Abstract W184

Genetic and phenotypic trends for milk yield in Holstein populations in Mexico

H. O. Toledo[1], F. J. Ruiz[2], C. G. Vazquez[1], J. M. Berruecos[1], M. A. Elzo*[3]

[1]Universidad Nacional Autónoma de México, Ciudad de México, DF, Mexico

[2]INIFAP, Querétaro, Querétaro, Mexico

[3]University of Florida, Gainesville, FL, USA

SUMMARY

The objectives were to evaluate genetic and phenotypic trends from 2007 to 2011 for milk yield in three Holstein populations representing 14% of the milk production in Mexico. Data consisted of first lactation milk yields adjusted to 305 d, adult equivalent and 2 milkings/d. Records were from the Holstein Association of Mexico (HAM; n = 43,668), the National Bank of Dairy Information (NBDI; n = 120,217), and the National Breeding Program of Mexico (NBPM; n = 163,885) which included records from HAM and NBDI. Best Linear Unbiased Predictions of breeding values (BV) were computed with ASREML using a mixed animal model. Fixed effects were herd-year-season. Random effects were animal and residual. Weighted and unweighted yearly means of sire BV were computed for HAM, NBDI, and NBPM. Weights were numbers of daughters per sire per year. Weighted yearly means of sire BV in NBPM were also computed by country of origin (USA, Canada, Mexico, Other). Lastly, yearly means of cow BV and phenotypic values (PV) were obtained for HAM, NBDI, and NBPM. The mean BV and PV of cows for milk yield in the HAM, NBDI, and NBPM populations increased between 2007 (BV = 108.4 ± 5.7 kg; PV = 217.3 ± 25.4 kg) and 2011 (BV = 242.9 ± 3.3 kg; PV = 486.3 ± 14.0 kg). Differences between yearly means indicated that cow BV from HAM tended to be higher than cow BV from NBDI (from 32.2 kg in 2009 to 47.2 kg in 2010). ***Holstein sires from the US tended to have substantially higher yearly mean BV for milk yield (from 722.4 kg in 2008 to 991.3 kg in 2010) than Holstein sires from Mexico. Breeders from HAM tended to choose sires with higher BV for milk yield (401.9 ± 15.1 kg) than those from NBDI (396.5 ± 11.0 kg). However, differences in weighted yearly means (from 221.9 kg in 2008 to 101.8 kg in 2010) suggested that NBDI breeders used sires with higher BV for milk yield more frequently than HAM breeders. Greater utilization of sires with increasingly higher BV for milk yield allowed dairy breeders in Mexico to consistently increase cow genetic and phenotypic means from 2007 to 2011.***

INTRODUCTION

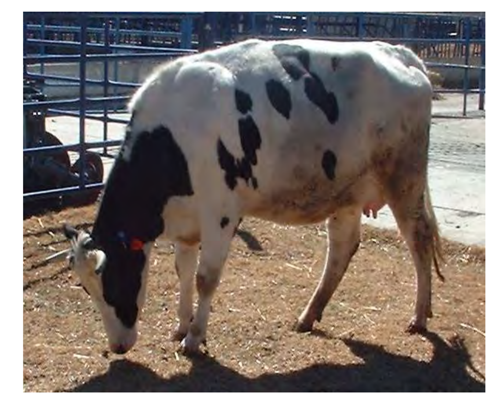
Genetic evaluations and research of Holstein cattle in Mexico are few and have only included animals registered in the Holstein Association of Mexico (HAM). Thus, genetic progress in Holstein herds outside the association is unknown. However, these herds are major contributors the national dairy population. In fact, the National Bank of Dairy Information (NBDI) which is part of the National Breeding Program of Mexico (NBPM), currently includes both HAM and NBDI. It is important to evaluate changes in breeding values of the parents of Holstein cows and their use in the population over time. The NBPM dairy database presents an excellent opportunity to evaluate genetic and phenotypic trends of cows and bulls for the past 5 years. Thus, the objectives of this study were: a) to analyze genetic and phenotypic trends for milk production in the first lactation of cows from the NBPM (i.e., NBDI and HAM); b) to evaluate the genetic trends of weighted and unweighted bull EBV means for NBPM, NBDI and HAM; c) to assess the genetic trends of bull EBV means weighted by the number of daughters in NBDI according to their country of origin.

