Seasonal Grouping in Year-Season Animal Model Evaluation of Sahiwal Cattle

M. S. Khan[1], A. Ali, S. Ali and M. Saleem[2]
Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad, 38040 Pakistan

ABSTRACT : Season is very important as it defines the contemporaries for sire and cow evaluation. An attempt is made for defining season for animal model evaluation of Sahiwal animals, using 1,227 records from 730 cows. Cows were required to have a lactation length of 305-days. Ten different combinations of months for two, four, five or other seasons were tried. The other fixed effect in the model was age defined within parity. The random effects were permanent environment and animal's breeding value along with the residual effects. A single trait animal model was used where all known relationships of an animal were incorporated in a relationship matrix. The error variance from the fitted model decreased as the number of year-season combinations increased, indicating a month-year model to be more appropriate. This, on the other hand, decreased the number of contemporaries for certain subclasses to a minimum of one, making the bull comparisons invalid. Use of a two season scenario, with winter (November through February) and summer (March through October) was better than the other combinations in terms of error variance of the fitted model and the number of lactations represented in any year-season subclass.
(**Key Words** : Season, Animal Model, Sahiwal Cattle)

INTRODUCTION

Sire evaluation procedures involve pre-correction of records for factors like age at calving and lactation length and fitting the effect of herd, year of calving and season in the model. Because interaction between herds, years and season of calving is very important source of variation in milk yield, herd-year-season effect is usually fitted in the model (Cooper and Hargrove, 1982; Wiggans, 1991). Herds are taken as a group of animals having common feeding and management. Definition of year is also very clear; it usually starts in January and ends in December. Season however, varies in definition. Its definition determines the progeny group (contemporaries) comparisons as the number of observations in a subclass would change when herd-year-season effect is fitted in the model. Comparisons are ineffective if number of animals compared in a subclass are very small. These important variation sources (herd, year and season) collectively explain some 40% of the total variation in milk yield (Chauhan, 1986).

For genetic evaluation, management groups (herd-year-season) defined are usually flexible (Wiggans and Dickinson, 1985). The number of months encompassed in a season are increased until at least five lactations are included (Wiggans, 1991). Seasons are thus defined as months but are not fixed and are allowed to move depending on the availability of records. This option assumes that difference in the adjacent months of calving is less than those further apart. The restriction of any subclass to have a minimum number of records, on the other hand ensures a valid comparison among the bulls to be made in a given herd. Thus reliability of PTA's (Predicted Transmitting Ability) for any trait under animal model evaluation requires careful consideration for the year-season definition.

Present study was thus undertaken to compare different strategies of grouping months for defining season in a year-season model for simultaneous evaluation of cows and bulls in a herd of Sahiwal cattle.

MATERIALS AND METHODS

Lactation records of Sahiwal cows for the last 25 years at Livestock Experiment Station Bahadurnagar, Okara, Pakistan were used for the present study. Lactations ending in abortions or ending before 305 days were not used. When lactation length was more than 305 days information up to 305 days was utilized. Cows were required to have at least sire identification. Number of parities was restricted to five. Thus 1,227 lactations from

[1] Address reprint requests to M. S. Khan.
[2] Livestock Production and Research Institute, Bahadurnagar, Okara, Pakistan.
Received April 27, 1996; Accepted October 17, 1996

730 cows were used for the analysis. Age at calving within parity was grouped into 22 classes. Lactation yields were analyzed by using an animal model having year-season as fixed effect, age code as an additional fixed effect, and permanent environment and animal breeding value as random effects.

$$Y_{ijkl} = YS_i + Age_j + A_k + P_k + e_{ijkl}$$

where

Y_{ijkl} ; Lactation record
YS_i ; Year-season effect (fixed)
Age_j ; Within parity age (22 classes) effects (fixed)
A_k ; Animal's breeding value (random)
P_k ; Permanent environmental effect (random)
e_{ijkl} ; Residual (random).

