Kasetsart J. (Nat. Sci.) 30 : 211 - 219 (1996)

Trend Analysis on Milk Production Traits in the Dairy Farming Promotion Organization of Thailand

Sanao Katkasame[1], Sornthep Tumwasorn[1], Bandhit Thanindratarn[1], and Somkiert Pasanpanich[2]

ABSTRACT

A total of 976 first lactation records from Dairy Farming Promotion Organization of Thailand during the years 1972 to 1991 were used to evaluate phenotypic trend and genetic trend based on sire contributions. All records were analyzed to obtain the solutions from solving the fixed and mixed model equations. Year of sire birth was considered to provide genetic grouping based on sire contributions. By regressing year of calf solutions on time, estimates of phenotypic changes were obtained. Genetic trend based on sire contribution were obtained by regressing year of sire birth solution on time. The phenotypic trends per year on milk yield, milk fat and fat percentage were found to be 35.98 kg, 1.2589 kg and -0.0104%, respectively. Genetic trend based on sire contributions for three traits were 45.05 kg, 0.448 kg and -0.0544% per year, respectively.

Key words: trend analysis, dairy cattle, milk yield.

INTRODUCTION

The increase on efficiency of production could be achieved either by improving the mean environment of the population or by improving the mean breeding value of the population, or by a combination of both. The change in production per unit of time due to change in mean environment was known as the environmental trend, and the change in mean breeding value was called the genetic trend. If the genetic trend was positive throughout the period of the study, it meant that selection had been successful. Improvement of a trait over time may also be caused by the improvement in feeding and management. In such a case, these inputs must be continuously increased to maintain a positive environmental trend.

The genetic, phenotypic and environmental trends in dairy cattle had been reported by many authors (Henderson *et al.*, 1959 ; Smith, 1962 ; Van Vleck and Henderson, 1961 ; Harville and Henderson, 1967 ; Powell and Freeman, 1974 ; Hintz *et al.*, 1978 and Meinert *et al.*, 1992). The purpose of this paper was to examine phenotypic trend and genetic trend by sire contribution and genetic trend by dam contribution of milk production traits conducted at the Dairy Farming Promotion Organization of Thailand.

[1] Beef and Dairy Cattle Breeding Research and Development in the Tropics Project, Department of Animal Science, Kasetsart University, Bangkok 10900, Thailand.

[2] Dairy Farming Promotion Organization of Thailand, Muag Lek, Saraburi 18180, Thailand.

MATERIALS AND METHODS

Data structure

A total of 976 first lactation record from 4 major dairy breeds collected from the Dairy Farming Promotion Organization of Thailand (DPO) were used for the study. All data obtained during the year 1972 to 1991. The milk yield for 305 days mature equivalent, fat yield and fat percent were the three traits considered in this study. Prior to analysis, data were adjusted for the joint effects of age and month of calving. All records were expressed on a 305 days Mature Equivalent (ME) basis, and incomplete lactation were extended to 305 days to avoid a possible bias from selection. Least square Means and standard deviations for all first lactation records by years of calf birth are presented in Table 1. Milk yields were found to range from 2,162.45 kg in 1981 to 3,270 kg in 1986. The herd mean for milk yield, milk fat and fat percentage averaged 2,554.14 kg, 115.62 kg and 4.54% respectively.

Table 1 Least squares mean (kg) and standard deviations for all first lactation records by years of calf birth.

