presented estimates of genetic trends in dairy cattle, including Strandberg and Danell (1988), who worked with Swedish dairy cattle, Murdia and Tripathi (1991), with Jersey herds in India, and Burnside *et al.* (1992), in Italian Holsteins.

The objectives of the crossbred development program were:

1. Formation of a population of dairy crossbred cattle adapted to Brazilian conditions, through progeny testing with young crossbred sires;
2. Estimation of environmental factors which affect traits of economic importance in the population;
3. Establishment of criteria of selection for productive traits to maximize genetic gains; and
4. Identification of the best genotypes and their dissemination in several regions of Brazil.

The objectives of the present research were to estimate phenotypic, genetic, and environmental trends for milk, fat and protein yields and fat and protein percentages. Each was expressed as performance for the entire lactation and as performance during the first 305 days of lactation.

## MATERIAL AND METHODS

Data came from the progeny test program and were from 20 cooperating herds in the southeast region of Brazil from 1977 to 1992. The program sampled 10 sires per year which were between 1/2 and 7/8 of European breed makeup (principally Holstein) and were sons of elite cows. They were selected from a population of 2300 cows from which 40 were chosen as dams of sires, with an average selection intensity of 2.04, as described by Valente *et al.* (1982).

In 1993 the program had 100 sires with semen stored (1000 doses each). Semen was randomly distributed among cooperating herds to obtain a sufficient number of daughters to obtain reliable sire proofs. Daughters in the data set were between 2/8 and 7/8 European breed composition and represented 2,343 lactations of 1,402 daughters of 80 sires. Records were initiated between 1981 and 1992.

Estimates of annual phenotypic trends (ΔP) were obtained by estimating year of calving effects by the method of ordinary least squares analysis of variance (Harvey, 1990), using the following mathematical model:

$$Y_{ij} = M + F_i + e_{ij} \quad \text{where}$$

$Y_{ij}$ represents the response variables, M the overall mean for each, and $F_i$ the set of fixed effects such as herd-genetic group, year and month of calving, age of cow at calving and length of lactation, and $e_{ij}$ represents random error with the usual assumptions.

Annual environmental trends (ΔE) were estimated from partial regression coefficients from the same model with cows included by maximum likelihood, with assumed t = 0.4045. Annual genetic trends (ΔG) were estimated by calculating the difference between the linear phenotypic and environmental trends, ΔG = ΔP - ΔE. All trends were listed as linear, and curvilinear changes if the latter were significant.

## RESULTS AND DISCUSSION

Means, standard errors and numbers of observations are in Table I. Summaries of the analyses of variance are in Tables II and III. All fixed effects included in the mathematical models were statistically significant, except for age of cow for fat percentage. Phenotypic, genetic and environmental trends are in Table IV.

**Table I** - Means, standard errors and number of observations for the traits studied.

| Trait | Number of observations | Least-squares means (kg) | Standard errors |
|---|---|---|---|
| Milk yield | 2343 | 2027 | 23.55 |
| Milk (305 days) | 2343 | 1865 | 25.99 |
| Fat yield | 1509 | 67.65 | 1.17 |
| Fat (305 days) | 1509 | 67.74 | 1.23 |
| Fat % | 1391 | 3.59 | 0.04 |
| Fat % (305 days) | 1391 | 3.59 | 0.04 |
| Protein yield | 2181 | 53.93 | 0.73 |
| Protein (305 days) | 2181 | 53.38 | 0.72 |
| Protein % | 1975 | 2.84 | 0.02 |
| Protein % (305 days) | 1975 | 2.84 | 0.02 |

### Phenotypic trends

Yearly phenotypic changes were negative for all traits except for protein percentage. Linear regressions for year of calving were -27.01 kg, -28.28 kg, -1.57

**Table II** - Summary of analyses of variance by method of maximum likelihood for milk (coded $10^{-3}$), fat and protein yields, and fat and protein percentages.