Genetic parameters for variance ratios of random factors to error variance were from the same data. Heritability was 0.32 and a repeatability of 0.41. When pedigree information was missing, phantom parents were defined for the four genetic paths and different periods (years pooled). Ten season scenarios were used where months were grouped as shown in table 1. Predicted values from the above model were fitted to predict the lactation yield ($\hat{Y}$). Error variances were calculated as follows;

$$\sigma^2_E = [\sum(Y-\hat{Y})^2]/(n-p)$$

where

σ^2_E ; Error variance
Y ; Actual lactation milk yield
$\hat{Y}$; Predicted lactation yield
n ; Number of observations and
p ; Number of parameters estimated.

To estimate the solutions for different months of calving, a model similar to the above was used. The fixed effect other than the age classes were however, separate effects for the year of calving and month of calving. The JAA computer program (Misztal, 1993) was modified and used for the analysis.

Table 1. Grouping of months into seasons

		12 Seas	2 Seas				3 Seas	4 Seas			5 Seas
Month	Date	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Jan.	01-15	1	Wi	Wi	Wi	Mc	Wi	Wi	Wi	Wi	Wi
	16-31	1	Wi	Wi	Wi	Mc	Wi	Wi	Wi	Wi	Wi
Feb.	01-15	2	Wi	Wi	Wi	Mc	Wi	Sp	Wi	Wi	Wi
	16-29	2	Wi	Wi	Wi	Mc	Wi	Sp	Wi	Sp	Sp
Mar.	01-15	3	Wi	Wi	Su	Mc	Su	Sp	Sp	Sp	Sp
	16-31	3	Wi	Wi	Su	Mc	Su	Sp	Sp	Sp	Sp
Apr.	01-15	4	Su	Wi	Su	Mc	Su	Sp	Sp	Sp	Sp
	16-30	4	Su	Su	Su	Mc	Su	Sp	Sp	Sp	Sp
May	01-15	5	Su	Su	Su	Mc	Su	Sp	Sp	Sp	Hd
	16-31	5	Su	Su	Su	Mc	Su	Su	Sp	Su	Hd
Jun.	01-15	6	Su	Su	Su	Lc	Su	Su	Su	Su	Hd
	16-30	6	Su	Su	Su	Lc	Su	Su	Su	Su	Hd
Jul.	01-15	7	Su	Su	Su	Lc	Ra	Su	Su	Su	Hh
	16-31	7	Su	Su	Su	Lc	Ra	Su	Su	Su	Hh
Aug.	01-15	8	Su	Su	Su	Lc	Ra	Su	Su	Su	Hh
	16-31	8	Su	Su	Su	Lc	Ra	Au	Su	Au	Hh
Sep.	01-15	9	Su	Su	Su	Lc	Ra	Au	Au	Au	Hh
	16-30	9	Su	Su	Su	Lc	Ra	Au	Au	Au	Au
Oct.	01-15	10	Wi	Su	Su	Lc	Ra	Au	Au	Au	Au
	16-31	10	Wi	Wi	Su	Lc	Ra	Au	Au	Au	Au
Nov.	01-15	11	Wi	Wi	Wi	Lc	Wi	Au	Au	Au	Au
	16-30	11	Wi	Wi	Wi	Lc	Wi	Wi	Au	Wi	Au
Dec.	01-15	12	Wi	Wi	Wi	Mc	Wi	Wi	Wi	Wi	Wi
	16-31	12	Wi	Wi	Wi	Mc	Wi	Wi	Wi	Wi	Wi

Wi = Winter; Su = Summer; Lc = Least calving; Mc = Most calving; Ra = Rainy; Hd = Hot dry; Hh = Hot humid.

RESULTS AND DISCUSSION

Solutions for different months of calving for milk yield are presented in figure 1. The effect of season on milk yield is apparent. Milk yield was worst in May, improved thereafter, reaching at its best in November and then showed a declining trend. This poor milk yield in summer months and better in cooler months has already been documented in Sahiwals (Ahmad, 1971; Husnain and Shah, 1985; Tahir et al., 1989).