MATERIALS AND METHODS

Animals and Data. The NBPM dataset included records from HAM and NBDI. The NBPM contained a total of 163,885 records of cows that were daughters of 1,694 sires. The HAM dataset included 43,668 cows that were sired by 767 bulls, while the BNIL dataset had 120,217 cows progeny of 1,528 sires. All datasets contained 305-d milk yield (MY) records first lactation cows obtained from 2007 to 2011. Records from cows under 18 months of age at first calving, MY records with less than 1,500 kg (lactation considered abnormal), and records from animals with less than 90 days in milk were eliminated to ensure at least three weightings. Edited datasets and pedigree files were created using a program in C# and the Statistical Analysis System (SAS).

Climate, nutrition and management. The data came from 22 states of Mexico: Aguascalientes, Baja California Norte, Coahuila, Chiapas, Chihuahua, Durango, Guerrero, Guanajuato, Hidalgo, Edo. Mexico, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sinaloa, Tlaxcala, Veracruz and Zacatecas. There were five different climate types in these states. Two states were dry desert, six were dry steppe, four were warm and humid, two were semi-humid warm and eight were temperate semi-humid. The dry desert climate had temperatures between 0 °C to 40 °C and rainfall lower than 400 mm per year in the summer. The dry steppe climate had temperatures between 8 and 28°C and rainfall below 750 mm in summer. The warm humid and semi-humid climates had temperatures between 18°C to 21°C and rainfall from 750 to 1500 mm (in the semi-humid occurs only in summer). The temperate semi-humid climate had temperatures from 12°C to 18°C and rainfall of 600-1500 mm in summer. A contemporary group effect was defined by combining the factors herd-year-season of calving. Seasons of calving were: Season 1 from December to May, and Season 2 from June to November. Feeding and management varied across herds and regions. Feeding was based on forage cut and carry, use of silo, hay and concentrates with mineral supplementation, and in addition, local products and industrial byproducts. The main forages were corn (*Zea mays*), oats (*Avena sativa*), alfalfa (*Medicago sativa*), forage sorghum (*Sorghum vulgare*), ryegrass (*Lolium spp.*), White clover (*Trifolium repens*), Kikuyu grass (*Pennisetum clandestinum*) and pastures from the region.

Estimation of breeding values. Predicted breeding values of animals were obtained using best linear unbiased predictor procedures. Computations were performed with ASREML. The model included the contemporary group (herd-year-season of calving) as fixed effect, and animal and residual as random effects. In matrix form, the mixed model was $y = Xb + Zu + e$, where: y = vector containing the PL1std records of cows, b = vector of herd-year-season, u = random vector of additive genetic effects, e = random vector of residual effects, X = incidence matrix relating records to elements in b, Z = incidence matrix relating records to elements in u, $G = A\sigma_a^2$, where A is the matrix of additive relationships and σ_a^2 = additive variance, and $R = I\sigma_e^2$, where I is an identity matrix and σ_e^2 = residual variance.



Estimation of mean breeding values. Yearly means of cow breeding values (BV) were computed within each population (NBPM, HAM, or NBDI) from 2007 to 2011. Similarly, yearly weighted and unweighted sire BV means were calculated within each population. Yearly weighted sire BV means in each population were calculated using the expression: $\bar{X}_i = \frac{\sum_{j=1}^{n} BV_j N_{ij}}{\sum_{i=1}^{n} N_{ij}}$, where $\bar{X}_i$ is the weighted sire BV mean for the *i-th* year, BV_j is the BV of the *j-th* sire and N_{ij} is the number of daughters of the *j-th* sire in the *i-th* year. Means for dams of cows were not computed (weighted or unweighted) due to the low percentage of dams of cows identified in NBDI (1%). Lastly, sire weighted BV means for NBPM were also estimated by country of origin of sire and classified into four categories: Canada, USA, Mexico, and Others (Germany, Australia, Austria, Spain, France, Britain, Holland, Italy, New Zealand, Czech Republic and Sweden).