Year of calf birth	No of record	ME milk yield		Milk fat		Fat percentage	
		Mean	SE	Mean	SE	Mean	SE
1972	19	2430.23	183.64	108.63	8.69	4.47	0.11
1973	40	2341.80	132.77	106.55	6.28	4.55	0.08
1974	64	2396.06	112.50	103.03	5.32	4.30	0.07
1975	70	2219.67	101.65	100.77	4.81	4.54	0.06
1976	43	2360.62	123.31	106.46	5.84	4.51	0.07
1977	139	2446.97	78.15	118.19	3.70	4.83	0.05
1978	136	2344.31	77.87	116.04	3.69	4.95	0.05
1979	51	2501.18	113.91	113.55	5.39	4.54	0.07
1980	22	2606.77	167.02	122.26	7.91	4.69	0.10
1981	39	2162.45	128.69	104.01	6.09	4.81	0.08
1982	61	2352.17	107.44	105.38	5.09	4.48	0.06
1983	54	2308.33	109.76	107.34	5.20	4.65	0.07
1984	36	2529.34	132.30	115.59	6.26	4.57	0.08
1985	51	2719.32	111.02	127.54	5.25	4.69	0.07
1986	47	3270.53	114.85	145.87	5.44	4.46	0.07
1987	49	3052.89	116.66	134.33	5.52	4.40	0.07
1988	24	422.51	161.36	109.01	7.64	4.50	0.10
1989	10	2845.50	240.20	121.79	11.37	4.28	0.14
1990	7	2861.47	290.73	125.33	13.76	4.38	0.18
1991	14	2910.59	204.62	120.79	9.68	4.15	0.12
Average		2554.14	140.42	115.62	6.65	4.54	0.09

Model and statistial analysis

Three mathematical models were used to evaluate trends in milk yields, fat percent and milk fat. The first model was utilized to estimate phenotypic trends where the second one was used to estimate the genetic trends based on sire contribution. All models used in this study make the assumption that no relationship existed among sires or dams or between sires and dams. Initially, the full models containing both fixed and random effects was analyzed to determine the importance of interaction effects. Since the analysis showed no interaction effects, then, models without interactions were used for further analysis. Details of the final models can be explained based on the following equations,

$Y_{ipn} = \mu_i + Fp + e_{ipn}$ 1

$Y_{ijklm} = \mu_i + SY_{ij} + S(SY)_{ijk} + Fl + e_{ijklm}$ 2

where,

Y_{ipn} = observation on the n^{th} experimental unit on the i^{th} trait,

Y_{ijklm} = observation on the $ijklm^{th}$ experimental unit on the i^{th} trait, (i=1, 2, 3) for milk yield, percent fat and milk fat, respectively,

μ_i = overall mean (fixed) of traits i,

Fp = set of fixed effects due to year of calf birth, age at first calving, season of calving, age of dam and breeding group,

F_l = set of fixed effects due to age at first calving, season of calving, age of dam and breeding group,

SY_{ij} = effect of the j^{th} year of sire birth (fixed) on the i^{th} traits,

$S(SY)_{ijk}$ = effect of the k^{th} sire born within the j^{th} year on the i^{th} traits. S_k is assumed NID $(0,\sigma^2_s)$,

e_{ipn} = the random error, assumed NID $(0,\sigma^2_{e1})$, and

e_{ijklm} = the random error, assumed NID $(0,\sigma^2_{e2})$.

Calving season was divided into four seasons as follow: November to January, February to April, May to July and August to October, respectively and breeding classes were divided by percent gene from Bos *Taurus* (Red Dane and Holstein Friesian) as shown in Table 2.

The corrected procedure is to fit sire and dam in the same model together with their relationships in order to best obtain genetic trend. However, if this procedure is not used, the use of genetic groups can be utilized as an alternative procedure to evaluate genetic trend. In this study, genetic groups were used in the evaluation of genetic trends. Year of sire birth and year of dam birth were defined as the genetic group of sire and dam.

Table 2 Breeding group for dairy cow.

Group	% gene of *Bos taurus*	Group	% gene of *Bos taurus*
1	100.0%	7	62.5%
2	>87.5 and <100%	8	>50.0 and <62.5%
3	87.5%	9	50.0%
4	>75.0 and <87.5%	10	>37.5 and <50.0%
5	75.0%	11	37.5%
6	>62.5 and <75.0%	12	<37.5%

Vinther (1974)

Estimation of phenotypic trend

To estimate phenotypic trend, the best linear unbiased estimated (BLUE) of year of calf birth solution were obtained from the output of PROC GLM from model 1. By regressing the year of calf birth solutions on year using PROC REG with the WEIGHT statement as outlined by SAS, the phenotypic change per year and its standard error were obtained. The weight factor assigned for the weight statement was the number of observations corresponding to the year of calf birth solutions.