| Sources of variation | Milk[1] | | Milk (305) | Fat | | Fat (305) | Protein | | Protein (305) | Fat % | | Fat % (305) | Protein % | | Protein % (305) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DF[2] | MS | MS | DF | MS | MS | DF | MS | MS | DF | MS | MS | DF | MS | MS |
| Cow (absorbed) | | | | | | | | | | | | | | | |
| Herd-genetic group | 55 | 983** | 996** | 44 | 843** | 872** | 51 | 666** | 618** | 40 | 0.748** | 0.708** | 47 | 0.152* | 0.148** |
| Year of calving | 11 | 559* | 595** | 11 | 1571** | 2036** | 11 | 1757** | 1673** | 11 | 1.462** | 1.377** | 11 | 1.384** | 1.337** |
| lin[3] | 1 | 804* | 922** | 1 | 4663** | 4788** | 1 | 4094** | 3786** | 1 | .075 | 0.110 | 1 | 1.632** | 1.491** |
| qua | 1 | 2233** | 2536** | 1 | 2513** | 3212** | 1 | 1525** | 1462** | 1 | 7.993** | 7.155** | 1 | 0.142 | 0.127 |
| cub | 1 | 1199** | 579* | 1 | 4918** | 7598** | 1 | 5882** | 5379** | 1 | .474 | 0.393 | 1 | 1.983** | 2.091** |
| qrt | 1 | 172 | 518* | 1 | 3 | 201 | 1 | 2094** | 2137** | 1 | .341 | 0.293 | 1 | .325* | 0.347** |
| qnt | 1 | 104 | 290 | 1 | 231 | 341 | 1 | 1663** | 1433** | 1 | .367 | 0.544 | 1 | 7.407** | 7.210** |
| res | 6 | 273 | 283* | 6 | 826** | 1043** | 6 | 677** | 701** | 6 | 1.139** | 1.036** | 6 | 0.623** | .573** |
| Month of calving | 11 | 188* | 238* | 11 | 251 | 489* | 11 | 204** | 201** | 11 | .299* | 0.342* | 11 | 0.204** | 0.183** |
| lin | 1 | 582* | 123 | 1 | 758* | 2432** | 1 | 121 | 166 | 1 | .583 | 1.210** | 1 | 0.431** | 0.335* |
| qua | 1 | 80 | 8 | 1 | 659* | 1187** | 1 | 1 | 52 | 1 | .217 | 0.363 | 1 | 0.005 | 0.003 |
| cub | 1 | 110 | 567* | 1 | 434 | 562 | 1 | 611** | 681** | 1 | .064 | 0.085 | 1 | 0.540** | 0.378* |
| qrt | 1 | 10 | 238 | 1 | 9 | 12 | 1 | 104 | 147 | 1 | .447 | 0.484 | 1 | 0.688** | 0.792** |
| qnt | 1 | 351 | 116 | 1 | 256 | 633* | 1 | 155 | 140 | 1 | .121 | .072 | 1 | 0.013 | 0.012 |
| res | 6 | 156 | 260 | 6 | 108 | 94 | 6 | 208* | 171 | 6 | .310 | 0.257 | 6 | 0.095 | 0.081 |
| Age of cow | | | | | | | | | | | | | | | |
| lin | 1 | 20191** | 13387** | 1 | 15443** | 15293** | 1 | 12429** | 11651** | 1 | .079 | 0.139 | 1 | 1.119** | 1.466** |
| qua | 1 | 527* | 9 | 1 | 1267* | 1754** | 1 | 1577** | 1348** | 1 | .581 | 0.387 | 1 | 0.025 | 0.003 |
| cub | 1 | 286* | 249 | 1 | 1 | 28 | 1 | 192 | 151 | 1 | .389 | 0.263 | 1 | 0.205 | 0.145 |
| Lactation length | | | | | | | | | | | | | | | |
| lin | 1 | 153621** | 8856** | 1 | 151096** | 92964** | 1 | 138874** | 80225** | 1 | 2.467** | 0.440 | 1 | 3.695* | .710** |
| qua | 1 | 983** | 58412** | 1 | 347 | 14713** | 1 | 706** | 20437** | 1 | 0.171 | 1.262** | 1 | 0.019 | 1.015** |
| cub | 1 | 1 | 10114** | 1 | 274 | 807* | 1 | 1582** | 1573** | 1 | 0.024 | 0.219 | 1 | 0.313* | 0.080 |
| Remainder | 2259 | 103 | 126 | 1436 | 145 | 160 | 2101 | 86 | 82 | 1322 | 0.166 | 0.167 | 1899 | 0.059 | 0.061 |