Estimation of mean phenotypic values. The phenotypic value (PV) of cows was estimated as: $\hat{p}_i = \hat{u}_i + \hat{e}_i$, where $\hat{p}_i$ is the phenotypic value for the record of the first milking of the *i-th* cow, $\hat{u}_i$ is the additive genetic value of the *i-th* cow, and $\hat{e}_i$ is the value of the residual of the first milking for the *i-th* cow. Residuals were estimated as: $\hat{e}_i = y_i - \widehat{gc}_i$, where $\hat{e}_i$ is the value of the residual of the first lactation of the *i-th* cow, y_i is the standardized production to 305 days and adult equivalent of the first milking of the *i-th* cow, and $\widehat{gc}_i$ is the estimate of the *i-th* contemporary group. These residual values were used to estimate yearly means of phenotypic values.

RESULTS AND DISCUSSION

Descriptive statistics of PV and BV of cows, and the BV of sires for milk yield during the first lactation for the entire population (NBPM) and for the two subpopulations (HAM and NBDI) are shown in Table 1.

Table 1. Descriptive statistics of Breeding Values (BV) and Phenotypic Values (PV) for the National Breeding Program of Mexico (NBPM), the Holstein Association of Mexico (HAM), and the National Bank of Dairy Information (NBDI).[1]

Weighted Sire BV	N	Mean	SD	Min	Max	SE
HAM	21,532	553.0	705.2	-3,546	2,640	4.81
NBDI	57,732	750.8	596.2	-1,722	2,949	2.48
NBPM	79,264	697.1	633.8	-3,546	2,949	2.25
Unweighted Sire BV						
HAM	2,006	401.9	678.2	-3546	2,640	15.1
NBDI	2,991	396.5	601.4	-1,722	2,949	11.0
NBPM	4,997	398.7	633.3	-3,546	2,949	8.96
Cow BV						
HAM	43,668	187.2	613.6	-2,846	2,695	2.94
NBDI	120,217	189.3	543.1	-2,344	3,357	1.57
NBPM	163,885	188.8	562.8	-2,846	3,357	1.39
Cow PV						
HAM	43,668	374.8	2671.9	-10,922	12,025	12.7
NBDI	120,217	378.7	2403.7	-10,572	14,219	6.93
NBPM	163,885	377.6	2478.0	-10,922	14,219	6.12

[1]N = Number of observations ; SD = Standard Deviation; Min = Minimum; Max = Maximum; SE = Standard Error.

Genetic trends. ***Yearly mean BV for milk yield at first calving for cows in NBPM, HAM and NBDI are presented in Figure 1.*** Yearly BV means for NBDI showed a similar pattern to those of HAM and NBPM. They increased between 2008 and 2011 implying that farmers gradually increased the genetic quality of the parents used in their herds over the years. The HAM showed greater mean BV than NBDI, except in 2011 when they had similar mean BV values. Mean BV for NBPM were similar to those for NBDI largely due to the greater proportion of cows from this subpopulation than from HAM in NBPM. ***Yearly weighted and unweighted sire and cow BV means for milk yield are shown in Figure 2 for HAM, Figure 3 for NBDI, Figure 4 for NBPM. Figure 5 shows yearly unweighted means and Figure 6 presents yearly weighted means for the 3 populations. Lastly, Figure 7 contains weighted sire BV means per country (Canada, Mexico, USA, and Other Countries).***

Phenotypic trends. ***Yearly PV means of dairy cows during their first lactation in NBPM, HAM, and NBDI behaved similarly to their BV means in Figure 1, except that cow PV means were twice as large as their BV means.***

