Genetic Aspects of Fertility and Longevity in Dairy Cattle

Anki Roxström

Abstract

The aim of this thesis was to explore conditions for selection and genetic improvement of fertility and longevity in dairy cattle. The background is that single-trait selection for milk production is known to lead to impaired fertility and consequently to shorter lifespan. This in turn results in financial losses and ethical concerns. Since many years, the Swedish dairy farmers have recorded milk production, fertility and health status, which have made studies based on field data possible. The statistical analyses in this thesis confirmed the unfavourable genetic relationship between milk production and fertility. The magnitude of the antagonistic genetic correlations increased with increasing lactation number, which might be a reflection of increased milk production. The results show that fertility during the heifer period should be considered as a separate trait from fertility of the lactating cow. A combination of several fertility traits, spanning the whole reproductive complex, is to be recommended for selection purposes. In the future, it would be desirable to move towards traits more closely reflecting the physiology, for example hormone levels, as management heavily influences many of the traits used today. If direct information on fertility and diseases is not available, measures of longevity can be used indirectly to improve these traits genetically. Defining longevity on the basis of the reason for culling increased the heritability of the trait. The risk of being culled because of impaired fertility, mastitis, or low production differed between and within lactations. In early lactation, there was a high risk of being culled for mastitis, while fertility problems resulted in culling toward the end of lactation. The risk of being culled for mastitis or low production was very low in first lactation. It was found to be more effective to select on cause-specific than on overall longevity, although direct selection based on fertility and mastitis was always superior. In this thesis, longevity analysed on a lactation basis rather than on the entire length of productive life was introduced. The approach resulted in a better fit of the model and may help clear the way for multiple-trait analysis of longevity and traits analysed with linear models, e.g. fertility.

Keywords: breeding, selection, correlations, reproduction, culling, productive life, survival analysis, dairy cow

Abstract

Roxström, A. 2001. *Genetic aspects of fertility and longevity in dairy cattle.* Doctor's dissertation.
ISSN 1401-6249, ISBN 91-576-5812-9

The aim of this thesis was to explore conditions for selection and genetic improvement of fertility and longevity in dairy cattle. The background is that single-trait selection for milk production is known to lead to impaired fertility and consequently to shorter lifespan. This in turn results in financial losses and ethical concerns. Since many years, the Swedish dairy farmers have recorded milk production, fertility and health status, which have made studies based on field data possible. The statistical analyses in this thesis confirmed the unfavourable genetic relationship between milk production and fertility. The magnitude of the antagonistic genetic correlations increased with increasing lactation number, which might be a reflection of increased milk production. The results show that fertility during the heifer period should be considered as a separate trait from fertility of the lactating cow. A combination of several fertility traits, spanning the whole reproductive complex, is to be recommended for selection purposes. In the future, it would be desirable to move towards traits more closely reflecting the physiology, for example hormone levels, as management heavily influences many of the traits used today. If direct information on fertility and diseases is not available, measures of longevity can be used indirectly to improve these traits genetically. Defining longevity on the basis of the reason for culling increased the heritability of the trait. The risk of being culled because of impaired fertility, mastitis, or low production differed between and within lactations. In early lactation, there was a high risk of being culled for mastitis, while fertility problems resulted in culling toward the end of lactation. The risk of being culled for mastitis or low production was very low in first lactation. It was found to be more effective to select on cause-specific than on overall longevity, although direct selection based on fertility and mastitis was always superior. In this thesis, longevity analysed on a lactation basis rather than on the entire length of productive life was introduced. The approach resulted in a better fit of the model and may help clear the way for multiple-trait analysis of longevity and traits analysed with linear models, e.g. fertility.

Keywords: breeding, selection, correlations, reproduction, culling, productive life, survival analysis, dairy cow

Author's address: Anki Roxström, Department of Animal Breeding and Genetics, SLU, SE-750 07 Uppsala, Sweden.

Appendix

Publications I-V

The present thesis is based on the following five publications, which will be referred to by their roman numerals.

I.   Roxström, A., Strandberg, E., Berglund, B., Emanuelson, U. & Philipsson, J. 2001. Genetic and environmental correlations among female fertility traits and milk production in different parities of Swedish Red and White dairy cattle. *Acta Agric. Scand. 51*, 7-14.

II. Roxström, A., Strandberg, E., Berglund, B., Emanuelson, U. & Philipsson, J. 2001. Genetic and environmental correlations among female fertility traits, and between the ability to show oestrus and milk production in Swedish Red and White dairy cattle. *Acta Agric. Scand.* Accepted for publication.

III. Strandberg, E. & Roxström, A. 2000. Genetic parameters of functional and fertility determined length of productive life in Swedish dairy cattle. *Anim. Sci. 70*, 383-389.

IV. Roxström, A. & Strandberg, E. 2001. Genetic analysis of functional, fertility-, mastitis-, and production-determined length of productive life in Swedish dairy cattle. Submitted for publication.

V.   Roxström, A., Ducrocq, V. & Strandberg, E. 2001. Survival analysis of longevity in dairy cattle on a lactation basis. In manuscript.

Publications I, II and III are reproduced in this thesis by kind permission of the journals concerned.

Abbreviations

Milk production

ECM_{23}	Average energy-corrected milk production (kg) from second- and third- month test-days
PY_{305}	Protein yield (kg) during first lactation, 305 days

Fertility

CFI	Interval between calving and first insemination (days)
CLI	Interval between calving and last insemination (days)
FLI	Interval between first and last insemination (days)
INTER	Interval between two consecutive inseminations within a lactation (days)
HI	Heat intensity score (1 = weak, 2 = normal, 3 = strong)
NINS	Number of inseminations per service period
NREPT	Number of treatments for reproductive disturbances (abortion, uterine prolapse, retained placenta, metritis, cystic ovaries, other gynaecological disturbances)
CI	Interval between two consecutive calvings (days)
CLA	Interval between calving and first luteal activity (days)

Some of the fertility traits are inter-related as illustrated below:
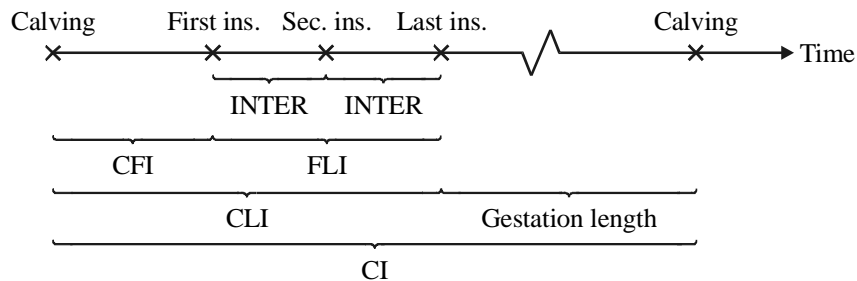
Longevity

PL	Length of productive life (days)
FPL	Fertility-determined length of productive life (days)
MPL	Mastitis-determined length of productive life (days)
PPL	Production-determined length of productive life (days)
LACTPL	Length of productive life defined on a lactation basis (days)