[1]Milk = total lactation yield; milk (305) = yield to 305 days.
[2]DF = degrees of freedom; MS = mean squares.
[3]lin = linear, qua = quadratic, cub = cubic, qrt = quartic, qnt = quintic, res = residual.
*P < 0.05; **P < 0.01.

kg, -1.68 kg, -0.0024%, -0.004%, -1.41 kg, -1.38 kg, 0.023% and 0.0217%, for total milk yield, milk yield during 305 days, total fat yield, fat yield during 305 days, total fat %, fat % in 305 days, total protein yield, protein yield during 305 days, and total % protein and % protein during 305 days, respectively. Regressions were curvilinear for all traits. Linear and curvilinear trends are presented in Figure 1. Similar results were obtained by Lobo *et al*. (1982), Moya *et al*. (1985) and Murdia and Tripathi (1991). Negative phenotypic trends indicate yearly reductions in these traits, doubtless due to a combination of environmental and/or genetic effects.

## Environmental trends

Environmental trends were -15.29 kg, -16.37 kg; -1.35 kg, -1.36 kg; -0.0056%, -0.0067%; -1.2 kg, -1.15 kg; 0.025%, and 0.024% for total and 305 day performance for the five traits. The $\Delta E$ also were curvilinear (Figure 2). Negative trends also were observed by Lobo *et al*. (1982) and Ledic (1992) in Brazil. However, Polastre *et al*. (1990) found positive trends for the herds which they studied.

These negative environmental trends evidently reflect the high cost of feed (real or perceived), princi-

**Table III** - Summary of analyses of variance by method of ordinary least square milk production (coded $10^{-3}$), fat, protein, fat percentage and protein percentage[1].

