Fertility in U.S. Holsteins by states

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Abstract *- This study looked at differences in management and genetics of fertility of U.S. Holsteins in several states. Traits included days open (DO) limited at 250 d, and pregnancy rate defined as PR=1/[(DO-X) /HI+1], where HI is heat interval and X is an approximate voluntary waiting period (VWP). X was set to 50, 80 and 120 d, with PR upper bound set at 1.0. The model included the effects of herd-yea, -month of calving, age at calving and the animal effects. The use of PR emphasises records with smaller DO. Higher heritability at longer X was indication of small genetic variation for records with DO < X. Heritabilities for DO and PR were 3-6%. For WI and NY, which have colder climates, the highest heritability was for DO, with heritability for PR at X=80 slightly smaller. For FL, which experiences heat stress all year, the highest heritability was for DO, with heritability for PR at X=120 slightly smaller. For GA and AZ, where heat stress is seasonal, the highest heritability was for PR with X=50. Larger VWP in colder states could be associated with higher profitability for longer lactations. For states with seasonal heat stress, low VWP during colder seasons maximizes the chance of pregnancy before the hot season. For FL, larger VWP maximizes the chance of pregnancy under heat stress. High DO may occur for different reasons, including management and heat stress.*

Introduction

Days open (DO) is the only fertility trait used in the US for the genetic evaluations of dairy cows (VanRaden et al., 2003). This is due to the lack of nationwide recording of inseminations although the situation in this area is improving. The distribution of unedited DO has a very long tail extending past 800 d even though the average is below 150 d (Oseni et al., 2003). To minimize the effects of large DO, such records are limited or discarded. AIPL/USDA uses an upper limit of 250 d (VanRaden et al., 2003) whereas other studies thresholds between 150 and 701 d.

Management of reproduction may vary in different states of the USA. Norman et al., (2002) identified Voluntary Waiting Period (VWP) between calving and first breeding, use of bST and designed reproductive programs as some key management factors which may impact genetic evaluations for DO. Also, Oseni et al. (2003) have shown that parameters of DO such as mean and SD varied by state and season of calving. In some cases, the distribution of DO was bimodal indicating delayed breeding due to summer heat stress. If breeding is delayed due to hot weather, prolonged DO would not only be due to low fertility but also due to management, and heritability estimates of records with large DO limit will be lower. If breeding for productive cows is delayed, such management (environmental) intervention could possibly lead to lower heritability estimates.

Days open as a fertility trait puts a large emphasis on long DO records. In contrast, pregnancy rate (PR), which can be derived approximately as a function of DO, puts a large emphasis on short DO records. PR can be approximately computed from DO assuming a VWP; PR is approximately reciprocal of DO and thus large variations of DO mean small variations of PR. The purpose of this paper was to examine the effect of different upper limits and length of the VWP

on genetic parameters of DO and PR in selected states in the USA. States included are those with high level of heat stress and at least moderate presence of dairying, and some selected major states in dairy production.

Material and Methods

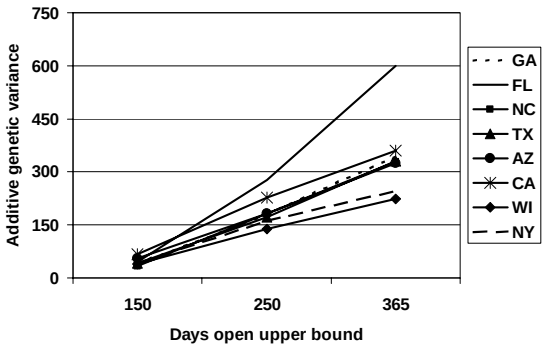
Fertility data on first parity calvings of Holstein cows for Georgia (GA), Florida (FL), North Carolina (NC), California (CA), Texas (TX), Wisconsin (WI), New York (NY) and Arizona (AZ) were extracted from the master file of the AIPL/ USDA. These datasets covered all states of the US over a period of six years (1997 – 2002). CA is the largest dairy state in the US and is located in moderate to hot climates with low humidity. WI and NY are the next largest dairy states with relatively moderate climatic conditions. GA, FL and NC are Southeastern states with hot and humid summers; FL is the hottest state. AZ is a very hot but low humidity state, and TX is less hot but more humid. Data editing included setting records greater than 21 days and less than 50 days to 50 days. Sub-sets of the data for each state were created by setting upper limits to DO at 150 d, 200 d, 250 d, 300 d and 365 d. By setting upper limits, records greater than a specific threshold were set to that threshold. CA, WI and NY had large datasets (over one million records each). For these three states, first parity records of the original datasets were randomly sampled by herd in order to reduce computing. PR was defined as follows:

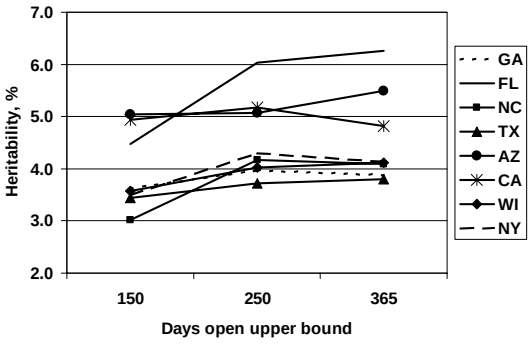
PR = 1/[(DO-VWP)/HI +1] where VWP = approximate VWP (set at 50 d) and HI = heat interval (set at 21 days). Sub-sets of the data for each state were created at different VWP of 50 d, 80 d and 120 d.

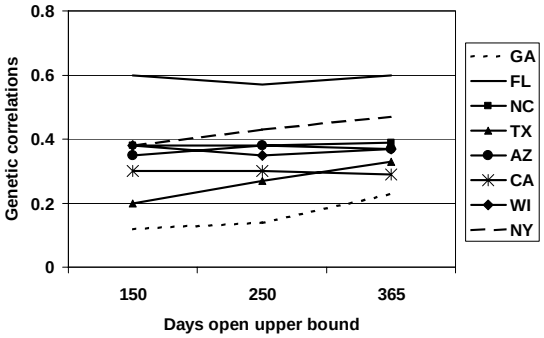
A bivariate animal model, with DO (or PR) and 305-d milk yield was fit using the effects of age class, month of calving, heard-year, and additive animal. Details on the data and the methods are available in Oseni et al. (2004b)

Results and discussions

The three figures below show estimates of genetic variance of DO, heritability of DO, and genetic correlations between DO and milk for 8 states and 3 upper limits. With the limit increased from 150 to 365 d, the genetic variance has increased almost 10 times. The largest estimate was for FL, the state under the most heat stress in the U.S., and the lowest estimate was for WI, the coldest state in this study. The genetic correlation

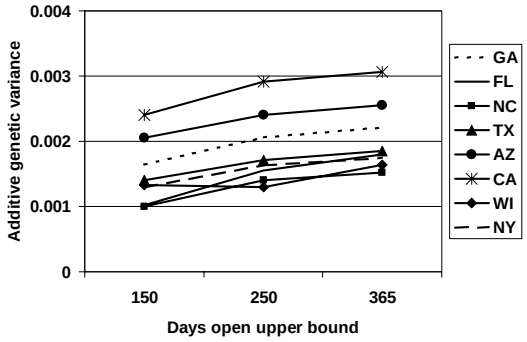


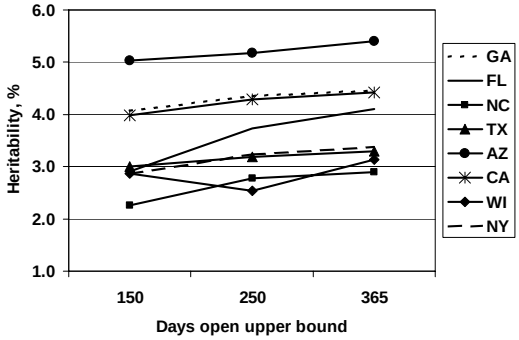


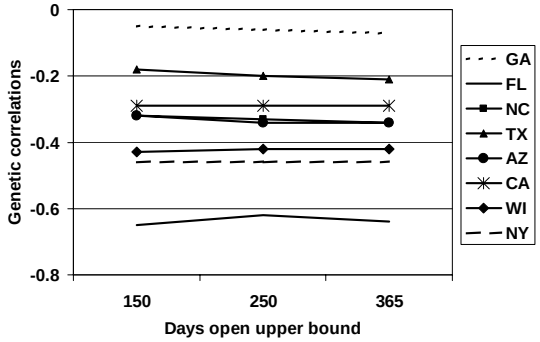


for milk was the largest for FL (around -0.6) and the smallest for GA (around -0.2), the state adjacent to FL. Heritabilities also varied by state and were the highest for FL.