Estimation of the environmental plus one-half the genetic trend

Sire often have numbers of daughters freshening for the first time in different years. However, the expectation of a sireís genetic contribution to his daughters was the same for all years. The other half of his daughterís genotype is contributed by the changing group for females to which he is mated in his first, second, and subsequent year for service. Hence, comparison of first lactation in continuous years should indicate the environmental trend plus one-half of genetic trend (Burnside and Legates, 1967)

Genetic trend under the sire model was estimated by regressing the year of sire birth solutions (obtained from the output of the analysis using PROC GLM according to model 2) on year. In this analysis involving a set of fixed effects and random nested effects. Interactions of random and fixed effects are assumed to be zero. The PROC REG from the statistical analysis system was employed to obtain these estimator.

RESULTS AND DISCUSSION

Phenotypic Trends

Phenotypic trends for the three traits obtained from a weighted regression method as shown in Table 3 were found to be 37.22 kg, 1.32 kg and -0.0104% per year, respectively. Year of calf birth solutions were obtained from solving equation in model 1 as shown in Table 4. The constants varied considerably from year to year for all three traits. A ranges of -369.94 to 748.14 kg was found for milk yield whereas ranges of -19.68 to 24.07 kg and 0.00 to 0.80% were observed for milk fat and fat percentage, respectively.

Profiles of phenotypic trend were presented in figures 1 through 3 by plotting year of calf birth solutions against year. The phenotypic trend for milk yield were found to be lower than the result reported by Burnside and Legates (1967) and Verde et al. (1972). The phenotypic trend for milk yield decreased more consistently during the year 1972 to 1981 and increased rapidly after the year 1981 as shown in Figure 1. However, the overall trends were found to be positive thought out the period of this study. As the phenotypic trend of the milk fat was found to be the same profile as that of the milk field (Figure 2). The only increasing periods of the percent fat profile were found during the years

Table 3 Phenotypic changes per years for milk yield, milk fat and fat percentage.

Trait	Phenotypic change per year		p value
	mean	SE	
Milk yield (kg)	37.22	10.28	0.0020
Milk fat (kg)	1.32	0.446	0.3199
Fat percentage	-0.0104	0.01007	0.0084

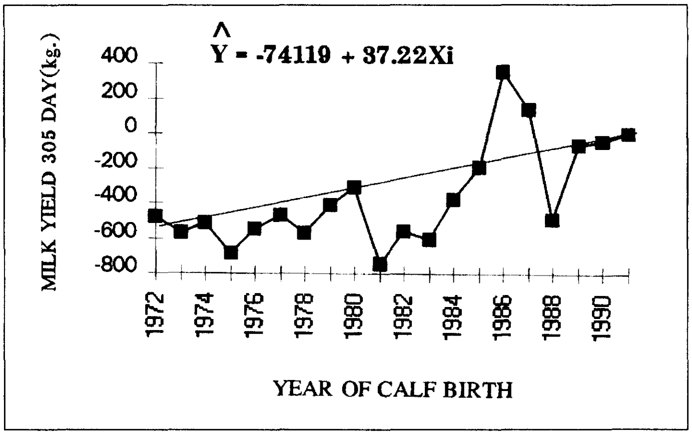

Figure 1 Phenotypic trend of milk yield based on year of calf birth solution obtained from fixed effect model 1.