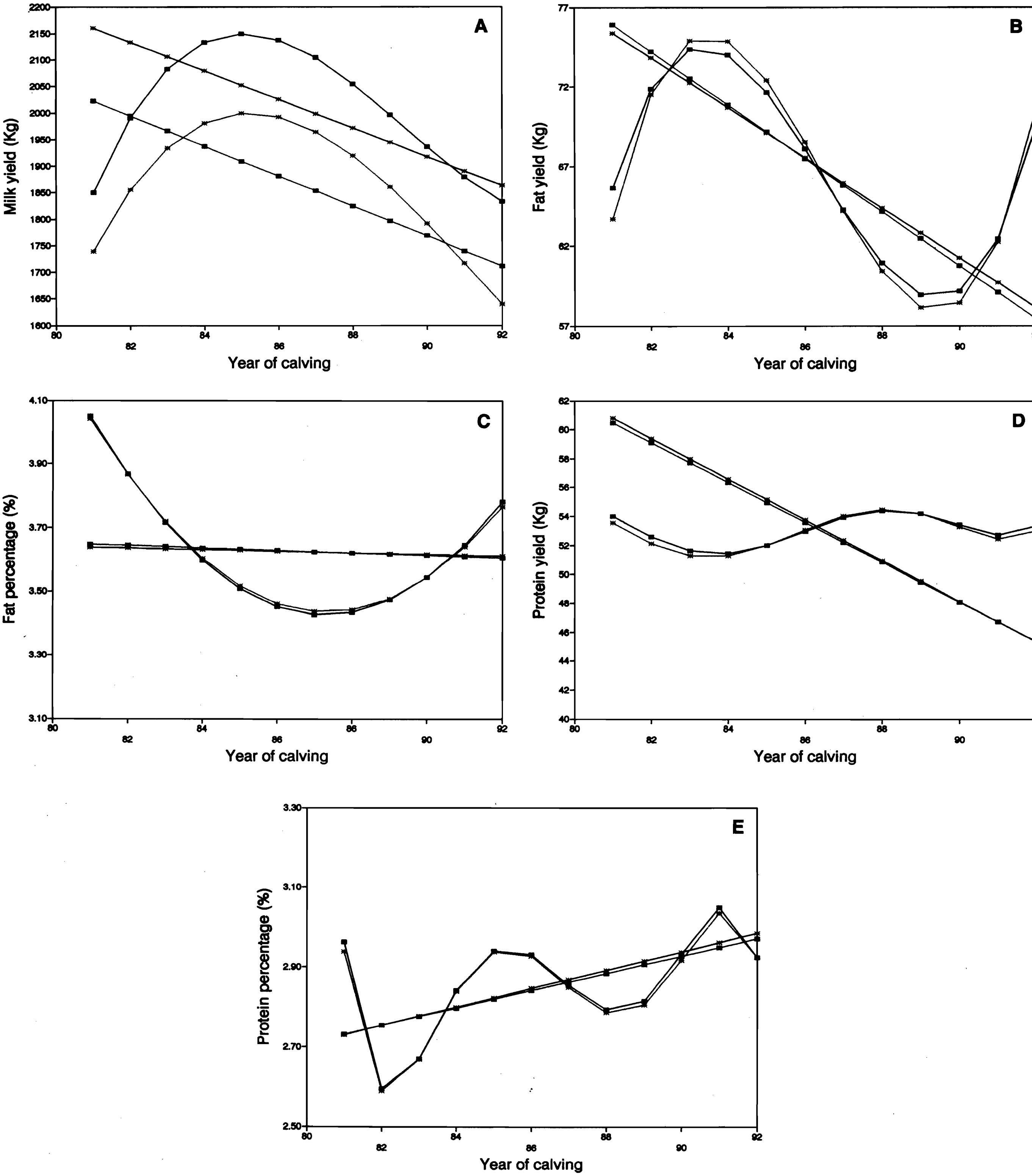
| Sources of variation | Milk[1] | | Milk (305) | Fat | | Fat (305) | Protein | | Protein (305) | Fat % | | Fat % (305) | Protein % | | Protein % (305) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DF[2] | MS | MS | DF | MS | MS | DF | MS | MS | DF | MS | MS | DF | MS | MS |
| Herd genetic group | 55 | 2296** | 2311** | 44 | 1692** | 1754** | 51 | 1424** | 1332** | 40 | 1.627** | 1.555** | 47 | 0.291** | 0.286** |
| Year of calving | 11 | 1393** | 1666** | 11 | 3064** | 3735** | 11 | 2979** | 2841** | 11 | 2.276** | 2.117** | 11 | 1.698** | 1.626** |
| lin | 1 | 5325** | 5841** | 1 | 12840** | 14681** | 1 | 12445** | 11893** | 1 | 0.029 | 0.078 | 1 | 3.089** | 2.737** |
| qua | 1 | 6272** | 7285** | 1 | 2486** | 2692** | 1 | 4227** | 4097** | 1 | 12.850** | 11.700** | 1 | 0.071 | 0.065 |
| cub | 1 | 879* | 304 | 1 | 8958** | 12445** | 1 | 7122** | 6564** | 1 | 0.785 | 0.661 | 1 | 2.628** | 2.794** |
| qrt | 1 | 304 | 890* | 1 | 0.2 | 350 | 1 | 3689** | 3770** | 1 | 0.559 | 0.492 | 1 | 0.550* | 0.581* |
| qnt | 1 | 3 | 886* | 1 | 93 | 243 | 1 | 1450** | 1130** | 1 | 0.492 | 0.753 | 1 | 8.400** | 8.093** |
| res | 6 | 423* | 520* | 6 | 1554** | 1780** | 6 | 639** | 632** | 6 | 1.720** | 1.600** | 6 | 0.657** | 0.603** |
| Model of calving | 11 | 359* | 408* | 11 | 435* | 764** | 11 | 281* | 274** | 11 | 0.390 | 0.424 | 11 | 0.354** | 0.328** |
| lin | 1 | 801* | 494 | 1 | 1372* | 3920** | 1 | 136 | 204 | 1 | 0.304 | 0.889 | 1 | 0.536* | 0.387* |
| qua | 1 | 67 | 59 | 1 | 513 | 1168** | 1 | 0.6 | 78 | 1 | 0.222 | 0.387 | 1 | 0.215 | 0.229 |
| cub | 1 | 757* | 937* | 1 | 1266* | 1542* | 1 | 941** | 984** | 1 | 0.200 | 0.208 | 1 | 0.489* | 0.373* |
| qrt | 1 | 0.1 | 8 | 1 | 41 | 25 | 1 | 351 | 444 | 1 | 0.225 | 0.282 | 1 | 1.350** | 1.531** |
| qnt | 1 | 537 | 241 | 1 | 310 | 942 | 1 | 200 | 198 | 1 | 0.185 | 0.131 | 1 | 0.040 | 0.035 |
| res | 6 | 297 | 459* | 6 | 215 | 135 | 6 | 243 | 184 | 6 | 0.526 | 0.462 | 6 | 0.195 | 0.176 |
| Age of cow | | | | | | | | | | | | | | | |
| lin | 1 | 34709** | 23403** | 1 | 24562** | 23475** | 1 | 18334** | 17411** | 1 | 0.050 | 0.143 | 1 | 1.405** | 1.701** |
| qua | 1 | 8 | 128 | 1 | 451 | 698 | 1 | 859* | 699** | 1 | 1.059** | 0.845 | 1 | 0.071 | 0.026 |
| cub | 1 | 1064* | 518 | 1 | 190 | 84 | 1 | 35 | 21 | 1 | 0.569 | 0.474 | 1 | 0.283 | 0.216 |
| Lactation length | | | | | | | | | | | | | | | |
| lin | 1 | 262016** | 17854** | 1 | 257797** | 161883** | 1 | 237331* | 141442** | 1 | 4.066** | 0.796 | 1 | 5.409* | 0.996** |
| qua | 1 | 1300** | 99046** | 1 | 781 | 24208** | 1 | 1384** | 32225** | 1 | 0.844 | 3.297** | 1 | 0.001 | 1.854** |
| cub | 1 | 19 | 14382** | 1 | 414 | 1153* | 1 | 3075** | 2938** | 1 | 0.144 | 0.541 | 1 | 0.317 | 0.044 |
| Remainder | 2259 | 170 | 212 | 1436 | 237 | 256 | 2101 | 136 | 129 | 1322 | 0.269 | 0.272 | 1899 | 0.089 | 0.092 |