The next three figures present the same results for PR with VWP set at 50

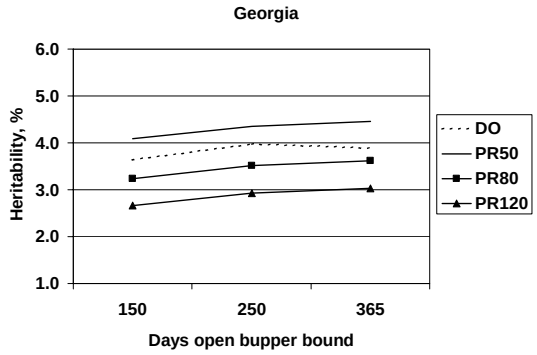


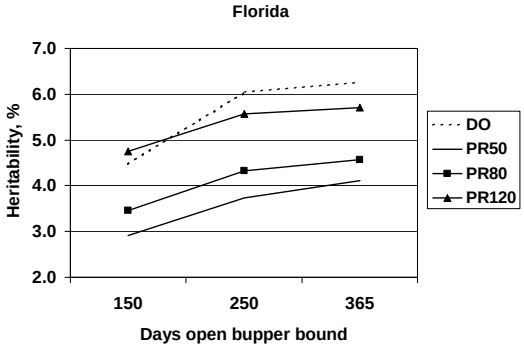


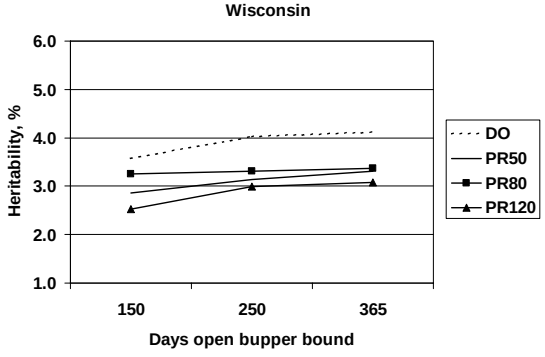


d. The genetic variance increased no more than 50% when the upper limit was raised from 150 to 250 d, and there was little change with the limit raised to 365 d. Heritabilities for PR were lower than for DO for most states other than GA and AZ. The pattern of genetic correlations by state was similar to those for DO, however, the sign changed and the magnitude of changes increased.

The last three figures show heritability of DO and PR (VWP set to 50, 80







or 120 d) for GA, FL and WI. The highest heritability for PR occurs for GA with VWP=50, for WI with VWP=80, and for FL with VWP=120. Higher heritability for PR than for DO suggest that important genetic differences for some states occurred in animals with low rather than high DO. For FL and also for CA (chart not shown), the highest heritability was at VWP=120 d. This suggests low genetic variability at DO < 120 d which perhaps, could probably be ignored. For these states, also, heritability for DO was always higher than for PR. This suggests that records with large DO, which received minimal weight under PR, contained substantial genetic information. High VWP

could be due to greater profitability at higher VWP when fertility is adequate (CA) or due to low conception rates at short VWP, particularly under constant heat stress (FL). These varied trends of PR with changing VWP agree with the report of Norman et al. (2002) that the length of the VWP was a management factor in the genetic evaluation of dairy cattle for fertility. Differences between states in the genetic parameters for PR could also be due to differences in heat detection (Washburn et al., 2002). These authors noted that in many herds, > 50% heats are undetected. Factors omitted in this study were differences between herds in reproductive management protocols (oestrous synchronization, timed AI, etc). Goodling et al., (2003) showed that heritability estimates for days to first breeding were higher for synchronized cows than for non-synchronized cows (8.0% vs 5.3% respectively).

Differences in management among states may result in G X E interaction for DO. Oseni et al. (2004a) analyzed DO by season. The heritability of DO for cows calving in Spring (and breeding in the summer time) was about two times higher than for cows calving in the remaining seasons.

Conclusions

Genetic parameters of DO varied by the upper limit and by state. The upper limit of 250 d seems reasonable. Estimates of variance components and heritability were more stable for PR across all limits when compared to DO, however heritabilities of PR were mostly lower than of DO. Heritability estimates for PR depended strongly on the assumed length of the VWP. Genetic correlations between DO (or PR) and 305-d milk yield were moderately to strongly antagonistic. Large differences in estimates from adjacent, hot states of GA and FL indictates that large managemental differences exist even in similar environments. Days open and PR can be analyzed more accurately when information on management of fertility such as the actual length of the VWP, service period, estrous synchronization, and bST are available.

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