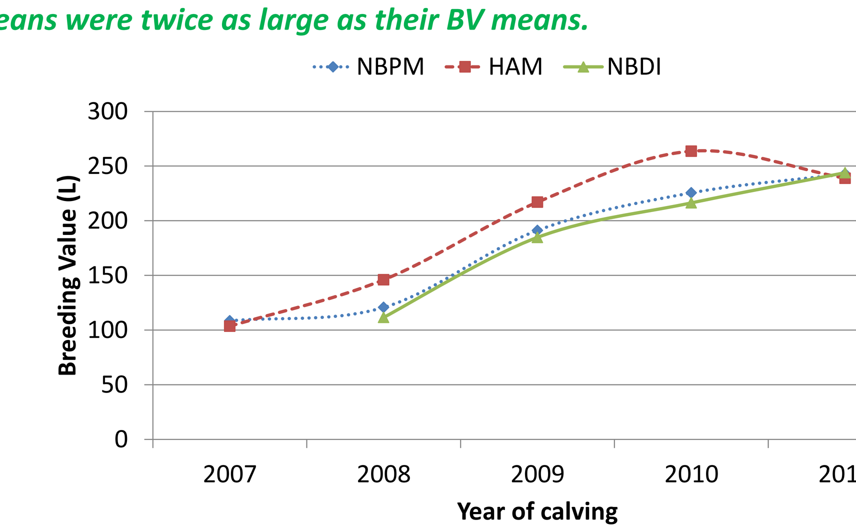


Figure 1. Genetic trends for milk production at 305 days of cows per year of calving, for the National Breeding Program of Mexico (NBPM); Holstein Association of Mexico (HAM) and the National Bank of Dairy Information (NBDI).

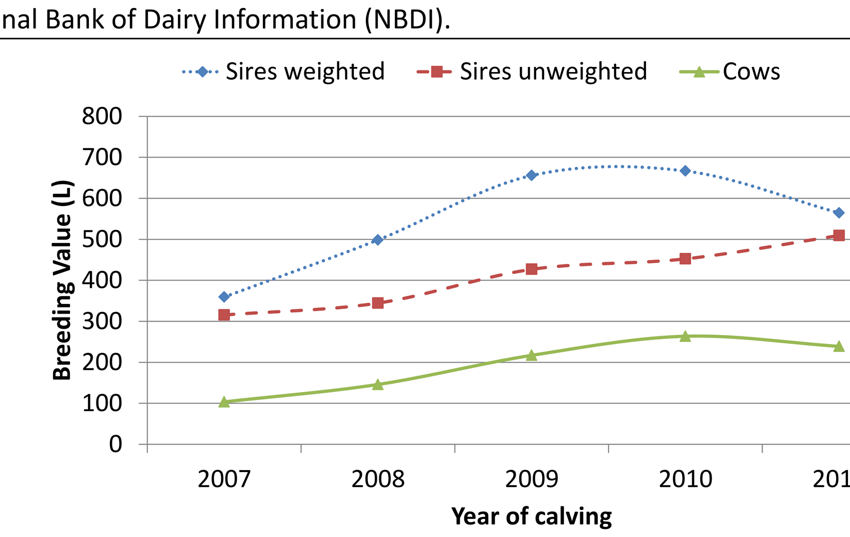


Figure 2. Genetic trends for milk production at 305 days per year of calving, for cows and sires (weighted and unweighted means) of the Holstein Association of Mexico (HAM).

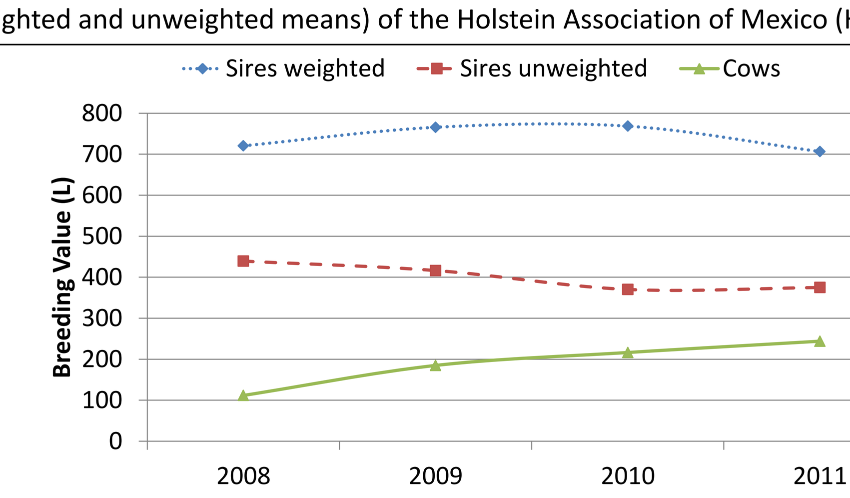


Figure 3. Genetic trends for milk production at 305 days per year of calving, for cows and sires (weighted and unweighted means) of the National Bank of Dairy Information (NBDI).