See Table II for description of sources of variation.

**Table IV** - Annual linear phenotypic, genetic and environmental trends[1].

| Traits | Phenotypic | | | Genetic | | Environmental | | |
|---|---|---|---|---|---|---|---|---|
| Milk yield | -27.01 | ± 4.82 | (1.4) | -11.72 | (0.6) | -15.29 | ± 5.48 | (0.8) |
| Milk yield (305) | -28.28 | ± 5.39 | (1.6) | -11.91 | (0.7) | -16.37 | ± 6.05 | (0.9) |
| Fat yield | -1.57 | ± 0.21 | (2.4) | -0.22 | (0.3) | -1.35 | ± 0.24 | (2.1) |
| Fat yield (305) | -1.68 | ± 0.22 | (2.8) | -0.32 | (0.5) | -1.36 | ± 0.25 | (2.2) |
| Fat % | -0.0024 | ± 0.007 | (0.06) | 0.0032 | (0.09) | -0.0056 | ± 0.008 | (0.1) |
| Fat % (305) | -0.0040 | ± 0.007 | (0.11) | 0.0027 | (0.07) | -0.0067 | ± 0.008 | (0.2) |
| Protein yield | -1.41 | ± 0.15 | (2.6) | -0.21 | (0.4) | -1.20 | ± 0.17 | (2.2) |
| Protein yield (305) | -1.38 | ± 0.14 | (2.7) | -0.23 | (0.4) | -1.15 | ± 0.17 | (2.2) |
| Protein % | 0.0230 | ± 0.004 | (0.8) | -0.0017 | (0.06) | 0.0247 | ± 0.005 | (0.8) |
| Protein % (305) | 0.0217 | ± 0.004 | (0.7) | -0.0019 | (0.06) | 0.0236 | ± 0.005 | (0.8) |