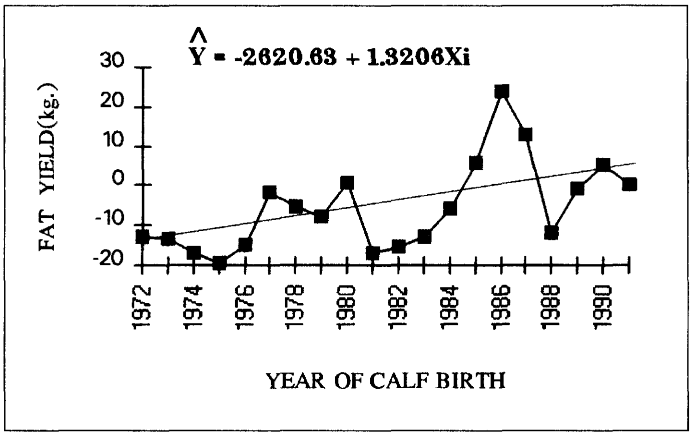

Figure 2 Phenotypic trend of fat yield based on year of calf birth solution obtained from fixed effect model 1.

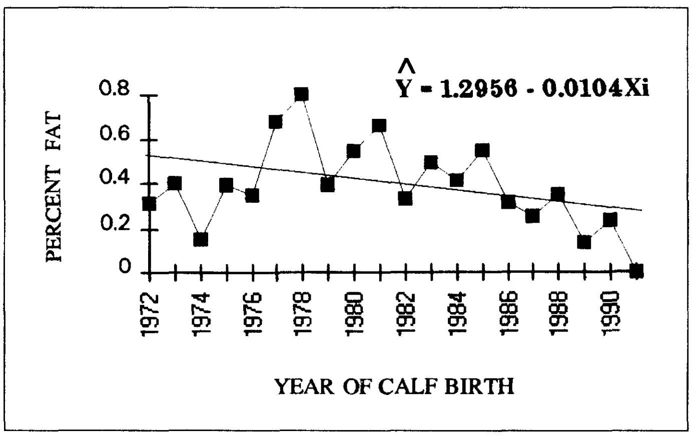

Figure 3 Phenotypic trend of fat percentage based on year of calf birth solution obtained from fixed effect model 1.

Table 4 Solutions for milk yield, milk fat and fat percentage by year of calf birth from fixed effects model 1.

Year of calf birth	No of record	ME milk yield Mean	ME milk yield SE	Milk fat Mean	Milk fat SE	Fat percentage Mean	Fat percentage SE
1972	19	-480.36	276.93	13.11	-13.18	0.31	0.17
1973	40	-568.79	245.99	11.64	-13.38	0.40	0.15
1974	64	-514.53	235.02	11.12	-16.78	0.15	0.14
1975	70	-690.92	227.70	10.78	-19.56	0.39	0.14
1976	43	-549.97	236.48	11.19	-14.73	0.35	0.14
1977	139	-463.62	218.15	10.33	-1.67	0.68	0.13
1978	136	-566.29	217.30	10.28	-5.49	0.80	0.13
1979	51	-409.41	232.41	11.00	-8.11	0.39	0.14
1980	22	-303.82	260.74	12.34	0.52	0.54	0.16
1981	39	-748.14	237.84	11.26	-17.07	0.66	0.14
1982	61	-558.42	231.37	10.95	-15.39	0.33	0.14
1983	54	-602.26	229.96	10.88	-13.02	0.49	0.14
1984	36	-381.26	240.98	11.41	-5.82	0.41	0.15

Table 5 Solutions for milk yield, milk fat and fat percentage by year of sire birth from fixed effects model 2.

Year of sire birth	No of record	ME milk yield Mean	ME milk yield SE	Milk fat Mean	Milk fat SE	Fat percentage Mean	Fat percentage SE
1966	219	-652.54	472.02	2.10	22.18	0.93	0.29
1967	5	-1214.30	471.66	-31.67	22.16	0.82	0.29
1968	70	-1229.23	380.02	-30.85	17.86	0.85	0.23
1969	37	-1801.82	397.30	-65.71	18.67	0.52	0.24
1970	66	-1511.78	349.87	-52.79	16.44	0.55	0.21
1971	101	-1470.85	372.49	-40.83	17.50	0.89	0.23
1972	92	-1500.81	472.36	-59.09	22.20	0.24	0.29
1973	119	-1451.02	346.55	-51.03	16.28	0.49	0.21
1974	156	-929.76	344.00	-32.94	16.16	0.28	0.21
1975	8	-1214.05	427.11	-41.18	20.07	0.40	0.26
1977	7	-1374.20	442.33	-48.53	20.79	0.40	0.27
1978	66	-1209.22	357.07	-40.35	16.78	0.45	0.22
1979	25	-634.39	372.81	-28.57	17.52	-0.04	0.23
1981	5	0.00	0.00	0.00	0.00	0.00	0.00

