Factors Associated with Dairy Cattle Genetic Improvement for Milk Production at Farm Level in Central Thailand

M. Sarakul[1], S. Koonawootrittriron[1], M.A. Elzo[2], and T. Suwanasopee[1]
[1]Department of Animal Science, Kasetsart University, Bangkok 10900, Thailand
[2]Department of Animal Sciences, University of Florida, Gainesville, FL 32611-0910, USA

ABSTRACT

Genetic improvement of dairy cattle is an important factor for milk production and sustainability of dairy farmers. Factors that affect genetic improvement also have influence on the efficiency and profitability of dairy operations. The objective of this study was to characterize factors associated with genetic improvement of dairy cattle for milk production at farm level. Accumulated 305-day milk yield and pedigree information from 1,921 first-lactation dairy cows were used. Cows calved from 1990 through 2007 in 161 farms in Central Thailand were used. Variance components were estimated using an average information restricted maximum likelihood procedure. Animal breeding values were predicted using an animal model that contained herd-year-season, calving age, and regression additive genetic group as fixed effects, and cow and residual as random effects. Estimated breeding values from cows that calved in a particular month within a year were used to estimate genetic trends for each individual farm. Within-farm genetic trends (b, regression coefficient of mean cow estimated breeding values per farm and calving month within year on year-month of calving) were used to classify farms into 3 groups: 1) farms with negative genetic trend ($b < -0.5$ kg/mo), 2) farms with no genetic trend (-0.5 kg/mo $\leq b \leq 0.5$ kg/mo), and 3) farm with positive genetic trend ($b > 0.5$ kg/mo). Questionnaires were used to gather information from individual farmers on educational background, herd characteristics, farm management, decision making practices, and opinion on dairy farming. Farmer's answers were then used to study factors affecting genetic improvement for milk production at farm level. Fisher's exact test was used to test the association between factors and farm groups. Estimated breeding values ranged from -849.22 to 2,448.63 kg for cows, -637.78 to 1,307.40 kg for sires, and -601.34 to 2,448.63 kg for dams. Estimated genetic trends for the complete population were 0.29 ± 1.02 kg/yr for cows, -1.47 ± 1.89 kg/yr for sires, and 1.44 ± 0.91 kg/yr for dams. At farm level, most farms (40%) had positive genetic trend (0.63 ± 4.67 to 230.79 ± 166.63 kg/mo) followed by farms with negative genetic trend (35%; -173.68 ± 39.63 to -0.62 ± 2.57 kg/mo) and those with no genetic trend (25%; - 0.52 ± 3.52 to 0.55 ± 2.68 kg/mo). However, none of the factors studied here was significantly associated to farm groups, except for educational background ($P < 0.05$).

Key Words: Genetic, Trend, Milk Production, Farmers, Tropical

INTRODUCTION

Genetic improvement of dairy cattle for economically important traits, particularly milk production, is an important component of an overall strategy to improve profitability and sustainability of dairy cattle operations. Identification and evaluation of factors that affect genetic evaluation, selection, and mating strategies in a population are essential to evaluate genetic improvement programs and determine areas in need of improvement. Genetic trends for milk production in Thai dairy populations have been small (less than 4 kg per year) in recent years (Koonawootrittriron et al., 2004; Department of Livestock Development, 2009).

However, these population estimates of genetic trends provide no information on genetic trends occurring in individual farms. Factors that affect genetic improvement may vary across farms, thus genetic trends may also vary among farms within a population. Within-farm genetic trends could be higher, similar, or lower than the genetic trend in the population. Differences among farmers (e.g., education background, experience, record keeping) were important for farm milk production (Rhone et al., 2008; Sarakul et al., 2009; Yeamkong et al., 2010), and they likely also affect dairy genetic improvement at farm and population levels. Central Thailand is the most important dairy production area. In 2009, this area produced 1,370,990 kg of milk (65% of the country) from 139,175 milking cows (68% of the country) in 12,240 dairy farms (69% of the country; Department of livestock Development, 2009). Thus, the objective of this study was to characterize factors associated with genetic improvement of dairy cattle for milk production at farm level in Central Thailand.