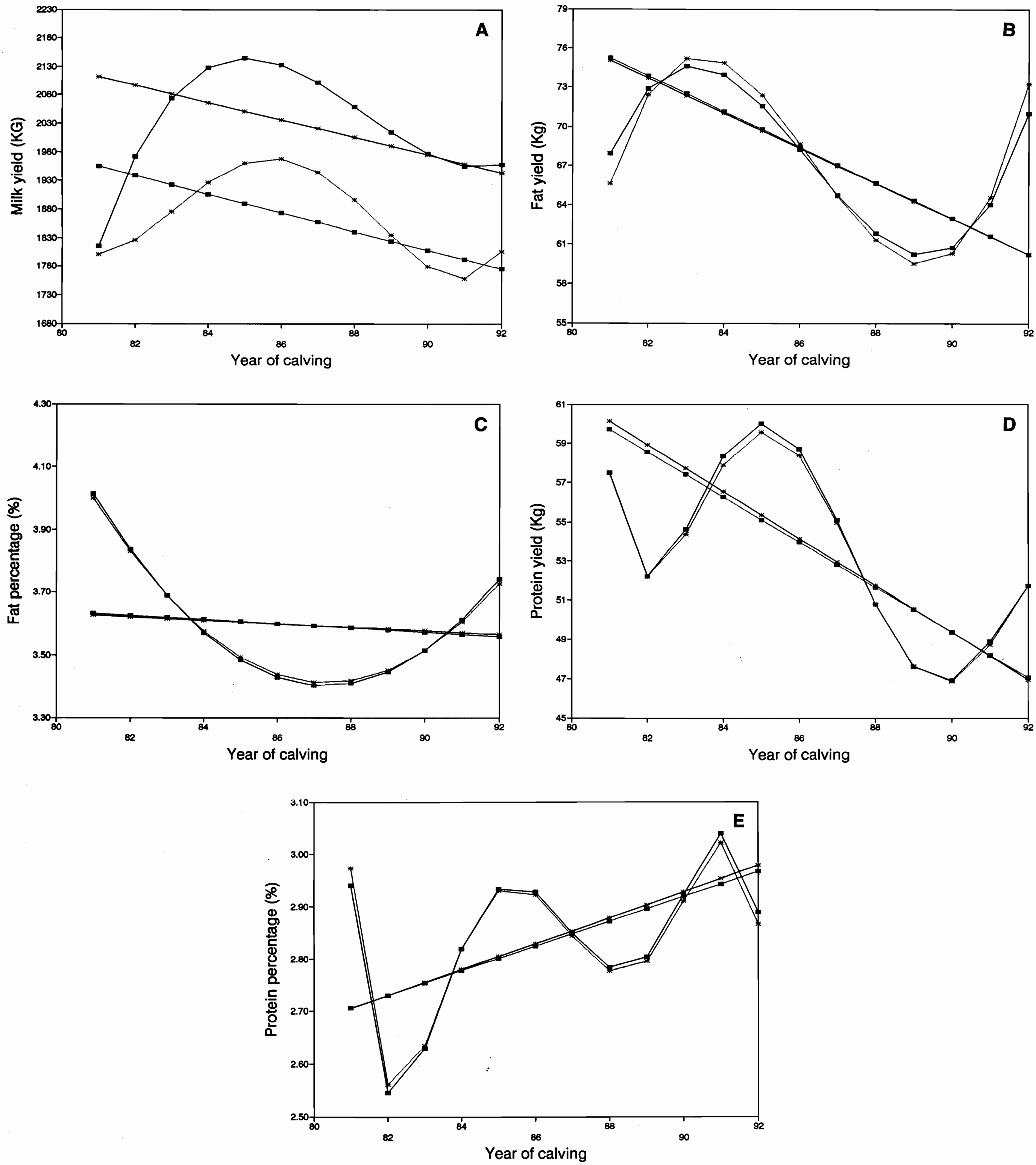
[1]Estimates represent annual changes.