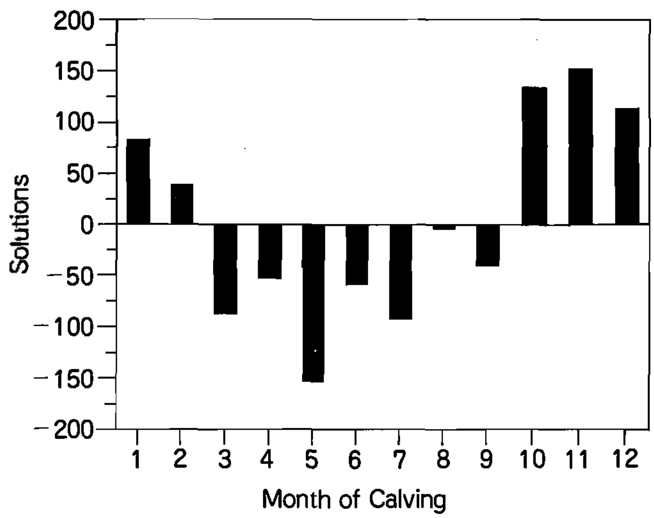

Figure 1. Milk yield solutions (kg) for month of calving.

Choice of different combinations of month (table 1) was based on the season definitions in the literature. Some modifications were also tried. A similar grouping was tried for defining season for buffalo evaluation (Khan et al., 1996). In the first season scenario (S1), months were not pooled. The S2 and S3 were two season scenarior having summer and winter of equal lengths of six months each but grouping into the winter and summer was slightly different. The S4 had also summer and winter but summer was longer in duration (8 months) as compared to winter of four months. The S5 had also two groupings of six months each but these groupings were based on the frequency of calving (table 2). It may be pointed out here that the six months in which the frequency of calving was greater were from December through May. Approximately 64% of cows calved in these six months while the other 36% calved from June through November. This of course is quite different from the calving pattern in Nili-Ravi buffaloes (Khan et al., 1996). The S6 was a three season scenario having winter, summer and rainy as the three seasons. The more commonly used four season scenarios were S7, S8, and S9. The S10 was a five season scenario having Autumn, Winter, Spring, and Summer partitioned into Hot dry and Hot humid seasons.

Table 2. Frequency (%) of calvings by month

Month	Number	%
January	144	11.7
February	152	12.4
March	146	11.9
April	144	11.7
May	100	8.1
June	99	8.1
July	61	5.0
August	78	6.4
September	61	5.0
October	47	3.8
November	92	7.5
December	103	8.4

The number of parameters in the model varied as the number of classes for year-season combination varied (table 3). Maximum combinations for the S1 where every month was considered as a separate class to affect the milk yield in combination with the year. The minimum was for the other extreme where 12 months were grouped into two seasons of six months each (S2, S3, and S4). The error variance differed among models, least being for the S1 where months were not grouped into seasons. Maximum value was obtained when grouping was as large as six months. The general trend being that it was minimum when number of parameters was minimum and vice versa. Among the two season scenarios however, S4 was a better grouping. Dividing the season on the basis of the calving season (most or least calving) was still better

Table 3. Error variance (kg^2) from different season scenarios under animal model analysis of milk yield

Season scenario	Number of seasons	Number of parameters	Error variance
S1	12	273	64,214
S2	2	71	73,680
S3	2	71	74,237
S4	2	71	71,332
S5	2	72	72,844
S6	3	92	69,545
S7	4	115	69,159
S8	4	117	66,870
S9	4	117	65,903
S10	5	138	65,819

than the S2 and S3 seasons where it was based on the temperature extremes. Among the traditionally used four season scenarios, S8 was better than the S7 and S9. For S8, winter was December-January; Spring, March-May; Summer, June-August; and Autumn, September-November. The five season scenario (S10) was better than the four season scenarios.