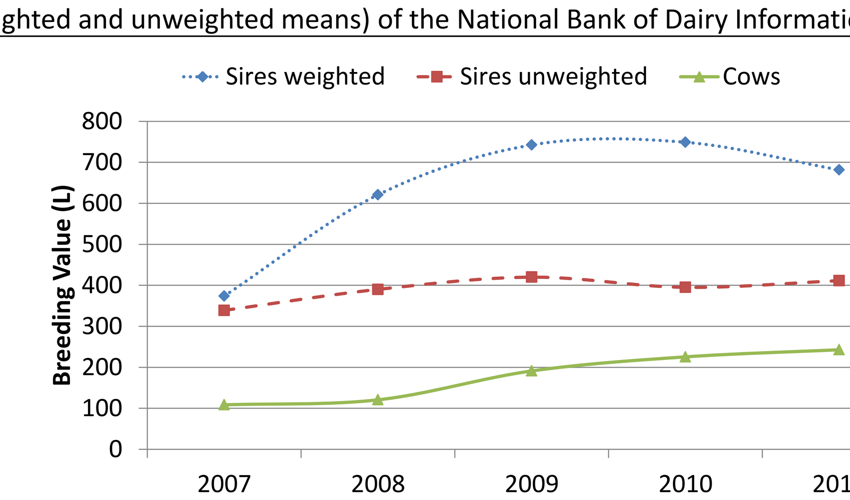


Figure 4. Genetic trends of milk production at 305 days per year of calving, for cows and sires (weighted and unweighted means) of the National Breeding Program of Mexico (NBPM).

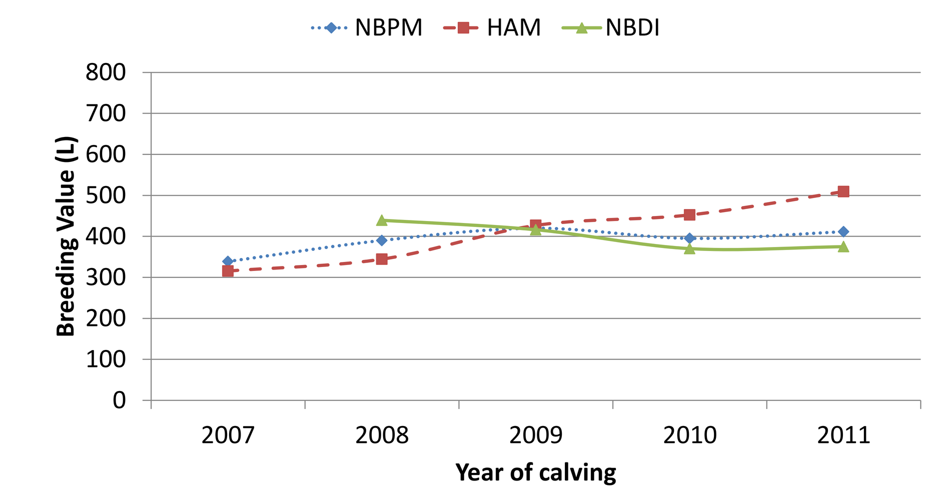


Figure 5. Genetic trends for milk production at 305 days of sires per year of calving (unweighted means), for the National Breeding Program of Mexico (NBPM); Holstein Association of Mexico (HAM) and the National Bank of Dairy Information (NBDI).