**Legend**

| | |
|---|---|
| ———— Total yield and percentage | ———— Linear total yield and percentage |
| - - - - - - 305 day milk yield and percentage | - - - - - - Linear 305 days milk yield and percentage |

**Figure 1** - Linear and curvilinear annual phenotypic trends in A: total and 305 day milk yield; B: fat yield; C: fat percentage; D: protein yield; E: protein percentage.




**Legend**

| | |
|---|---|
| Total yield and percentage | Linear total yield and percentage |
| 305 day milk yield and percentage | Linear 305 days milk yield and percentage |

**Figure 2** - Linear and curvilinear annual environmental trends in A: total and 305 day milking yield; B: fat yield; C: fat percentage; D: protein yield; E: protein percentage.

**Table V** - Average selection intensity (i) of dams of sires selected for progeny test.

| Birth year of sire | Number of sires | i | Calving year of first daughters | Birth year of sire | Number of sires | i |
|---|---|---|---|---|---|---|
| < 75 | 5 | 0.49 | 81 | 68-75 | 6 | 0.47 |
| 75 | 7 | 0.50 | 82 | 75-75 | 3 | 0.48 |
| 76 | 2 | 1.86 | 83 | 68-77 | 8 | 1.59 |
| 77 | 9 | 1.83 | 84 | 75-78 | 7 | 1.67 |
| 78 | 12 | 1.63 | 85 | 78-80 | 10 | 1.46 |
| 79 | 18 | 1.65 | 86 | 78-80 | 5 | 1.94 |
| 80 | 27 | 1.58 | 87 | 79-81 | 10 | 1.84 |
| 81 | 31 | 1.73 | 88 | 80-81 | 2 | 1.91 |
| 82 | 19 | 1.56 | 89 | 80-82 | 11 | 1.91 |
| 83 | 18 | 1.42 | 90 | 81-83 | 7 | 1.70 |
| 84 | 11 | 2.81 | 91 | 79-85 | 11 | 1.72 |
| 85 | 14 | 2.02 | | | | |
| 86 | 10 | 2.70 | | | | |
| 87 | 5 | 5.56 | | | | |
| General | 189 | 1.81 | | | 80 | 1.51 |

pally concentrates, which hampered adequate management in these herds. In other countries, many authors found negative environmental trends including Moya *et al.* (1985) and Murdia and Thipathi (1991), but most found positive trends (Strandberg and Danell, 1988; Burnside *et al.*, 1992; Meinert and Pearson, 1992; and others).

## Genetic trends

Yearly genetic trends also were negative, except for fat percentage. Values were -11.72 kg; -11.91 kg; -0.22 kg, -0.32 g; 0.0032%, 0.0027%; -0.21 kg, -0.23 kg; -0.0017% and -0.0019%. For yields, these estimates were 0.3% to 0.6% of the population average and 0.06% to 0.09% for percentages.

Declining genetic trends may be due to low intensity of selection in the first sire groups chosen. In Table V it may be observed that only sires born from 1984 to 1987 resulted from selection intensities of > 2.0. Selection intensities of bull dams represented only 33% of selection in the herds (Robertson and Rendel, 1950). Daughters of sires born after 1984 began production about 1991. Thus, estimates represent only the early phases of the program.

Several researchers who utilized information from herds in tropical environments found negative or low positive genetic trends (Lobo *et al.*, 1982; Moya *et al.*, 1985; Polastre *et al.*, 1990; Murdia and Tripathi, 1991; Ledic, 1992). In specialized European breeds in temperate climates, genetic trends were positive and relatively large (Strandberg and Danell, 1988; Meinert and Pearson, 1992; Burnside *et al.*, 1992 and others).