Now the other important condition to fulfill for season definition was to have appropriate number of lactations (contemporaries) represented in it so that comparisons among animals can be made with minimum error. This can be seen in table 4 where the statistics for number of observations in a given year-season subclass for different season scenarios are presented. It may be noted that as the number of year-season combinations increased, the average number of lactations represented in them decreased. Highest average (25.1) was for two season scenarios and lowest (4.9) for S1 where months were not grouped. If each subclass should at least be represented by five lactations (Wiggans and Dickinson, 1985) the number of classes for which the animals can not be properly compared is not large for two or even the five season scenarios. The condition on the other hand, may only be appropriate for year-season combinations within a herd when many herds are involved in the genetic evaluation.

Table 4. Number of observations represented in a year-season subclass in different season scenarios

Season scenario	Number of year-seasons	Number of observations per year-season subclass			
		Range	Average	< 5	< 10
S1	251	1-19	4.9	138	225
S2	49	2-73	25.1	1	4
S3	49	3-68	25.1	1	4
S4	49	3-59	25.1	1	2
S5	72	1-70	24.6	1	6
S6	70	3-51	17.5	4	15
S7	93	1-39	13.2	9	36
S8	95	1-41	12.9	5	34
S9	95	1-44	12.9	7	38
S10	116	2-39	10.6	15	67

Less than 10 number of lactations in any year-season subclass have the same trend. In the first case (S1), out of 251 subclasses, 225 did not have 10 lactations to estimate the effect of year-season. The five season scenario which was the second best in terms of error variance had the same problem that 67 out of 116 classes could not meet this criterion. The two season scenarios did not have as low error variance as the S1 or S10 yet the number of year-season classes having 10 or less number of lactations were not more than 5 percent. As among the two season scenarios, S4 had the lowest error variance, it would be preferred over the other choices. Thus, as the number of recorded animals are increassed and more herds are involved in progeny testing, a four or five season scenario may be chosen. Time may come when we might prefer the months instead of seasons to define the contemporaries but this involves a huge effort in terms of field recording of cows. Thus, although seasonal variation from month to month within the same year is large (Chauhan and Hill, 1986), and long seasonal grouping may not be preferable for progeny group comparisons and sire evaluation, it is smaller data size that limits the choices for valid comparisons among the animals.

REFERENCES

Ahmad, Z. 1971. Genetic analysis of a purebred herd of Sahiwal cattle. Ph.D. Thesis. West Pakistan Agriculture University, Lyallpur (Faisalabad), Pakistan.

Chauhan, V. P. S. 1986. Partitioning of herd, year and season variation in milk production. Livestock Prod. Sci. 16:107-116.

Chauhan, V. P. S. and W. G. Hill. 1986. Seasonal grouping in a herd-year-season model of sire evaluation. Anim. Prod. 43:63-71.

Cooper, J. B. and G. L. Hargrove. 1982. Age and month of calving adjustments of Holstein protein, milk and fat lactation yields. J. Dairy Sci. 65:1673-1678.

Husnain, H. U. and S. K. Shah. 1985. Sahiwal Cattle of Pakistan. Pakistan Agricultural Research Council, Islamabad.

Khan, M. S., S. A. Bhatti, A. A. Asghar, M. A. Chaudhry, and M. Q. Bilal. 1996. Definition of season in Animal Model evaluation of Nili-Ravi buffaloes. Asian-Aust. J. Anim. Sci. 10:70-74.

Misztal, I. 1993. User notes on JAA-Mixed model program using iteration on data with support for animal model.

Tahir, M., M. R. Qureshi, and W. Ahmad. 1989. Some of the environmental factors influencing milk yield in Sahiwal cows. Pak. Vet. J. 9:173-175.

Wiggans, G. R. 1991. National genetic improvement programs for dairy cattle in the United States. J. Anim. Sci. 69:3853-3860.

Wiggans, G. R. and F. N. Dickinson. 1985. Standardization of NCDHIP dairy lactation records. Fact Sheet G-2. USDA extension service, USA.