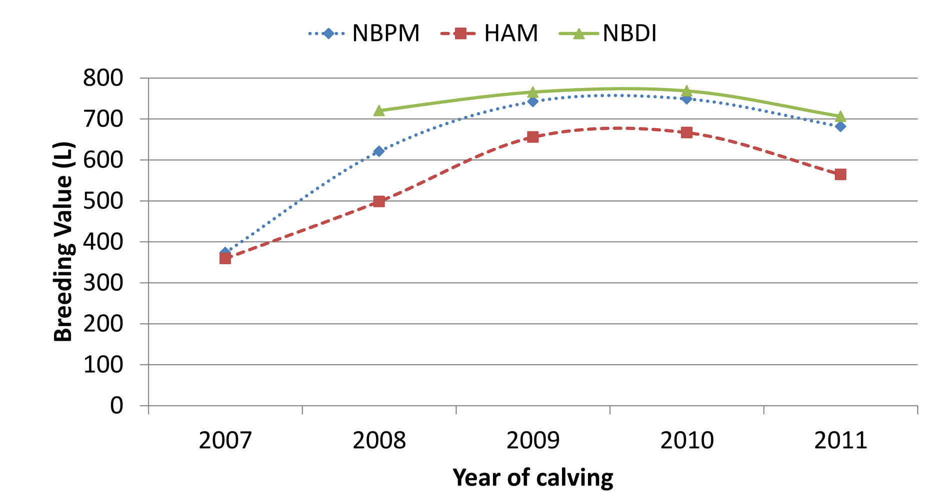


Figure 6. Genetic trends for milk production at 305 days of sires per year of calving (weighted means), for the National Breeding Program of Mexico (NBPM); Holstein Association of Mexico (HAM) and the National Bank of Dairy Information (NBDI).

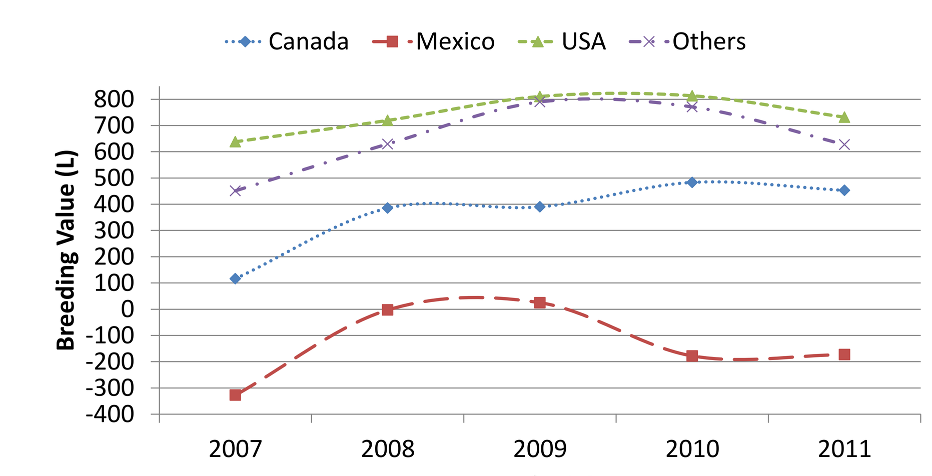


Figure 7. Genetic trends for milk production at 305 days per year of calving for sires (weighted means), of the National Breeding Program of Mexico (NBPM) originating in Canada, Mexico, U.S.A., and Others (Germany, Australia, Austria, Spain, France, Britain, Holland, Italy, New Zealand, Czech Republic and Sweden).

FINAL REMARKS

Farmers consistently used sires with increasingly higher breeding values during the years of the study. The frequent use of sires with higher breeding values allowed the increase of genetic and phenotypic values of dairy cows in Mexico. It is important for NBDI farmers to be included in national genetic evaluations programs. These programs are essential to continue to increase milk production and meet the growing demands for dairy products in Mexico. Foreign sires had BV greater than Mexican sires and were more frequently used by farmers during the years of the study. If farmers continue to import significant amounts of semen from the USA and other countries, genetic trends for milk production in Mexico will continue to influenced by both immigration of genetic material and internal selection of sires and cows.

REFERENCES

Rosales, A. J., and M. A. Tewolde. 1993. Estimación del progreso genético en hatos de bovinos en Holstein mexicanos. Vet. Mex. 3: 185-188.

Toledo, A. H., L. F. Ruiz, P. C. Vásquez, V. J. Berruecos, and M.A. Elzo. 2013. Estimación de parámetros genéticos para producción de leche en poblaciones de ganado Holstein en México bajo dos modalidades de control de producción. Tec Pec Mex. (In press)

Valencia, P. M., L. F. Ruiz, V. H. Montaldo, J. F. Keown, L. D. Van Vleck. 1999. Evaluación genética para la producción de leche en ganado Holstein en México. Téc Pec Méx. 37:1-8.

Powell, R. L., and G. R. Wiggans. 1991. Animal model evaluations for Mexican Holsteins. J. Dairy Sci. 74:1420-1427.

McDowell, R. E., G. R. Wiggans., J. K. Camoens, L. D. Van Vleck, and D. G. Luis. 1976. Sire comparisons for Holsteins in Mexico versus the United States and Canada. J. Dairy Sci. 59:298-304.