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Advances in Statistical Methods for Genetic Improvement of Livestock

Daniel Gianola · Keith Hammond (Eds.)

# Advances in Statistical Methods for Genetic Improvement of Livestock

With 5 Figures



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## Preface

Developments in statistics and computing and their application to the genetic improvement of livestock have gained momentum during the past 20 years. In particular, best linear unbiased prediction and associated mixed linear model methodology are now considered to be standard procedures for identifying genetically superior animals and estimating genetic trends in breeding programs. Nevertheless, research in this field continues to be very active, to: (1) develop improved statistical and computing strategies, (2) assess robustness to departures from ideal conditions, and (3) obtain maximum economic benefit from information in data sets resulting from recording the performance of animals. Ideally, it would be desirable to integrate these statistical procedures with the designs of the breeding programs.

This volume grew out of an international symposium which took place in Armidale, Australia, February 16-20, 1987. The idea of organizing such a symposium evolved during a visit of Keith Hammond to the University of Illinois in November, 1984. We felt that it was time to review and consolidate the underlying statistical foundations of animal breeding, in the light of sweeping developments in techniques for genetic evaluation taking place in the 1970's and 1980's. We considered it important to include both Bayesian and frequentist approaches.

The 12 main speakers and 7 moderators invited from 6 different countries represented well "the state of the art" as well as areas which merit further research and development.

This 23-chapter volume is organized into seven main sections: I General, II Design of Experiments and Breeding Programs, III Estimation of Genetic Parameters, IV Prediction and Estimation of Genetic Merit, V Prediction and Estimation in Non-Linear Models, VI Selection and Non-Random Mating, and VII Statistics and New Genetic Technology. Each of the sections contains three or four "main" chapters plus a summary written by the corresponding moderator; the summaries reflect the moderator's viewpoint and the main points discussed when the presentations took place. The volume is, therefore, lengthy but complete, and we feel that it "cuts the work" needed in the next 20 years or so.

In editing this book, no attempt was made to unify notation and terminology because it would have been difficult to achieve this objective. We read the original manuscripts as carefully as feasible, and attempted to clarify the message of the authors when this was needed. The authors of individual chapters are responsible for the substance of the contribution, but we are responsible for typographical or grammatical errors remaining. We worked hard to catch obvious mistakes and would very much appreciate it if the readers bring additional ones to our attention, for future correction. No book is entirely free of errors (even after several printings!) and this will probably be no exception.

The book should be useful as a reference source to animal breeders, quantitative geneticists, and statisticians working in these areas. Alternatively, it could be used as a text in graduate courses in animal breeding methodology with prerequisite courses in linear models, statistical inference, and quantitative genetics. Many universities in North America and other countries now offer post-graduate courses in statistical aspects of animal breeding. Several

chapters in this book could be used in such courses to provide excellent supplementary reading; however, intense instructor guidance will be needed because of the depth and difficulty of the material.

The symposium was sponsored by the A.S. Nivison Trust, Australian Association of Animal Breeding and Genetics, Australian Meat and Livestock Research and Development Corporation, Devon Cattle Breeders' Society of Australia Ltd, Holstein-Friesian Association of Australia, Pig Research Council, Reserve Bank of Australia, The Australian Poll Hereford Society Ltd, Mr. Dugald Mactaggart of "Waterloo", Glen Innes and Mr. Jock Nivison, of "Yalgoo", Walcha NSW.

We thank Mrs Coral Rogers for assisting with the Symposium, Ms. Glen Andrews for carrying the brunt of the typing, Mrs Elaine Farrell for much of the proofing, and Mr. Bruce Tier for technical assistance with word processing. We also appreciate additional editorial assistance provided by Drs. R.W. Everett, S. Sivarajasingam, S.P. Smith and R.D. Scarth and Mr. A.A. Swan.

We hope the material in this book will be useful to stimulate further research needed in this area of animal breeding, so vital to scientific animal production.

Daniel Gianola, Urbana  
Keith Hammond, Armidale

September 1989



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**Part I: General**