# CONCLUSIONS

A final evaluation of the efficacy of this program can only be obtained in future years. Such results would include performance of daughters born more recently. Their sires were selected more intensively. It is important for future genetic improvement of this crossbred population that sires having the highest estimated breeding values be used.

# RESUMO

Foram analisados, para estimar as tendências genéticas, fenotípicas e ambientais, dados do desempenho produtivo de gado leiteiro mestiço em 20 fazendas no Sudeste do Brasil. Os dados foram originados dos rebanhos participantes do teste de progênie de touros leiteiros mestiços do Centro Nacional de Pesquisa de Gado de Leite (EMBRAPA) no período de 1977 a 1992. Foram 2343 registros de 1402 vacas e 80 touros; as vacas eram cruzamentos de raças Européias x Zebuínas (2/8 até 7/8). As raças Européias eram Holstein (maior contribuinte) e Jersey e Brown Swiss (menores contribuintes). Estudou-se as produções de leite, gordura e proteína, e porcentagens de gordura e proteína, cada um baseado na lactação total e no desempenho em 305 dias. As médias para o

desempenho total e aos 305 dias foram: produção de leite, 2027 e 1865 kg; produção de gordura, 67,7 e 62,7 kg; produção de proteína, 53,5 e 53,4 kg; porcentagem de gordura, 3,59 e 3,59%; e porcentagem de proteína, 2,84 e 2,84%. As tendências anuais foram curvelíneas. Expressas como mudanças lineares por ano, as tendências nas produções foram negativas e nas porcentagens foram variáveis, algumas negativas outras positivas. As tendências anuais lineares negativas para as produções foram na média 2,3% (fenotípica), 0,5% (genética) e 1,7% (ambiental).

# REFERENCES

**Burnside, E.B., Jansen, G.B., Givati, G.** and Dadoti, E. (1992). Observed and theoretical genetic trends in a large dairy population under intensive selection. *J. Dairy Sci. 75*: 2242-2253.

**Harvey, W.R.** (1990). User's guide for LSMLMW PC-1 version. Ohio State University Press, Columbus, pp. 59.

**Ledic, I.L.** (1992). Investigação sobre produção de leite e peso ao parto em gado Gir. *Rev. Soc. Bras. Zoot. 21*: 815-826.

**Lobo, R.B., Duarte, F.A.M., Bezerra, L.A.F.** and **Wilcox, C.J.** (1982). Genetic trends in milk production following formation of a tropical dairy breed (Pitangueiras). *Rev. Brasil. Genet. 2*: 353-361.

**Meinert, T.R.** and **Pearson, R.E.** (1992). Estimates of genetic trend in an artificial insemination progeny test program and their association with herd characteristics. *J. Dairy Sci. 75*: 2254-2264.

**Moya, J., Wilcox, C.J., Bachman, K.C.** and **Martin, F.G.** (1985). Genetic trends in milk yield and composition in a subtropical dairy herd. *Rev. Brasil. Genet. 3*: 509-521.

**Murdia, C.K.** and **Tripathi, V.N.** (1991). Estimation of trends in various first lactation traits of different Jersey bull mother farms in India. *Indian J. Dairy Sci. 44*: 594-597.

**Polastre, R., Pons, S.B.** and **Baccari Jr., F.** (1990). Avaliação do programa de seleção e tendências ambientais de algumas características de produção e reprodução em um rebanho mestiço Holandes-Zebu. *Rev. Soc. Bras. zoot. 19*: 31-38.

**Robertson, A.** and **Rendel, J.M.** (1950). The use of progeny testing with artificial insemination in dairy cattle. *J. Genet. 50*: 21-31.

**Strandberg, E.** and **Danell, B.** (1988). Genetic trends in milk production and days open in the first three lactations of Swedish dairy cattle. *Act. Agric. Scand. 38*: 89-100.

**Valente, J., Lemos, E.M., Freitas, A.F., Rehfeld, O.A.M., Martinez, M.L.** and **Madalena, F.E**. (1982). Desenvolvimento de Mestiço Leiteiro Brasileiro. 1 - Vacas-elites e touros em test. *Pesq. Agropec. Bras. 17*: 143-148.

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