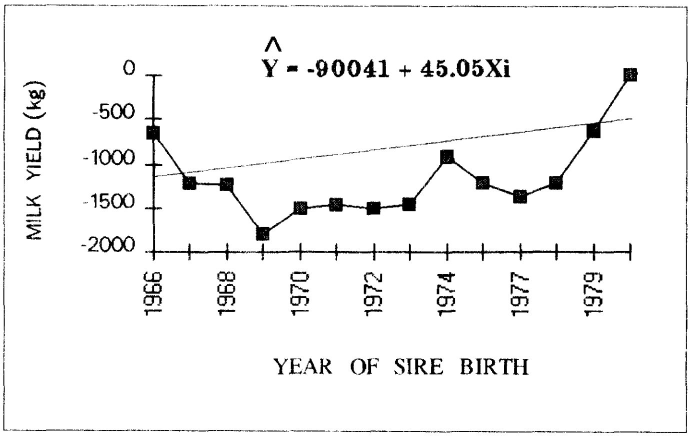

Figure 4 Genetic trend of milk yield based On year of sire birth solution obtained from model 2.

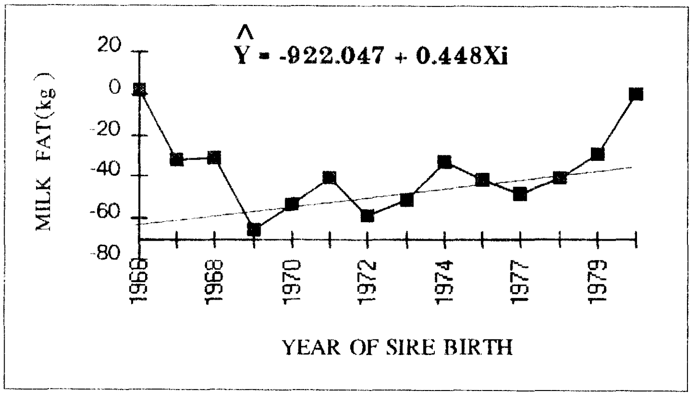

Figure 5 Genetic trend of milk fat based on year sire birth solution obtained from model 2.

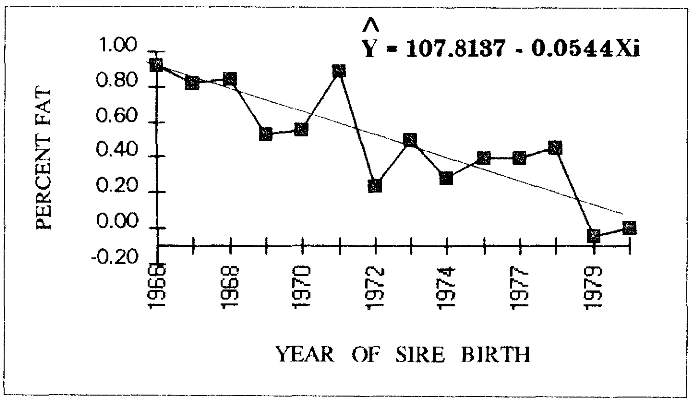

Figure 6 Genetic trend of fat based on year of sire birth solution obtained from model 2.

1972 to 1978 and decreased more consistently during the years 1979 to 1991 as shown in Figure 3. The phenotypic change for percent fat found in this study was higher than the estimate reported by Burnside and Legates (1967).