MATERIAL AND METHODS

Animals and management. The dataset contained accumulated 305-day milk yield and pedigree information from 1,921 first-lactation dairy cows. These cows calved from 1990 through 2007 in 161 farms located in Central Thailand. Seasons were winter (November to February), summer (March to June) and rainy season (July to October). Breeds represented in the population were classified as Holstein (H) and other breeds (O). Calving age was defined as the number of months from birth to first calving. Farmers kept cows in open barns. Some farmers used fans to reduce heat stress. Dairy cows were machine milked twice a day (morning and evening). Milk was transported to a cooperative or private milk collection center after each milking. Feed and feeding varied among farms and seasons. Farmers fed cows concentrate and fresh grass from their own land or from public areas (small holders). Rice straw, urea-treated rice straw, crop residues, and agricultural byproducts were used as supplement as needed. Cows had free access to a mineral supplement throughout the year. Farmers bred their cows by artificial insemination all year round.

Genetic prediction and genetic trends. An average information restricted maximum likelihood procedure was used to estimate variance components. An animal model that contained herd-year-season, calving age, and H fraction as fixed effects, and cow and residual as random effects was used to predict animal breeding values. Genetic trends for each individual farm were estimated using the regression of mean cow estimated breeding values for milk production per farm and calving month within year on year-month of calving. Within-farm regression coefficients (b) were used to classify farms into 3 groups: 1) farms with negative genetic trend (NEG; $b < -0.5$ kg/mo), 2) farms with no genetic trend (NOG; -0.5 kg/mo $\leq b \leq 0.5$ kg/mo), and 3) farms with positive genetic trend (POS; $b > 0.5$ kg/mo).

Questionnaires and association tests. Questionnaires were used to gather information from individual farmers on educational background, herd characteristics, farm management, decision making practices, and opinion on dairy farming. Educational background was classified as primary school, high school, and bachelor degrees. Experience was defined as number of years of dairy farming until 2009. Number of milking cows was used to classify farms into small (less than 10 milking cows), medium (10 to 19 milking cows) and large (more than 19 milking cows). Farms workers were classified as family members, hired persons, and both family members and hired persons. Data recording was defined as records or no records. Farmer decision making on sire selection was classified as without help and with help. Advisory personnel for sire selection were classified as government officers, other farmers, and academic persons. Preferred dairy sires were classified as Holstein, crossbred

Holstein, and other breeds. Farmer's answers were then used to study factors affecting genetic improvement for milk production at farm level. Differences among factors were tested using a t-test. Fisher's exact test was used to test the association between factors and farm groups.

RESULTS AND DISCUSSION

The genetic variance for 305-d milk yield was 212,003 ± 50,840 kg^2, the phenotypic variance was 628,043 ± 25,050 kg^2, and the heritability was 0.34 ± 0.08. Estimated breeding values ranged from -849.22 to 2,448.63 kg for cows, -637.78 to 1,307.40 kg for sires, and -601.34 to 2,448.63 kg for dams. Estimated genetic trends for the complete population were 0.29 ± 1.02 kg/yr for cows (Figure 1), -1.47 ± 1.89 kg/yr for sires, and 1.44 ± 0.91 kg/yr for dams. Cow phenotypic values for milk yield from 1990 to 2007 ranged from 3,528.27 to 4,423.80 kg, and the phenotypic trend for milk yield during this period was 14.57± 10.63 kg/yr (Figure 1).

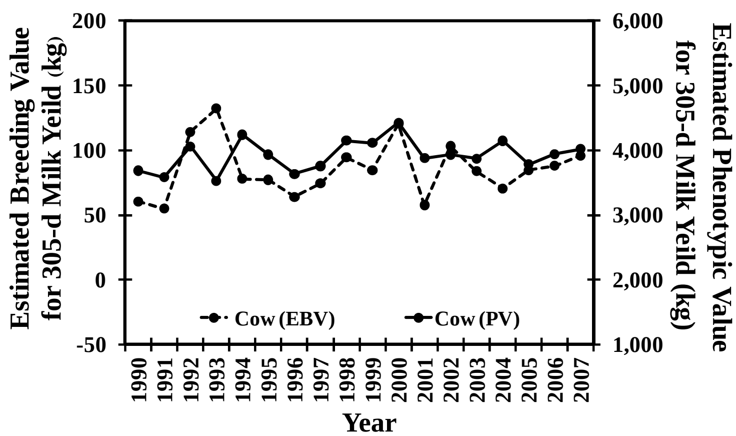

Figure 1 Genetic and phenotypic trends for 305-d milk yields of cows from 1990 to 2007

Considering genetic improvement at farm level, most farms had positive genetic trends (POS; 40%; 0.63 ± 4.67 kg/mo to 230.79 ± 166.63 kg/mo), followed by farms with negative genetic trends (NEG; 35%; -173.68 ± 39.63 kg/mo to -0.62 ± 2.57 kg/mo) and those with no genetic trend (NOG; 25%; - 0.52 ± 3.52 kg/mo to 0.55 ± 2.68 kg/mo).

Educational background was significantly associated to farm group ($P < 0.05$). The proportion of farmers with primary school, high school and bachelor degree education by farm group was 71%, 7%, and 22% for NEG, 13%, 37%, and 50% for NOG, and 67%, 22%, and 11% for POS. Most farmers in NEG (71%) and POS (67%) had primary school education, in contrast to farmers in NOG where the majority (50%) had a bachelor's degree. It should be pointed out that all bachelor degrees in all farm groups (NEG, NOG and POS) were in areas unrelated to agriculture or dairy production (e.g., mechanics, accounting, management, education). Although there was an overall association between educational background and farm group, it is unclear how educational background was associated with dairy genetic trends at farm level. Perhaps the ability of farmers to identify and purchase semen of appropriate sires changed little between 1990 and 2007.

Farms in NOG had the highest level of experience (22.00 ± 2.71 years), number of milking cows (54.00 ± 13.66 cows), and number of workers (4.87 ± 0.84 workers), followed by farms in NEG and in POS (Table1). No farm in this study was small (less than 10 milking cows). The proportion of medium (31% in NEG, 33% in NOG, and 25% in POS) and large size farms (69% in NEG, 67% in NOG, and 75% POS) in all farm groups was similar. Most farms used family members (57% of NEG, 88% of NOG, and 76% of POS) as farm workers. The proportion of farmers that kept dairy records was 71% for NEG, 37% for NOG and 78% for POS.

Table 1 Least squares means and standard errors of experience, number of milking cows and number of workers by farm groups

Traits \ Farm groups	Negative genetic trends	No genetic trends	Positive genetic trends	P-Value
Experience (years)	21.64 ± 2.06	22.00 ± 2.71	17.00 ± 2.56	0.3063
Number of milking cows	31.00 ± 9.28	54.00 ± 13.66	27.81 ± 11.82	0.3069
Number of workers	3.28 ± 0.64	4.87 ± 0.84	3.13 ± 0.84	0.2634

Farmers that made decisions on sire selection by themselves were 64% for NEG, 62% for NOG, and 25% for POS. When farmers sought help on sire selection, they usually consulted with government officials (36% of NEG, 29% of NOG, and 67% of POS) rather than other farmers or academic persons. The preferred dairy sires were crossbred Holstein (64% of NEG, 50% of NOG, and 56% of POS). However, none of these factors was significantly associated to farm groups. Thus, only the educational background of farmers was important to dairy genetic improvement for milk production in the studied Thai multibreed dairy population. This research needs to be repeated with a larger dairy dataset in order to gain a more thorough understanding of the factors associated with genetic improvement of dairy cattle at farm level in Thailand.

REFERENCES

Department of Livestock Development. 2009. Number of dairy cattle. Information Technology Center, Department of Livestock Development. Ministry of Agriculture and Cooperatives of Thailand, Bangkok.

Koonawootrittriron, S., M.A. Elzo, P. Sopanarat, S. Tumwasorn, T. Thongprapi, C. Chaimongkol and K. Nithichai. 2004. A case study on phenotypic and genetic trends for first lactation productions of a multibreed dairy population in Thailand. Pages 41-46. *In* Proc. The 42nd Kasetsart University Conference, February 3 – 6, 2004, Bangkok.

Rhone, J.A., S. Koonawootrittriron, and M.A. Elzo. 2008. Record keeping, genetic selection, educational experience and farm management effects on average milk yield per cow, milk fat percentage, bacterial score and bulk tank somatic cell count of dairy farms in the Central region of Thailand. Trop. Anim. Health Prod. 40:627-636.

Sarakul, M., S. Koonawootrittriron, T. Suwanasopee, A. Hirunwong and T. Thongprapi. 2009. Situation of production and attitude for sire selection of dairy farmers in Thailand (2008). Pages 174 - 181. *In* Proc. 47th Kasetsart University Conference, March 17 - 21, 2009, Bangkok, Thailand.

Yeamkong, S., S. Koonawootrittriron, M. A. Elzo, and T. Suwanasopee. 2010. Effect of experience, education, record keeping, labor and decision making on monthly milk yield and revenue of dairy farms supported by a private organization in Central Thailand. Asian-Aust. J. Anim. Sci. 23:814-824.