Genetic trend based on sire contribution

The solution for year of sire birth on milk yield shown in Table 5 ranged from -1802 kg in the year 1969 to zero for the year 1981. The genetic trend for milk yield, milk fat and fat percentage based on sire contribution were found to be 45.05 kg, 0.448 kg and -0.054% per year, respectively.

Genetic trends for milk yield , milk fat and fat percentage were estimated based on sire contributions. Change in these constants over years should reflect one-half of genetic trend plus environmental trend. Regressions of the year of sire birth solution on year are plotted in Figures 4, 5, and 6. Regression constants for milk yield on this study were generally positive, however, there rapidly decreased in the first three to four year.

CONCLUSION AND RECOMMENDATIONS

In this study 976 lactation records collected during the years 1972 to 1991 from the Dairy Farming Promotion Organization of Thailand were analyzed. A fixed effect model was used to estimate the phenotypic trends using the weighted regression method. Mixed model was used to estimate genetic changed based on sire contributions. Random effects were sire effects whereas fixed effects were year of calf birth, year of sire birth, age at first calving, age of dam, season of calving and length of lactation. Year of sire birth was considered to provide genetic grouping based on sire contributions. By regressing year of calf solutions on time, estimates of phenotypic changes were obtained. Genetic trend based on sire contribution were obtained by regressing year of sire birth solution on time. The phenotypic trend on milk yield, milk fat and fat percentage were found to be 37.22 kg, 1.32 kg and -0.0104%, respectively. Genetic trends on these respective three traits based on sire contribution were 45.05 kg, 0.448 kg and -0.0544%.

ACKNOWLEDGMENTS

The authors would like to thank the Kasetsart University Research and Development Institute (KURDI) in supporting fund under Project No. 1.34 for Beef and Dairy Cattle Breeding Research and Development in the Tropics Project. They also thank Department of Animal Science, Faculty of Agriculture, Kasetsart university and Dairy Farming Promotion Organization of Thailand for their encouragement throughout the project.

LITERATURE CITED

Burnside, E. B. and J. E. Legates. 1967. Estimation of genetic trends in dairy cattle populations. J. Dairy Sci. 50 : 1448-1457.

Harville, D. A. and C. R. Henderson. 1967. Environmental and genetic trends in production and their effects on sire evaluation. J. Dairy Sci. 50 : 870-875.

Henderson, C. R., O. Kempthorne, S. R. Searle, and C. M. Von Krosigk. 1959. The estimation of environmental and genetic trends from records subject to culling. Biometrics 15 : 192-218.

Hintz, R. L., R. W. Everett, and L. D. Van Vleck. 1978. Estimation of genetic trends from cow and sire evaluations. J. Dairy Sci. 61 : 607-613.

Meinert, T. R., R. E. Pearson, and R. S. Hoyt. 1992. Estimates of genetic trend in an artificial insemination progeny test program and their association with herd characteristics. J. Dairy

Sci. 75 : 2254-2264.

Powell, R. L. and A. E. Freeman. 1974. Genetic trend estimators. J. Dairy Sci. 57 : 1067-1075.

SAS institute Inc. 1985. SAS User's Guide : Statistics, Version 5 Edition. SAS Institute Inc., Cary, North Carolina. 956 p.

Smith, C. 1962. Estimation of genetic changes in farm livestock using field records. Anim. Prod. 4 : 239-251.

Van Vleck, L. D., and C. R. Henderson. 1961. Measurement of genetic trend. J. Dairy Sci. 44 : 1705-1710.

Verde, O. G., C. J. Wilcox, F. G. Martin, and C. W. Heaves. 1972. Genetic trends in production in Florida dairy herd improvement association herds. J. Dairy Sci. 55 : 1010-1012.

Vinther, K. M. 1974. Production Performance of the Thai Dairy Herd and Evaluation of the Breeding Plan at the Thai-Danish Dairy Farm. The dairy farming promotion organization of Thailand, Muag lek, Saraburi. 78 p.